Examining Intrafamilial Correlation of Early-life Mortality Risk among Siblings in South Asian Countries

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1. Background

Infant mortality, the loss of children under one year, remains a significant public health challenge in South Asia despite recent improvements in healthcare access and quality. While South Asia, comprising Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka, accounted for a quarter of global live births in 2021, it also had the highest share (62%) of neonatal deaths (children dying before 28 days) relative to under-five mortality globally (UNIGME, 2023). However, the risk of infant mortality often does not affect families uniformly. Prior studies have documented the phenomenon of intrafamilial mortality clustering, where some families experience a higher rate of infant deaths while others face none (Dijk, 2019). Many studies have separately examined mortality clustering in specific South Asian countries, with the majority focused on Bangladesh and India.

2. Theoretical focus and study objectives

The intrafamilial clustering of infant mortality is rooted in various socioeconomic and biological determinants. However, most extant studies have tried to explain mortality clustering using the "scarring effect," where the survival chances of siblings are correlated. The intrafamily mortality clustering and scarring effect have further been demonstrated through three factors. First, surviving siblings may suffer physical or immune system damage after exposure to infectious diseases and death. Second, parents grieving the loss of a child may experience depression, potentially affecting the care and wellbeing of the remaining surviving children. Third, infant deaths are associated with short birth intervals through the maternal depletion hypothesis: interrupted breastfeeding can hasten a mother's return to fertility, and parents might quickly choose to replace the void left by the deceased child. Short birth intervals, however, elevate the risks for both maternal and child mortality by causing maternal depletion, which heightens the chances of pregnancy complications, preterm births, and low birth weight.

Very few studies have collectively examined the determinants and differences in infant mortality risk factors in South Asia. This paper investigates the clustering of infant mortality among siblings in South Asian countries, focusing on critical socioeconomic, demographic, and health-related factors that may explain this pattern. Additionally, we compare the extent of intrafamilial mortality clustering among the South Asian countries by calculating a mortality clustering index. The study contributes to the growing body of literature on intrafamily health transmissions and provides insights for policies to reduce infant mortality.

3. Data

3.1 Data source

To examine the intrafamilial clustering of infant deaths, we utilized the Demographic and Health Survey (DHS) datasets of six South Asian countries publicly available until 2024 (see Table 1).

DHS data from all countries are collected based on a standard framework and can be utilized to assess infant mortality clustering in South Asia collectively. The DHS data offers detailed maternal and child health information, household characteristics, and socioeconomic indicators, making it ideal for examining sibling mortality clustering. We cannot use the data for Bhutan (due to its non-availability) and Sri Lanka (it is not publicly available). All DHS surveys implement a multistage sampling design.

Table 1: Surveys of South Asian countries used for pooling

Code	Country name	Survey rounds
1	Afghanistan	2015
2	Bangladesh	1993-94, 1996-97, 1999-00, 2004, 2007, 2011, 2014, 2017-18, 2022
3	India	1992-93, 1998-99, 2005-06, 2015-16, 2019-21
4	Maldives	2009, 2016-17
5	Nepal	1996, 2001, 2006, 2011, 2016, 2022
6	Pakistan	1990-91, 2006-06, 2012-13, 2017-18

3.2 Study sample construction and selection

This study utilized the information on complete retrospective birth histories (till the interview date) of South Asian women in the reproductive age group (aged 15-49 years). DHS collected information from a single woman from each household; therefore, the mother level is equivalent to the household level. We manually created a pooled dataset of the six South Asian countries. Note that all datasets were harmonized to ensure the study variables had consistent categorization and numerical codes, and cross-country unique identifiers (level-wise) and the pooled survey weight variable were re-constructed (Schmidt & Elkasabi, 2020).

3.3 Study outcome and independent variables

This study's outcome variable is the survival status of the index child during infancy, i.e., from birth to 11 months. We included child-, mother-, household- and community-level covariates of infant mortality in line with the Mosley-Chen framework of child survival (Mosley & Chen, 1984) which are shown below:

Table 2: Brief description of independent variables in study

Variable level	Variable name	Variable categorization
Child	Index child experienced death scarring	No, Yes, First order births
	Preceding birth interval in months	28 and more, 19-27, Less than 19, First order births
	Birth cohort of index child	2010 above, 2000-2009, 1990-1999, 1980-1989, 1979 below
	Birth order of index child	1-2, 3, 4, 5 and more
	Gender of index child	Female, Male
	Season during birth of index child	Summer/pre-monsoon, Monsoon, Winter/post-monsoon
Mother	Mother's age during childbirth in years	Less than 20, 20-24, 25-29, 30 and more
	Mother's level of education	Secondary or higher, Upto Primary, No formal schooling
Household	Gender of household head	Female, Male
	Household wealth quintile	Richest, Richer, Middle, Poorer, Poorest
	Social status	Minority group, Majority group
Community	Place of residence	Urban, Rural
	Community education standard	High, Medium, Low
	Community wealth standard	High, Medium, Low
	Country	Afghanistan, Bangladesh, India, Maldives, Nepal, Pakistan

4. Research methods

4.1 Descriptive characteristics and bivariate analysis

To comprehend South Asia and its constituent countries, we examined their demographic characteristics (the population size and share during 2021, the average annual infant mortality rate (IMR) and the total fertility rate (TFR) in 30 years preceding the surveys) and economic characteristic (Gross national income (GNI) per capita in 2021). The population size and GNI per capita information were obtained from the World Bank Databank (World Bank Group, 2023). Next, we examined the distribution of births and the mean survival duration during infancy, corresponding to the explanatory variables in South Asia. Owing to censored observations in infant mortality data, log-rank tests were performed to examine the bivariate association between the infant mortality risk and the independent variables. Additionally, as a crude measure of excess infant deaths, we examine the mothers' distribution by their parity and infant deaths in South Asia and country-wise, respectively.

4.2 Regression model selection and infant mortality heterogeneity

We estimated parametric survival regression models with shared frailty at the family level to examine the adjusted association of independent variables with infant mortality. Parametric survival regression models allow us to choose the underlying distribution of time-to-infant mortality. We chose among prominent parametric survival models (Exponential, Weibull, Gompertz, Lognormal and Loglogistic) and used the model with the lowest AIC/BIC scores and proper theoretical justification. The survival models with family-level frailty assume that the infant death risk among children born to the same family is correlated due to unmeasured family-related characteristics (Cleves et al., 2013). We estimate the Median Hazard Ratio (MHR), which gives the median relative change in the hazard of infant mortality among identical children from two randomly selected mothers who are ordered by mortality risk (Austin et al., 2017). The MHR is always greater than or equal to one such that the higher the value, the more heterogeneity in the infant mortality risk across mothers (Paul et al., 2021; Paul & Rashmi, 2022). The multivariable association between the explanatory variables and infant mortality risk was shown using hazard ratios (HR).

4.3 Intrafamily mortality clustering index and cross-country comparison

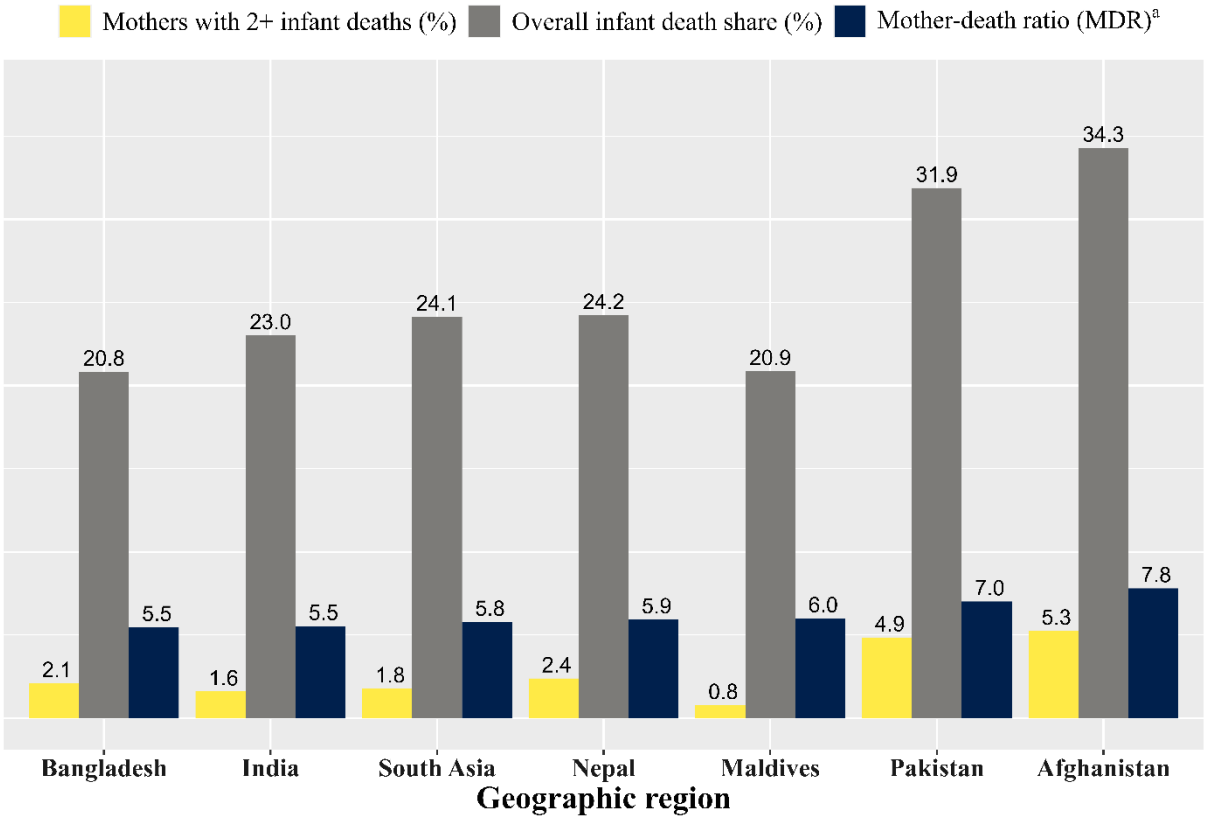
Imperatively, cross-country comparison of infant death heterogeneity parameters (HR and MHR) may be misleading even though the country-specific regression models may adjust for the same covariates. However, in the DHS datasets used for analysis, the mothers across countries may have different reproductive life courses, unequal exposure duration to infant mortality risk and number of child deaths. Therefore, as a solution to the cross-country comparison problem, we calculate the infant mortality clustering index (IMCI) based on extant research (McMurray, 1997). All mothers with IMCI greater than one and having at least two or more infant deaths were classified as high-risk mothers (those who experienced excess infant deaths) (McMurray, 1997). To undertake cross-country comparisons, we calculated the percentage of mothers who experienced excess infant deaths per country.

5. Expected findings

Based on our preliminary analysis (see Figure 1), we anticipate finding significant intrafamilial clustering of infant mortality in South Asia, with certain families facing disproportionately high mortality risks. We also expect differences in intrafamilial mortality clustering among South

Asian countries, reflecting the variability in healthcare systems and socio-cultural factors across South Asia. The intrafamilial mortality clustering is likely to correlate with the phenomenon of death scarring, where the survival chances of the previous sibling are associated with the survival chances of the current sibling. Additionally, we expect to find that children born with a lower birth interval had lower survival chances during infancy, which, together with death scarring, would be attributed to the maternal depletion hypothesis. Further, socioeconomic disadvantage and lower maternal education levels would be correlated with infant mortality. The findings likely highlight the need for targeted health interventions focusing on high-risk families to break the cycle of health disadvantage passed across generations.

Figure 1: Country-wise distribution of mothers with 2 and more infant deaths and their death share



Note: (a) MDR is the ratio of mothers with 2+ infant deaths and their overall death share

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