Parental educational similarity and inequality implications for health in Sweden

Govert Bijwaard[1] Damiano Uccheddu[2]

[1]Netherlands Interdisciplinary Demographic Institute (NIDI)

[2]University of Louvain

EAPS HMM, Luxembourg, September 2025

nidi

Motivation

- Education is a well-established determinant of health (Mackenbach et al., 2016, Snyder-Mackler et al., 2020).
- Higher parental education positively influences health outcomes in offspring (e.g. Balaj et al., 2021).
- Parental education also influences children's cognitive and non-cognitive skills (e.g. Lundborg et al., 2014, 2018, Mönkediek et al., 2023)
- These skills, in turn, can subsequently impact health outcomes

Shortcomings in previous research

1. Predominantly focused on either maternal or paternal education separately (Abufhele et al., 2022, Chevalier and O'Sullivan, 2007, Monden and de Graaf, 2013, Ruiz et al., 2015).
2. Ignoring mediating pathways, direct and indirect mechanisms, with (non-)cognitive skills serving as key (Link et al., 2008, Link and Phelan, 2005).
3. Impact of parental education and (non-)cognitive abilities on health likely differs by health measurement (Koffijberg et al., 2012, Alicandro et al., 2020, Zaidman et al., 2023).

Issues on focussing on the education of only one parent

- Presence of assortative mating (Chiappori et al., 2009)
  Part of the effect attributed to one parent's education may reflect the influence of their partner's education.
- Educational levels may contribute differently to child health outcomes (Huebener, 2019)
- Resource compensation: highly educated parent may offset disadvantages of low-educated parent
- Assortative mating may also exacerbate disparities in child investments (Bratsberg et al., 2023)

Mediating pathways

- Parental education influences child health not only through direct pathways but also through indirect mechanisms.
- Parental educational attainment fosters children's (non-)cognitive skill development (Hoff and Laursen, 2019).

Health is a complex construct

- Certain health conditions require complex treatments that may be more effectively managed by individuals with higher parental education or better (non-)cognitive skills (Zaidman et al., 2023).
- Diseases with simpler or less effective treatments may reduce the influence of these resources on health outcomes (Huebener, 2020).
- Similarly, (non-)cognitive abilities differentially influence health outcomes (Conti et al., 2010)

Our contribution: Impact of Parental educational on health

1. Effect of joint parental education by accounting for both paternal and maternal education (and their interaction)
2. Structural causal mediation analyses to investigate the pathways from parental education, through (non)-cognitive skills on health.
3. Investigating different dimensions of health:
   BMI (Overweight/Obese), height, blood pressure and, strength.

nidi

Swedish Military Conscription Data

Examinations for military service men born 1951-1969: 446,545 individuals with siblings.

- Detailed info on individual demographic and socioeconomic characteristics, including parental age at birth, birth order, parental education, IQ test and psychological assessment
- Health measurements (at military examination):
  - Binary: overweight (BMI $>$ 25), obese (BMI $>$ 30), hypertension
  - Continuous: height (cm), BMI (kg/m^2), systolic/diastolic blood pressure (mmHg), muscle strength (and muscular = strength/weight).
- Parental education :
  operationalized as a continuous variable reflecting the average years of schooling for each (7) educational category.
- mediators IQ and psychological assessment (at military examination): stanine score 1-9

nidi

Health outcomes by parental education

	Paternal			Maternal		
	(1)[a]	(4)[a]	(7)[a]	(1)[a]	(4)[a]	(7)[a]
health						
Overweight	8.54%	6.20%	4.28%	8.13%	6.26%	2.71%
Obese	1.59%	0.83%	0.40%	1.50%	0.72%	0.32%
Hypertension[b]	19.40%	17.38%	17.85%	19.74%	17.30%	19.14%
Height	178.4	179.5	180.8	178.3	179.9	180.7
BMI	21.6	21.3	20.9	21.5	21.4	21.0
Systolic	128.6	128.0	127.7	128.7	127.8	127.9
Diastolic	67.9	67.2	67.2	68.3	66.8	67.2
Strength	2075	2090	2062	2065	2094	2083
Muscular[c]	30.45	30.59	30.26	30.44	30.51	30.53

[a] (1) $<$ 9 years; (4) full secondary education; (7) PhD.
[b] hypertension: systolic blood pressure $\geq$ 140 or diastolic blood pressure $\geq$ 90.
[c] muscular= strength/weight

nidi

Mediators by parental education and outcomes

	Paternal			Maternal		
	(1)[a]	(4)[a]	(7)[a]	(1)[a]	(4)[a]	(7)[a]
mediators						
Av. IQ-rank[b]	4.6	5.8	7.1	4.6	6.0	7.3
Av. Psych-rank[b]	4.8	5.5	6.0	4.8	5.5	6.0
	Overweight	Hypertension	bmi	sys	height	strength
IQ rank 1[b]	9.8	20.3	21.6	128.8	176.4	1944
IQ rank 9[b]	4.4	18.4	21.1	128.2	180.9	2084
Psych-rank 1[b]	7.0	18.3	21.1	128.0	177.2	1908
Psych-rank 9[b]	7.4	19.6	22.0	128.6	180.9	2237

[a] (1) $<$ 9 years; (4) full secondary education; (7) PhD.
[b] stanine score 1-9 running from low to high.

nidi

Methodology

Causal mediation analysis offers a formal framework to uncover causal mechanisms, a set of causal pathways connecting parental education and health.
decomposing the total effect of parental education on health into an indirect effect operating through both mediators (IQ and Psychological assessment) and a direct effect that does not operate through the mediators.

- Counterfactual potential outcome framework
- Structural model with family random effects
- Parental education: father, mother and interaction

nidi

Counterfactual analyses

Use Counterfactual analyses with potential outcomes and potential mediators:

Outcome: $Y(e, m_1, m_2)$

for given parental education (combination) e, m_1 and m_2

Mediator(s) : $M_1(e), M_2(e)$

Sequential ignorability:

$$\begin{aligned} \{Y_i(e', m), M_{1i}(e), M_{2i}(e)\} &\perp \{E_{mi}, E_{pi}\}|X_i = x, U = u_j \\ Y_i(e', m) &\perp M_{1i}(e), M_{2i}(e)|\{E_{mi}, E_{pi}\} = e, X_i = x, U = u_j \end{aligned}$$

for all e, e' that are possible combinations of paternal- E_p and maternal E_m education, for all x and where $\perp$ denotes independence.

nidi

Structural model: parental Education on health

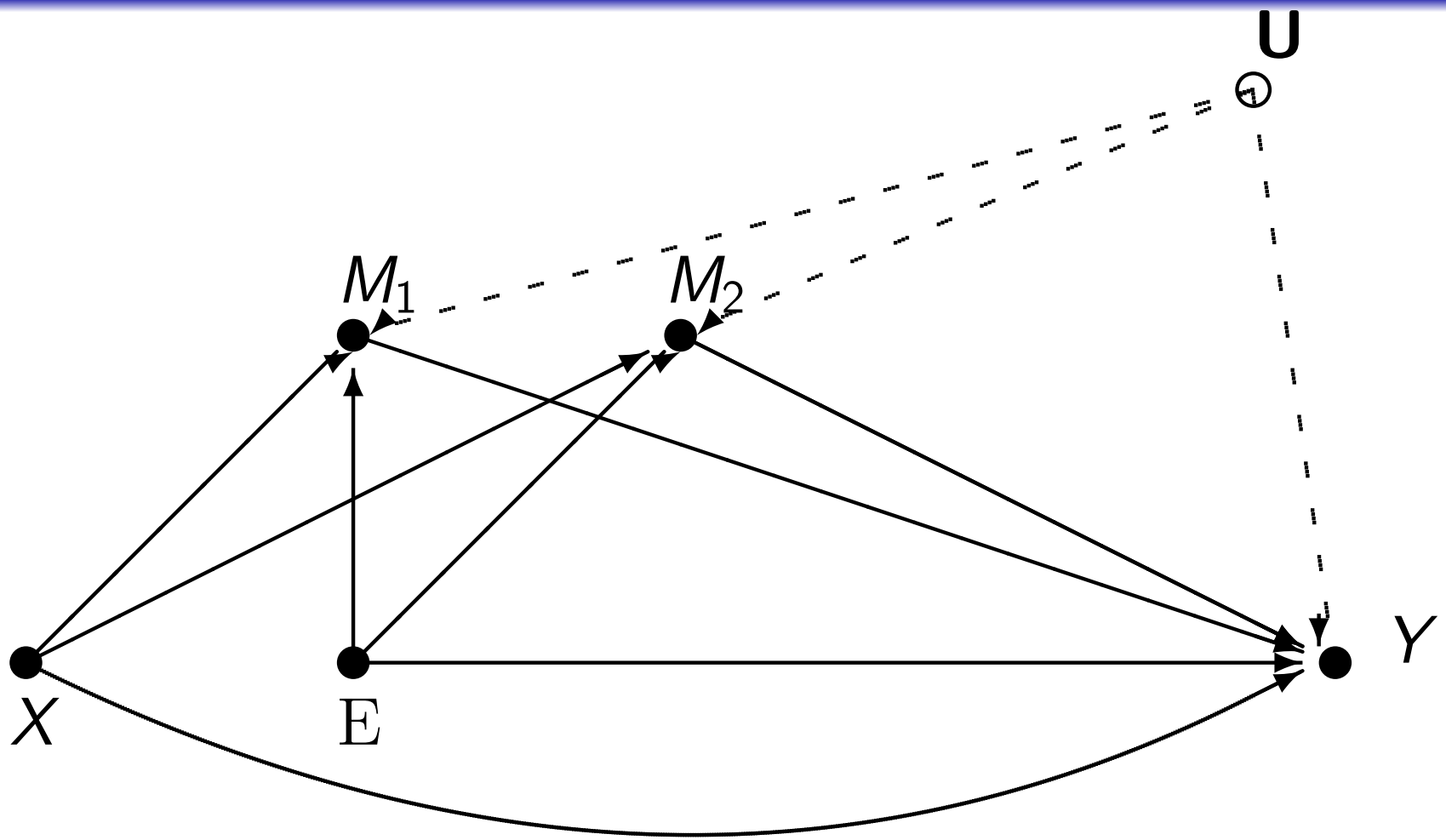


Figure: Directed acyclic graph of impact of parental education, E, on Health, Y, mediated through M_1 (IQ) and M_2 (psychological assessment) conditional on X. Health, M_1 and, M_2 are all affected by (family) random effects U.

Methodology

We use a family panel data model with Mundlak specification (Mundlak, 1978) for each component of the structural model.

$$
\begin{aligned}
Y_{ij} &= \beta_p E_{pj} + \beta_m E_{mj} + \beta_c E_{pj} \cdot E_{mj} + \beta_1 M_{1ij} + \beta_2 M_{2ij} + \beta_x X_{ij} + \\
&\qquad \beta_a (X_{ij} - \bar{X}_j) + \alpha_y U_j \\
M_{1ij} &= \gamma_{1p} E_{pj} + \gamma_{1m} E_{mj} + \gamma_{1c} E_{pj} \cdot E_{mj} + \gamma_{1x} X_{ij} + \\
&\qquad \gamma_{1a} (X_{ij} - \bar{X}_j) + U_j \\
M_{2ij} &= \gamma_{2p} E_{pj} + \gamma_{2m} E_{mj} + \gamma_{2c} E_{pj} \cdot E_{mj} + \gamma_{2x} X_{ij} + \\
&\qquad \gamma_{2a} (X_{ij} - \bar{X}_j) + \alpha_2 U_j
\end{aligned}
$$

NB probit outcome model for binary outcomes.

nidi

Average treatment effect

The average (total) treatment effect when the treatment (paternal education, E_p) changes from e to e' (given maternal education E_m) is

$$\mathrm{ATE}(e, e'|E_m) = \int\int \mathrm{E}\Big[Y_i|M_{1i} = m_1, M_{2i} = m_2, E_p = e, E_m, x, u\Big]$$
$$\times f_{m_1}\big(m_1|E_p = e, E_m, x, u\big) f_{m_2}\big(m_2|E_p = e, E_m, x, u\big)\, dm_1 dm_2 dF_x dF_u$$
$$- \int\int \mathrm{E}\Big[Y_i|M_{1i} = m_1, M_{2i} = m_2, E_p = e', E_m, x, u\Big]$$
$$\times f_{m_1}\big(m_1|E_p = e', E_m, x, u\big) f_{m_2}\big(m_2|E_p = e', E_m, x, u\big)\, dm_1 dm_2 dF_x dF_u$$

where $f_{m_1}(\cdot)$ and $f_{m_2}(\cdot)$ represent the density of the mediators given treatment T, covariates X and random effect u. Similarly for the direct and indirect effects (▸ direct and indirect treatment).

nidi

Using marginal effects

- In principle there are infinitely many treatment effects, for any e and e'.
- Interested in the marginal effect of parental (father or mother) education on health.
- This is the derivative of the treatment effect: marginal effect paternal education, E_p, given maternal education E_m is

$$\frac{d\mathrm{ATE}(e|E_m)}{dE_p} = \lim_{\delta \to 0} \mathrm{ATE}(e, e-\delta|E_m)/\delta$$

nidi

Marginal effect of paternal education on ATE

$$\frac{d\mathrm{ATE}(e|E_m)}{dE_p} = \int\int \frac{d\mathrm{E}\Big[Y_i|M_{1i}=m_1, M_{2i}=m_2, E_p=e, E_m, x, u\Big]}{dE_p}$$
$$\times f_{m_1}\left(m_1|E_p=e, E_m, x, u\right) f_{m_2}\left(m_2|E_p=e, E_m, x, u\right) dm_1 dm_2 dF_x dF_u$$
$$+ \int\int \mathrm{E}\Big[Y_i|M_{1i}=m_1, M_{2i}=m_2, E_p=e, E_m, x, u\Big]$$
$$\times \frac{f_{m_1}\left(m_1|E_p=e, E_m, x, u\right) f_{m_2}\left(m_2|E_p=e, E_m, x, u\right)}{dE_p} dm_1 dm_2 dF_x dF_u$$

where $E_p = e$ refers to paternal education and E_m to maternal education

(▸ marginal effects of direct and indirect treatment).

nidi

Estimated marginal effect of parental education, in %-point

	direct	indirect		total
		IQ	psychological	
overweight				
Mother	−0.1232**	−0.0416**	0.0034**	−0.1613**
Father	−0.2455**	−0.0486**	0.0043**	−0.2898**
obese				
Mother	−0.0315**	−0.0078**	−0.0107**	−0.0500**
Father	−0.0587**	−0.0091**	−0.0135**	−0.0813**
hypertension				
Mother	−0.2358**	−0.0065	−0.0029	−0.2419**
Father	−0.1194**	−0.0076	−0.0036	−0.1307**

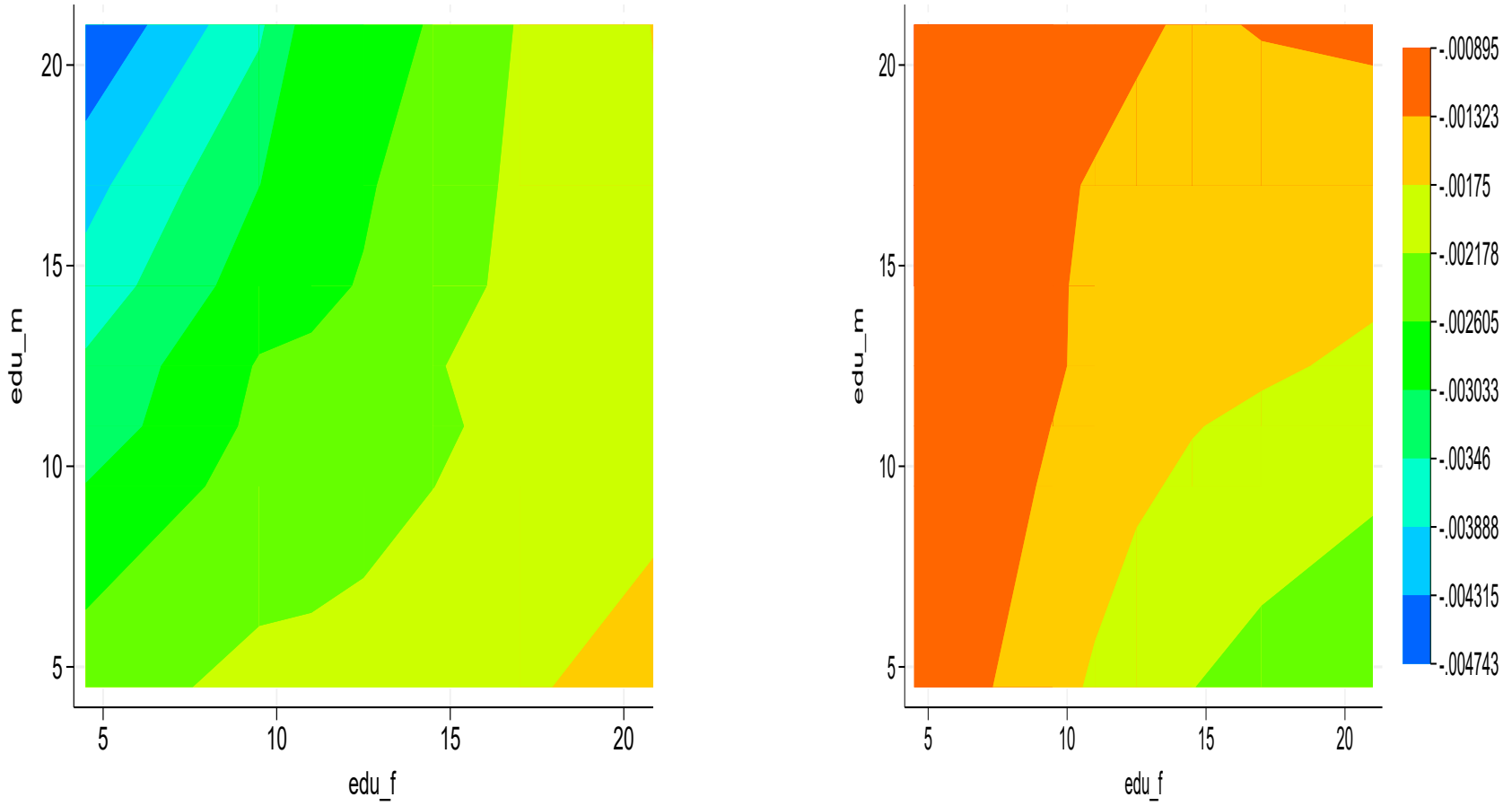
included control variables: birth order, paternal- and maternal age at birth, birth year. $^{**}p < 0.01$.

Estimated marginal effect of parental education (2)

	direct	indirect IQ	indirect psych	total
height				
Mother	0.0365**	−0.0112**	−0.0372**	−0.0118**
Father	0.0388**	−0.0131**	−0.0470**	−0.0212**
bmi				
Mother	−0.0125**	−0.0085**	−0.0086**	−0.0295**
Father	−0.0363**	−0.0099**	−0.0108**	−0.0571**
systolic				
Mother	−0.0927**	−0.0058**	−0.0837**	−0.1822**
Father	−0.0508**	−0.0068**	−0.1057**	−0.1633**
diastolic				
Mother	0.0182**	−0.0040**	−0.0536**	−0.0394**
Father	0.0200**	−0.0046**	−0.0677**	−0.0524**
strength				
Mother	−0.1063**	−0.0034	0.1064**	−0.0033
Father	−1.7963**	−0.0039	0.1343**	−1.6659**
muscular				
Mother	−0.0133**	0.0092**	−0.0079**	−0.0120**
Father	−0.0212**	0.0108**	−0.0099**	−0.0204**

Heatmap: (Total) Marginal effect of parental education on Overweight

Total effect



Father **Mother**

Summary: Impact of Parental educational on health

Higher parental education is associated with better health

- Paternal and maternal education interact in their influence on health of their offspring
- Deeper understanding of the mechanisms, through (non)-cognitive skills, linking parental education to offspring health
- Parental health affect on different health measurements
  Overweight, hypertension, height and, strength.

nidi

Conclusion: Impact of Parental educational on health

Higher parental education is associated with better health

- Health outcomes known for their high preventability exhibit stronger associations with parental education.
  theory of "fundamental causes" of social inequalities in health (Link and Phelan, 1995, Phelan et al., 2010)
- Overweight: Highly educated parent offsets disadvantages of low-educated parent, resource compensation theory (Ross and Mirowsky, 2006).
- Intelligence plays a larger role as an indirect pathway for overweight, whereas psychological assessment plays a larger role in explaining height, blood pressure and strength.

nidi

Discussion

Limitations

- Only men
- Only men with siblings, needed to estimate family random effects
- Swedish sample 1950-1969
- Men with severe mental illness were exempted from the military examination
- Potential mediators (e.g. health literacy or parental investment) not observed

Thank you!

Comments or suggestions?

bijwaard@nidi.nl.

nidi

References I

Abufhele, A., Pesando, L. M., and Castro T., A. F. (2022). Parental educational similarity and inequality implications for infant health in Chile: Evidence from administrative records, 1990–2015. *Research in Social Stratification and Mobility*, 82:100736.

Alicandro, G., Bertuccio, P., Sebastiani, G., La Vecchia, C., and Frova, L. (2020). Parental education and cancer mortality in children, adolescents, and young adults: A case-cohort study within the 2011 Italian census cohort. *Cancer*, 126(21):4753–4760.

Balaj, M., York, H. W., Sripada, K., Besnier, E., Vonen, H. D., Aravkin, A., Friedman, J., Griswold, M., Jensen, M. R., Mohammad, T., et al. (2021). Parental education and inequalities in child mortality: a global systematic review and meta-analysis. *The Lancet*, 398(10300):608–620.

Bratsberg, B., Markussen, S., Raaum, O., Røed, K., and Røgeberg, O. (2023). Trends in assortative mating and offspring outcomes. *The Economic Journal*, 133(651):928–950.

Chevalier, A. and O'Sullivan, V. (2007). Mother's education and birth weight. Discussion Paper 2640, IZA.

Chiappori, P.-A., Iyigun, M., and Weiss, Y. (2009). Investment in schooling and the marriage market. *American Economic Review*, 99(5):1689–1713.

Conti, G., Heckman, J. J., and Urzua, S. (2010). The education-health gradient. *American Economic Review*, 100:234–238.

Hoff, E. and Laursen, B. (2019). Socioeconomic status and parenting. In Bornstein, M. H., editor, *Handbook of Parenting: Biology and Ecology of Parenting*, volume 2, pages 421–447. Routledge/Taylor & Francis Group, New York: USA, 3$^{\mathrm{rd}}$ edition.

Huebener, M. (2019). Life expectancy and parental education. *Social Science & Medicine*, 232:351–365.

Huebener, M. (2020). Parental education and children's health throughout life. In Bradley, S. and Green, C., editors, *The Economics of Education (Second Edition)*, chapter 7, pages 91–102. Academic Press, second edition edition.

nidi

References II

Koffijberg, H., Adami, J., Buskens, E., and Palme, M. (2012). Parental education and adult health outcomes: A cohort study examining disease-specific effects of education levels using Swedish nationwide registries across two generations. *Longitudinal and Life Course Studies*, 3(3):298–311.

Link, B. G. and Phelan, J. C. (1995). Social conditions as fundamental causes of disease. *Journal of Health and Social Behavior*, pages 80–94.

Link, B. G. and Phelan, J. C. (2005). Fundamental sources of health inequalities. In Mechanic, D., Rogut, L., Colby, D., and Knickman, J., editors, *Policy Challenges in Modern Health Care*, chapter 5, pages 71–84. Rutgers University Press, New Brunswick, NJ.

Link, B. G., Phelan, J. C., Miech, R., and Westin, E. L. (2008). The resources that matter: Fundamental social causes of health disparities and the challenge of intelligence. *Journal of Health and Social Behavior*, 49(1):72–91.

Lundborg, P., Nilsson, A., and Rooth, D.-O. (2014). Parental education and offspring outcomes: Evidence from the Swedish compulsory school reform. *American Economic Journal: Applied Economics*, 6(1):253–278.

Lundborg, P., Nordin, M., and Rooth, D. O. (2018). The intergenerational transmission of human capital: The role of skills and health. *Journal of Population Economics*, 31:1035–1065.

Mackenbach, J. P., Kulhánová, I., Artnik, B., Bopp, M., Borrell, C., Clemens, T., Costa, G., Dibben, C., Kalediene, R., Lundberg, O., et al. (2016). Changes in mortality inequalities over two decades: register based study of european countries. *BMJ*, 353:i1752.

Monden, C. W. S. and de Graaf, N. D. (2013). The importance of father's and own education for self-assessed health across Europe: an East–West divide? *Sociology of Health & Illness*, 35(7):977–992.

Mönkediek, B., Diewald, M., and Lang, V. (2023). Does social origin modify the heritability of cognitive ability? a close look at the relevance of different parental resources. *Research in Social Stratification and Mobility*, 86:100824.

Mundlak, Y. (1978). On the pooling of time series and cross section data. *Econometrica*, pages 69–85.

nidi

References III

Phelan, J. C., Link, B. G., and Tehranifar, P. (2010). Social conditions as fundamental causes of health inequalities: Theory, evidence, and policy implications. *Journal of Health and Social Behavior*, 51(1_suppl):S28–S40.

Ross, C. E. and Mirowsky, J. (2006). Sex differences in the effect of education on depression: resource multiplication or resource substitution? *Social Science & Medicine*, 63(5):1400–1413.

Ruiz, M., Goldblatt, P., Morrison, J., Kukla, L., Švancara, J., Riitta-Järvelin, M., Taanila, A., Saurel-Cubizolles, M.-J., Lioret, S., Bakoula, C., et al. (2015). Mother's education and the risk of preterm and small for gestational age birth: a DRIVERS meta-analysis of 12 European cohorts. *Journal Epidemiological Community Health*, 69(9):826–833.

Snyder-Mackler, N., Burger, J. R., Gaydosh, L., Belsky, D. W., Noppert, G. A., Campos, F. A., Bartolomucci, A., Yang, Y. C., Aiello, A. E., O'Rand, A., Harris, K. M., Shively, C. A., Alberts, S. C., and Tung, J. (2020). Social determinants of health and survival in humans and other animals. *Science*, 368(6493):eaax9553.

Zaidman, E. A., Scott, K. M., Hahn, D., Bennett, P., and Caldwell, P. H. (2023). Impact of parental health literacy on the health outcomes of children with chronic disease globally: A systematic review. *Journal of Paediatrics and Child Health*, 59(1):12–31.

nidi

Average direct treatment effect

The average direct effect when the treatment changes from e to e' (given education of other parent) is

$$\theta(e, e'|x) = \int\int \Big\{ \mathrm{E}\Big[Y_i | M_{1i} = m_1, M_{2i} = m_2, E_i = e, x, u \Big] - \mathrm{E}\Big[Y_i | M_{1i} = m_1, M_{2i} = m_2, E_i = e', x, u \Big] \Big\} \times f_{m_1}\big(m_1 | E_i = e, x, u\big) f_{m_2}\big(m_2 | E_i = e, x, u\big)\, dm_1 dm_2 dF_x dF_u$$

Average indirect treatment effect

The average indirect effect of mediator 1 when the treatment changes from e to e' (given education of other parent) is

$$\delta_1(e, e') = \int \int \mathrm{E}\Big[Y_i | M_{1i} = m_1, M_{2i} = m_2, E_i = e, x, u\Big] \times \Big\{ f_{m_1}\big(m_1 | E_i = e, x, u\big) - f_{m_1}\big(m_1 | E_i = e', x, u\big) \Big\} f_{m_2}\big(m_2 | E_i = e, x.u\big)\, dm_1 dm_2 F_x dF_u$$

Similar for mediator 2, back

nidi

Marginal effect of paternal education on direct treatment effect

$$\frac{d\theta(e|E_m)}{dE_p} = \int\int \frac{d\mathrm{E}\Big[Y_i|M_{1i}=m_1, M_{2i}=m_2, E_p=e, E_m, x, u\Big]}{dE_p}$$
$$\times f_{m_1}\left(m_1|E_p=e, E_m, x, u\right) f_{m_2}\left(m_2|E_p=e, E_m, x, u\right) dm_1 dm_2 F_x dF_u$$

where $E_p = e$ refers to paternal education (similar for maternal education).

nidi

Marginal effect of paternal education on indirect treatment effect

mediator 1

$$\frac{d\delta_1(e|E_m)}{dE_p} = \int\int \mathrm{E}\Big[Y_i|M_{1i}=m_1, M_{2i}=m_2, E_p=e, E_m, x, u\Big]$$
$$\times \frac{f_{m_1}\left(m_1|E_p=e, E_m, x, u\right)}{dE_p} f_{m_2}\left(m_2|E_p=e, E_m, x, u\right) dm_1 dm_2 F_x dF_u$$

where $E_p = e$ refers paternal education (similar for maternal education). Similar for the marginal effect of the indirect treatment effect of mediator 2. back

nidi