Understanding the Daughter-Only Families Deficit in South Asia: A Measure of Prenatal Discrimination Behaviors Using Fertility Tables

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Introduction

South Asia is currently marked by a decline in fertility. Despite the original framework that considers declining fertility as a demographic pressure that favors prenatal sex selection (Guilmoto, 2009), one of its consequences has been an increase in same-sex siblings, and consequently, in daughter-only families (Allendorf, 2020). Assuming a total fertility rate of two children per woman (and in the absence of prenatal sex discrimination), the theoretical probability of a woman having only daughters is approximately 25%. However, several countries with strong son preference, demonstrate an imbalance, with an under-representation of daughter-only families (Pandian & Allendorf, 2022), representing effects of prenatal discrimination, i.e., the combined influence of the male-preferring stopping rule of childbearing and the use of prenatal sex selection. Nevertheless, the decline in fertility to about two or less children per woman increases the likelihood that some families will remain with only daughters. This exerts pressure on families with a strong preference for sons, and could therefore challenge patrilineal society (Allendorf, 2020; Pandian & Allendorf, 2022).

With regard to fertility strategies, families can adopt two practices for having the desired number of sons: (1) the male-preferring stopping rule of childbearing (or gendered preferential fertility), i.e. that families will continue childbearing until they reached the desired number of sons (Basu and De Jong 2010; Yamaguchi 1989) and (2) prenatal sex selection, mainly through sex-selective abortions (Guilmoto 2009). Pandian and Allendorf (2022) primarily emphasize the daughter-only families' deficit. Using counterfactual distribution methods, they illustrate the gap between observed and theoretical proportions of families without sons. However, their approach does not represent the respective contributions of prenatal sex selection and the preferential stopping rule. The present work seeks to estimate these respective contributions to the observed deficit of daughter-only families within specific populations. To do so, I employ parity-specific fertility tables to capture family behavior based on both the number of children and sibling's gender composition. Following the logic of cause-specific and cause-deleted life tables, I construct "son preference behaviors-deleted" fertility tables to measure the gain in daughter-only proportion that a population could have when certain fertility strategies linked to son preference are deleted. A fictive population is then calculated under various scenarios to quantify the relative impact of both the preferential stopping rule and prenatal sex selection behaviors on the sibling compositions' distribution. This method is applied to India, Nepal, Bangladesh and Pakistan, i.e., countries exhibiting different expressions of son preference, to identify the distinct forms and intensity of prenatal discriminations

Data

Calculations are based on Demographic Health Survey (DHS) data on India, Bangladesh, Nepal, and Pakistan. Additionally, the Indian analysis is conducted across different regions, i.e., in Kerala, Punjab/Haryana/Rajasthan. DHS surveys are nationally representative surveys, where respondents are women in reproductive age, i.e., 15-49 years old, and answer questions on reproductive health topics. DHS surveys provide therefore the birth history of each women surveyed, allowing the reconstruction of every birth's order and gender composition of sibling at the time of the birth.

The value of comparing these countries/regions lies in the application of the proposed methodology application to populations that experience different forms of son preference. Thus, we compare populations:

- Where families use both prenatal sex selection and the stopping rule of childbearing (India – including Punjab/Haryana/Rajasthan, and Nepal)
- Where families resort solely to the stopping rule of childbearing (Bangladesh, Pakistan)
- Where families do not resort to prenatal discrimination practices, and have no gender preference (Kerala)

Methods

I use fertility tables by parity, which are part of the multistate population model – also called increment-decrement life tables – reflecting population's evolution toward different state (Palloni 2001, Schoen 2016). The particular aspect of parity fertility table is their hierarchical transition, i.e., that individuals can only transit from parity 0 to parity 1, from parity 1 to parity 2, etc. (Schoen 2016). Calculations of parity fertility tables are based on children's birth order and siblings' gender composition at the time of the birth.

The siblings' gender distribution is influenced by two key factors: the male preferring stopping rule of childbearing and the prenatal sex selection. However, the measurement of prenatal sex selection in DHS surveys is subject to considerable variability, primarily due to the sex ratio at birth estimation (because of sample size and its impact on confidence interval). To ascertain the respective contributions of prenatal sex selection and the stopping rule of childbearing, a fictive population evolution is conducted under a series of assumptions. These scenarios are based on the same principle as cause-deleted life tables and cause-of-death life tables. In mortality analysis, the primary objective of cause-specific life tables and cause-of-death life tables is to assess the impact of a specific cause of mortality on a given population (Meslé 2002). These methods estimate therefore gains in life expectancy that a population could have when a certain cause of death is deleted. In this analysis, individuals will evolve under different scenarios in order to quantify the respective contributions of the stopping rule of childbearing and prenatal sex selection. The following scenarios are posited:

- (1) Only stopping rule of childbearing: individuals evolve based on observed parity transition probabilities (differentiated by siblings gender composition). However, children's gender at birth follows a natural sex ratio at birth (i.e., 105 male births for 100 female births), and therefore delete the prenatal sex selection's impact on births' gender distribution.
- (2) No son preference: Families evolve based on the population's parity transition probabilities (without considering siblings' gender composition), with a natural sex ratio at birth.

Therefore, scenario (1) aims to illustrate the gain in daughter-only families' proportion that a population could have if prenatal sex selection is deleted, and scenario (2) aim to verify if results are consistent with a theoretical distribution (see robustness analysis section).

Robustness analysis

To verify the robustness of the model, a "no son preference" scenario is applied. In this scenario, families do not demonstrate any behaviors associated with gender preference. Consequently, the sex ratio at birth is hypothetical, and the parity transition probabilities align with the studied population (i.e., without consideration of siblings' gender composition). This scenario aims to verify whether our assumption in which families exhibit no preference for family gender composition corresponds to a theoretical distribution. I calculate theoretical distributions of siblings' composition using counterfactual scenarios, following Pandian and Allendorf (2022) method. These theoretical distributions represent the proportion of siblings that a population could have in the absence of son preference (i.e., without the practice of the preferring stopping rule and prenatal sex selection).

Preliminary results

Firstly, our results show that the 'no son preference' scenario produces proportions that are similar to the theoretical, validating the robustness of our results regarding siblings' distribution when son preference causes are deleted. Secondly, the 'only stopping rule' scenario represents the distribution of families in a population under the assumption that individuals do not resort to prenatal sex selection, meaning that births have a natural sex ratio. By subtracting the observed proportion, which may be affected by the stopping rule and prenatal sex selection, from the 'only stopping rule' scenario, we can quantify the missing daughter-only families due to prenatal sex selection.

The missing daughter-only families' proportion due to prenatal sex selection varies between populations. India has the highest deficit due to prenatal sex selection. At the national level this deficit represents 2.9% of daughter-only families missing due to prenatal sex selection, reaching 3.5% in Punjab/Haryana/Rajasthan. In contrast, Kerala's population best corresponds to a theoretical distribution, with no effect of prenatal sex selection. Additionally, Kerala's daughter-only families observed proportion is similar to the theoretical distribution, both in the no son preference scenario, and the counterfactual framework, demonstrating the absence of gender preference in this population. Nepal has a deficit linked to prenatal sex selection similar to the Indian's level (2.7%). Finally, Bangladesh and Pakistan, countries mainly affected by the male-preferring stopping rule of childbearing, are the population that makes the least use of prenatal sex selection (with the exception of Kerala), with a deficit equivalent to 0.8% and 0.7% respectively.

First conclusions and perspective

To the best of my knowledge, this work proposes, for the first time (1) a novel methodological framework that can measure respective contributions of prenatal sex selection and the male-preferring stopping rule of childbearing, and (2) first recent evidence from South Asia on the effect that these prenatal discriminations have in the daughter-only families' deficit. Subsequent research will aim to utilize this method to map the male-preferring stopping rule of childbearing and the prenatal sex selection in India. The choice of India as a case study is justified by its geographical, anthropological, and social diversity with regard to son preference.

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Country/Region	Family type	Observed proportion	Proportion - sex selective abortions deleted	Proportion - son preference deleted	Theoretical proportion	Deficit due to PSS	Deficit due to stopping rule	Total deficit
India (2019-21)	Daughter-only	0.1160	0.1451	0.1885	0.1885	-0.0291	-0.0434	-0.0725
	Son-only	0.2504	0.2410	0.2076	0.2077	0.0094	0.0333	0.0427
	Mixed siblings	0.6337	0.6139	0.6039	0.6039	0.0197	0.0101	0.0298
Kerala (2019-21)	Daughter-only	0.2325	0.2320	0.2329	0.2329	0.0006	-0.0010	-0.0004
	Son-only	0.2603	0.2610	0.2550	0.2550	-0.0006	0.0060	0.0053
	Mixed siblings	0.5071	0.5071	0.5121	0.5121	0.0001	-0.0050	-0.0049
Punjab Haryana Rajasthan (2019-21)	Daughter-only	0.0608	0.0962	0.1822	0.1822	-0.0354	-0.0860	-0.1214
	Son-only	0.2616	0.2465	0.2013	0.2014	0.0151	0.0451	0.0602
	Mixed siblings	0.6776	0.6574	0.6165	0.6164	0.0202	0.0409	0.0612
Nepal (2022)	Daughter-only	0.1148	0.1413	0.1953	0.1953	-0.0265	-0.0540	-0.0805
	Son-only	0.2605	0.2529	0.2144	0.2144	0.0076	0.0385	0.0461
	Mixed siblings	0.6247	0.6058	0.5903	0.5903	0.0189	0.0155	0.0345
Bangladesh (2022)	Daughter-only	0.1412	0.1481	0.1719	0.1719	-0.0069	-0.0238	-0.0307
	Son-only	0.1995	0.2018	0.1905	0.1905	-0.0023	0.0113	0.0089
	Mixed siblings	0.6593	0.6501	0.6376	0.6376	0.0092	0.0125	0.0218
Pakistan (2017-18)	Daughter-only	0.0468	0.0546	0.0718	0.0718	-0.0077	-0.0173	-0.0250
	Son-only	0.0975	0.1010	0.0819	0.0819	-0.0035	0.0190	0.0155
	Mixed siblings	0.8557	0.8445	0.8464	0.8462	0.0112	-0.0018	0.0095

Table 1 - Families distribution by type of siblings and scenarios, in different countries (rounded values)