# Supplemental Online Content

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**eAppendix.** Notes on Education-Mortality Link
**eReferences.**

This supplemental material has been provided by the authors to give readers additional information about their work.

## eAppendix. Notes on Education-Mortality Link

Although there is a steep education gradient in all health outcomes, including mortality, it is unclear how much of this gradient is potentially causal. We searched the peer-reviewed literature to find studies that attempted to isolate the potential causal relationship between an additional year of educational attainment and mortality risk—using econometric techniques such as instrumental variables, regression discontinuity, and natural experiments—and that included enough detail about methods to calculate a relative risk reduction. We used the 7 studies meeting these criteria[1-7] to contribute to an overall estimate of the marginal effect of 1 additional year of education on mortality risk.

Best practice would use the closest analogue possible among published studies for this analysis, which would suggest limiting the studies to those from the US. However, there are only 2 studies from the US that met our inclusion criteria, both of which show large associations between interrupted education and mortality. The association may be due to the relatively poor social safety net in the US, to differences in the data available, to differences in the set of instruments available to identify exogenous variation in education, or to methodological differences in the studies.

The other available studies are heavily weighted toward Scandinavian countries, where extensive records are routinely kept on all residents resulting in extremely large sample sizes. Across the studies we used, over 95% of the combined sample is from Norway and Sweden, yet the mortality-education connection in these 2 countries with robust social protections, strong vocational programs, meaningful income equality and universal health care is unlikely to be a good model for the effects of education on mortality in the US, which has none of these structural supports for those with limited education.

For each study a single effect size estimate was used, in each case the one that appeared to be the most methodologically defensible. Where estimates from a variety of age ranges were available, the estimates for the middle of life were preferred, because theoretical reasons and empirical results suggest that the influence of contextual factors including education on mortality approaches 0 as age advances.[2]

eTable 1 below presents the available effect sizes, and eTable 2 presents several weighted and unweighted averages. These estimates come from highly heterogeneous studies. There are large differences in the time-frames in which the educational change happened, the reasons for the exogenous variation in education, different ages at which mortality was measured, different approaches to methodology, different sets of controls, and different levels of reporting data necessary to compute the relative risk reductions. This is all in addition to the heterogeneity caused by the different social and policy contexts of the years and countries involved.

Cochrane Collaborative guidance advises that when heterogeneity is too great, either statistically or conceptually, a formal meta-analysis is not warranted.[8] Yet the objective of this study requires that an effect-size estimate be obtained from the existing literature. In light of the above considerations, 2 distinct effect sizes were used in the analyses: (1) the weighted average effect size among US studies and (2) the weighted average effect size among non-US studies.

**eTable 1: Effect Sizes**

| Study | Gender[a] | Estimation Type[b] | Country[c] | Sample Size | Estimated RR[d] | SE of Estimated RR[e] | Weight[f] | Source of Effect size |
|---|---|---|---|---|---|---|---|---|
| Lleras-Muney (2005) | All | Linear | US | 4,792 | 0.425 | 0.174 | 1600 | Table 4, Column 4 (p. 210) |
| Mazumder (2008) | All | Linear | US | 4,797 | 0.648 | 0.331 | 1736 | Table 3, Panel A, line 4, column IV (p. 9 original and p. 2 erratum (same value)) |
| Clark and Royer (2013) | All | 2-Stage logistic | UK | n/a[g] | 1.001 | 0.044 | 4162 | Average of Overall column of Panels A and B of Table 3 (p. 2105) |
| Gathmann, Jürges and Reinhold (2015) | Strat | Logistic | Europe | 13,619 | 0.948 | 0.019 | 9849 | Pooled 30-year estimates from Table 5 divided by increase in education in Table 4 (p. 79) |
| Grytten, Skau and Sørensen (2020) | All | Linear | Norway | 451,920 | 0.911 | 0.037 | 33058 | Table 1, line 4, 1st column (p. 4) |
| Meghir, Palme and Simeonova (2018) | Strat | Linear | Sweden | 2,184,857 | 0.990 | 0.043 | 200550 | Table 4: RD/LPM[h], 1st column (p. 249) |
| van Kippersluis, O'Donnell and van Doorslaer (2011) | All | Linear | Netherlands | 66,891 | 0.946 | 0.018 | 12346 | Table 4, bottom panel, linear (p. 708) |
| | | | | | | | | |

a. All: estimates pooled by gender were available; Strat: stratified estimates by gender in original, which were combined in a simple average
b. Linear: linear probability model estimated; Logistic: odds ratios estimated; 2-Stage Logistic: Clark and Royer use a 2-step process in which odds ratios are not directly estimated, but simulated.
c. US: United States; UK: United Kingdom
d. RR: Relative Risk associated with an additional year of education, calculated from original estimates.
e. SE: Standard Error
f. Calculated as the inverse of the variance of the untransformed estimates as reported in the original sources
g. The estimate from Clark and Royer is from a two-stage process in which the relevant odds-ratio was modeled rather than estimated, and no sample size was reported.
h. RD/LPM refers to a regression-discontinuity (RD) model to identify exogenous variation in education in a linear probability model (LPM).

**eTable 2: Average Effect Sizes**

| | Relative Risk | 95% CI |
|---|---|---|
| Weighted average across non-US studies | 0.976 | 0.910 – 1.042 |
| Weighted average across US studies | 0.541 | 0.166 – 0.916 |
| Average of above | 0.758 | 0.566 – 0.950 |

## eReferences


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