Identifying Attributable Risk Factors of Age-Specific Mortality in Older Children, Adolescents and Youth

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Abstract

To date, a considerable breadth of literature has been produced pertaining to the estimation of mortality and its determinants in children below age five. This starkly contrasts with the body of work on mortality in older children and adolescents owing to comparably lower mortality at these ages. Consequentially, this divide has driven greater progress in reducing under-five mortality over recent decades, whilst mortality improvements in children over five have stagnated. These changes have shifted the burden of premature mortality into older age groups including older children and adolescents. In this study, we aim to provide new insights into over-five mortality by levying existing DHS survey data to determine the effects of mortality differentials. Our approach involved reconstructing birth histories across the most recent DHS available for each country, split by age group up to fifteen and censored to an observation window of within 10 years of the interview date. Survivorship was regressed against differentials, accounting for interactions and associated rate ratios calculated within each age group. Preliminary results revealed a decreasing contribution of Socio-Demographic Index (SDI) differentials on mortality as age increases beyond five years. However, this decline is uneven across age groups and differentials with some (e.g. maternal education) remaining significant into older ages whilst the effect of others (e.g. maternal age at birth) is eroded considerably beyond the youngest age groups. Further analysis will aim to understand the interplay between different covariates on mortality at older ages.

Background and Introduction

Currently, some 4.8 million children under the age of five are thought to die globally per annum, mostly from entirely preventable causes. Extending counting of premature deaths to older children, adolescents and young adults (ages 5-24), yields a further 2.1 million deaths [1]. The fewer deaths at older ages owe themselves to lower probabilities of dying in each five-year age-group between 5-24 compared with under-five mortality. This discrepancy helps to explain the greater impetus on estimating and understanding mortality for children under-five when compared with their older counterparts. However, the comparative neglect of older children has not been without consequence. Recent trends in age-specific mortality before the 25th birthday show uneven progress. Under-five mortality witnessed a remarkable 59% decline during the period 1990-2021, whereas mortality among older children, adolescents, and youth aged 5-24 exhibited a modest decline of 34% [2,3]. Under these trends, 14 million children (5-24) are expected to die between 2025-2030, with developing countries shouldering a greater share of annual deaths in these age groups [1,4].

Additionally, adjustment of some mortality estimates, namely the Global Burder of Disease, Injuries and Risk Factors Study (GBD), has revealed a longstanding history of underestimation in older child mortality. This year's release identified mortality was 87.3% higher than previously estimated [4]. Worse still, the same study revealed, mortality gains in adolescents are being reversed for some regions (Andean Latin America, Caribbean, High-Income North America, Eastern Europe) with increases witnessed between 2011 and 2023.

Largely, these stagnations and reversals in mortality gains are driven by avoidable external determinants where disadvantaged groups shoulder the greatest burden. To develop targeted health interventions to mitigate premature mortality, the assessment of social and economic disparities is required. In children under-five clear links have been established between differentials, the interventions they inform and the direct effect on reducing mortality [5]. Comparably, the contribution of these differentials on over-five mortality has not been comprehensively assessed limiting our ability to draw conclusions on the efficacy of similar interventions.

In this study we attempt to disentangle the effects of social, economic and environmental determinants on over-five mortality addressing two main aims:

1. How does the effect of differentials on mortality vary across different age-groups, sexes and countries?
2. Do differentials interact with one another to produce significantly different mortality risks?

Data and Methods

For this analysis we utilised birth and individual recode files from the Demographic and Health Surveys (DHS, www.dhsprogram.com). For each country, only the most recent Standard DHS was selected. In total, 73 countries for which we had data access met the necessary requirements for this analysis.

For each country, the birth and individual recode files were merged and full birth histories calculated for each child which were then split into standard age groups. Records were truncated to contain individuals lived experience up to age fifteen after which data sparsity in the DHS results in a high degree of uncertainty around estimates. A second truncation limited the observation window to within 10 years of the date of interview to account for unseen changes in differential levels.

The differentials selected for this analysis correspond to those previously understood to significantly impact under-five mortality. These included the following SDI variables: maternal education, wealth index, urban/rural residency, maternal age at birth and distance & monetary barriers to health access. Prior knowledge was used to reclassify some of these variables in a binary framework for preliminary analysis and visualisation. The resulting variables were then regressed against mortality using a quasi-poisson model, accounting for survey structure and offset against exposure time.

Preliminary Results

Our preliminary findings explore interactions of bivariate differentials with different age groups and their associated significance. Our findings, as seen in Figure 1 (page 4), indicate that the influence of all differentials on mortality declines with age beyond five years. The effect of almost all differentials was considerably diminished for the oldest age group (10-15 years). However, the degree of contribution varied depending on the variable. The strongest predictor among those studied was maternal education which was significant for 75% of surveys below age five and for 50% of surveys (5-10) and 35% of surveys (10-15). Comparably maternal age at birth was a weak predictor of mortality even at younger ages. Significance was recorded in roughly 33% of surveys for post-neonates and around 13% of surveys for children above age 5. Even when significant, the magnitude of these contributions is considerably lower than other differentials. In part the lower significance of covariates at older ages can be attributed to larger confidence intervals on account of sparser records relative to children under-five.

Next Steps

With general framework constructed across DHS surveys, models can be easily customized for further analysis. There remains scope for further exploration of the interacted relationships between non-bivariate differentials (e.g., maternal education, wealth index and maternal age at birth) and age group, expanding on the results generated in Figure 1. This would require some creativity to synthesise the results and extract trends across multiple differential categories, age-groups and surveys. With this increased granularity we would be able to identify which sub-groups are at increased risk of premature mortality at older ages. This would enable us to determine the precise level at which a differential becomes a protective advantage for older children.

We are also interested in understanding inter-differential effects on older child mortality as current approaches have only studied these effects in isolation. This involves measuring interactions between different differentials for each age group. Analysing these interactions helps isolate the true effects of variables that may be correlated or share causal pathways, revealing whether their influence is independent, synergistic, or confounded. This also allows us to detect effect modification and better understand variation across subgroups. Such interactions can reveal combinations of risk factors that disproportionately elevate mortality risk, guiding targeted interventions.

References

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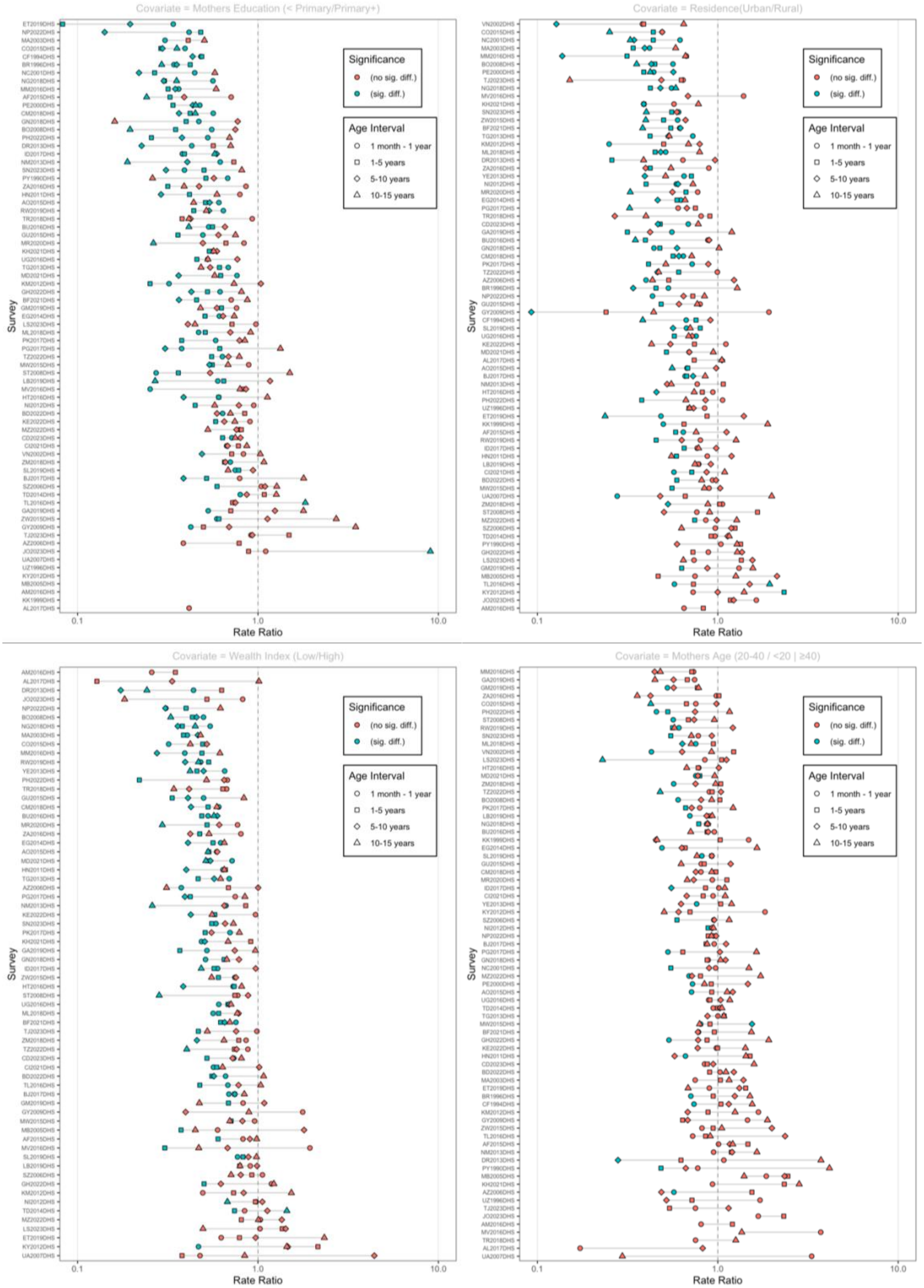

Figure 1: Age Specific Rate Ratios of Mortality from DHS Birth Histories by Differential