Ganguly *et al. Genus* (2022) 78:29
https://doi.org/10.1186/s41118-022-00177-3

Genus

ORIGINAL ARTICLE Open Access

Explaining the diminishing of Muslim advantage in child survival in India

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Abstract

Religion is one of the key instrumental social institutions in determining child health and mortality. Muslim advantage in child survival in India has been widely reported. Recent India's National Family Health Survey (NFHS) shows that the gap between Hindu–Muslim childhood mortality rates is shrinking—reversing decades of child survival advantage for Muslims. This study examines the factors linked to the diminishing of Muslim advantage in childhood survival and attempts to uncover the mechanisms accounting for the convergence using the characteristics hypothesis of Goldscheider (Population, modernization, and social structure Little, Brown & Co; 1971) and the analytical framework of Guillot and Allendorf (Genus 66(2), 2010). We have analyzed a pooled sample of 23,47,245 all live births and 428,541 of last live births from four rounds of NFHS (1992–2016). Kaplan–Meier survival plots over time by religion confirm convergence in Hindu–Muslim child survival probabilities. The Pyatt decomposition model reveals that the gap in Hindu–Muslim childhood mortality is diminishing due to a decline in within-Hindu inequality. Cox proportional hazard regression model shows that improvement in household and maternal socioeconomic factors has contributed to Hindu children catching up with Muslims—leading to a convergence in Hindu–Muslim childhood survival probabilities. Conditional β-convergence regression model also suggests the convergence in socio-economic status and maternal health care is driving the convergence in child survival of Hindus and Muslims across Indian states.

Keywords: Religion, Characteristics hypothesis, Childhood mortality, Socio-demography, Maternal health care, India

Introduction

Under-five mortality rate ([U5MR] under-five children deaths per 1000 live births), i.e., the probability of dying before the age of 5 years is a critical global indicator of child health and overall well-being (UN IAEG, 2016; UNICEF, 2016,). Globally, U5MR has declined by 60% from 93 per 1000 live births in 1990 to 38 per 1000 live births in 2019 (UN IGME, 2020). India currently accounts for almost a third of global under-five deaths. The U5MR in 2019 was also higher in India (34 per 1000 births) relative to other South Asian countries, such as Nepal (31 per 1000 births), Bangladesh (31 per 1000 births), Bhutan (30 per 1000), and Sri Lanka (7 per 1000) (UN IGME, 2020). However, within India, there has been a considerable decline in U5MR during the last two decades across

the regions and socio-economic groups (Dandona et al., 2020; IIPS & ORC Macro, 1995; IIPS & ICF, 2017; Ram et al., 2013).

Notably over the last few decades, despite being disadvantaged socially and economically (e.g., education and wealth wise), Muslim[1] children have experienced lower child mortality rates relative to Hindus. This paradox is attributed to socio-economic, religion-specific cultural factors, in particular to better sanitation practices, and greater urban residence (Bhalotra & Soest, 2008; Bhalotra et al., 2010; Bhat & Zavier, 2005; Brainerd & Menon, 2015; Geruso & Spears, 2014; Guillot & Allendorf, 2010; Shariff, 1995). However, the results from successive rounds of the National Family Health Survey (NFHS) reports show that U5MR among both Hindus and Muslims have not only declined, but also present a clear picture of a noticeable trend toward Hindu–Muslim convergence in child survival (IIPS & ORC Macro, 1995; IIPS & ICF, 2017). Given this background, our study seeks to address three questions: (1) is there any systematic evidence of Hindus catching up with Muslims; in other words, is there any reversal of the Muslim advantage in child survival? (2) Is this process uniform across all Indian states? (3) What are the mechanisms and factors that may be linked to the diminishing Muslim advantage in child survival?

Our study makes significant contributions to the existing literature. Ours is the first study to identify and report a reversal in Muslim advantage in child survival and identify factors that are contributing to Hindu–Muslim convergence in child survival probabilities, using an innovative and robust empirical approach while carrying out classical survival analyses. From a methodological perspective, following the *characteristics hypothesis* (Goldscheider, 1971; Goldscheider & Mosher, 1988) and the analytical framework of Guillot & Allendorf (2010), we observe changes in percentage differences in socioeconomic and demographic characteristics over the study period for Hindu and Muslim separately, identifying characteristics that can be qualified as "advantages" or "disadvantages" for Muslim or Hindu children shaping their survival chances. Each socio-demographic characteristic is qualified as "advantages" or "disadvantages" for Muslim or Hindu children based on a two-step approach: first, we examined who are in an advantageous position in a particular characteristic in the base year based on the variable's relationship with U5MR. Second, we calculated the percentage difference in terms of change in that variable across Hindus and Muslims over the period. If the socio-demographic characteristic is negatively associated with U5MR (i.e., positive change in this variable reduces childhood mortality), and if it is improved more in Hindus than Muslims, this particular variable is qualified as a Hindu advantage for this study. Previously, Guillot & Allendorf (2010) used the same analytical framework for identifying factors linked to the paradox of Muslim advantage in child survival in India. We have further elaborated on this analytical framework in the methodology section.

With the above said analytical framework, our goal is to clarify which variables may provide Hindus with an advantage and potentially explain the Hindu–Muslim child mortality convergence, and which variables may operate in the other direction. Using Cox

[1] India's population is religiously diverse. According to the latest available Census of India (2011), Muslims are the second largest religious group representing 13.4% of the total population (after Hindus 80.5%). In India, with the exception of child survival, Muslims have traditionally been disadvantaged in almost all dimensions of development relative to Hindus (Sachar et al., 2006).

proportional hazard regression models, we have treated the effect of religion on child survival by controlling for factors favouring Hindus and Muslims separately. By doing so, the basic idea is that after treating for Hindu advantage factors, we would expect the relative risk of child mortality to increase for Hindu children compared to their Muslim counterparts, thereby increase in Hindu–Muslim child mortality gaps. Similarly, when we are treating for Muslim advantage factors, we would expect that the relative advantage of child survival for Muslims will decrease, thereby decrease in Hindu–Muslim child mortality gaps. This analytical mechanism allows us to identify transitions in key socio-demographic factors that have improved Hindu child survival probability, facilitated a Hindu catch-up with child survival rates of Muslims. We used multiple robustness checks (viz. Absolute and Conditional Barro regressions and kernel density plots) to verify our main findings. Our study shows that Hindu–Muslim child survival gaps narrowed due to a greater decline within Hindu socio-economic inequalities in child survival rates as a result of enhanced progress in socio-economic status and maternal and child health care.

Background

A large international literature has examined the association between religious affiliation and child survival probabilities. One set of research has contended that the religious differentials in child mortality can partly be explained by differences in socio-economic and demographic characteristics, also called the *characteristics hypothesis*. Recent studies on Latin America by Wood et al. (2007) and Verona et al. (2010) have found that socio-economic factors such as education, household income, and access to sanitation facilities are associated with low child mortality among Protestants relative to the socio-economically disadvantaged Catholics. Other studies from Africa have found that religious differences in household living standards, parental education, and accessibility to health care services lowered the risk of child mortality among Catholic and Protestant members relative to other denominations (Antai et al., 2009; Gyimah, 2007; Gyimah et al., 2006; United Nations, 1985; Verona et al., 2010).

Another strand of literature has found that religious differentials in childhood survival may be due to differences in lifestyle and religious observance among different religious groups—termed as the *particularised theology hypothesis*. This body of research has empirically established that religious differences in child mortality remain after controlling for socio-economic variables across the groups (Goldscheider, 1971; Goldscheider & Mosher, 1988). For instance, during the nineteenth and early twentieth century, Jewish children in the United States and Europe had better health outcomes than Christians, independent of their socioeconomic and demographic characteristics (Condran & Kramarow, 1991; Derosas, 2000; Preston et al., 1994; Valle et al., 2009). Several studies based on West Africa reveal that the religion Islam and its associated belief system and family formation has a strong influence on access to health care services. Lack of access to these resources leads to a higher risk for mortality in Islam children than in their Christian counterparts, particularly in Nigeria, where they account for a majority of the population (Antai et al., 2009; Caldwell, 1990; Cau et al., 2013). However, these two hypotheses are not mutually exclusive and simultaneously play a crucial role in religious differentials in child health in general and survival chances in particular.

Furthermore, another line of research has explored the *minority isolation hypothesis*—the effect of isolation of minorities which potentially reduces their exposure to contagious diseases and related child mortality (Anderson et al., 1992; Poppelet al., 2002). However, compared to this hypothesis, the *characteristics hypothesis* and *particularised theology hypothesis* have widely been investigated in contemporary scholarly research in social demography and social epidemiology. In particular, in this study, we used the *characteristics hypothesis* that change in the set of advantageous and disadvantageous factors over time shaping the child survival probabilities in Hindu and Muslim religion populations in India. In particular, we hypothesize that socio-economic heterogeneity within Hindus has declined which contributed to closing the gap in Hindu–Muslim child mortality rates.

Muslim advantage in child survival in India

More than a quarter-century ago, Caldwell (1986) alluded to the higher burden of infant and child mortality in developing countries with high Muslim populations. These issues have since been widely discussed among demographers (Akseer et al., 2018; Caldwell & Caldwell, 1993). However, these studies did not claim that *characteristics* are inherent, particularly to the Islam religion but rather highlighted their practices given the cultural context of those countries. Nevertheless, Caldwell's study failed to address the heterogeneous relationship between child mortality and religion in different geographical contexts (Faour, 1989; Ghuman, 2003; Jejeebhoy & Sathar, 2001; Youssef, 1978; Weeks, 1988).

Previous research has also examined the persistent puzzle of Muslim advantage in child survival from various other dimensions (role of socioeconomic and cultural beliefs) for decades (Bhalotra et al., 2010; Basu et al., 2007; Borooah et al., 2010; Bhat & Zavier, 2005; Guillot & Allendorf, 2010, Geruso & Spears, 2014; Shariff, 1995). For instance, Bhat and Zavier (2005) have attributed the Muslim advantage in child survival to their higher levels of urbanization relative to Hindus (with greater access to health care facilities), and the practice of son preference among Hindus. Geruso and Spears (2014) have attributed the Muslim advantage to sanitation externalities and a healthy living environment among Muslims relative to Hindus.

Bhalotra et al. (2010) analyzed an extensive range of socioeconomic, demographic, and health indicators, but were unable to explain the Muslim advantage in child mortality. Unobserved historical, cultural, and biological factors may play a critical role in Muslim advantage in child survival, which cannot solely be associated with religious values and beliefs but is rather related to community-specific practices within a religion. A substantial body of research has argued that this paradox may be explained by religion-based cultural factors. These include lower son preference, closer kinship ties, healthier diets, better hygiene, and child care practices among Muslims than Hindus (Bhat & Zavier, 2005; Bhalotra et al., 2010; Brainerd & Menon, 2015; Guillot & Allendorf, 2010).

Basu et al. (2007) attribute the unusual Muslim advantage in child survival in India to the greater social isolation of the Muslim minorities, termed the *minority group status* hypothesis. Summing up, the previous researchers have explained the reasons for better child survival among the underprivileged Muslim minority in India. However, the evidence on changing nature of the relationship between 'religion and child mortality (i.e.,

emerging Hindu–Muslim convergence in child survival) amid the change in socio-economic and demographic characteristics associated with it, is missing from the existing literature. Using the *characteristics hypothesis*, we systematically examine the changes in socio-economic and demographic characteristics of the child population in Hindus and Muslims to identify "advantageous" and "disadvantageous" characteristics that are shaping the emerging Hindu–Muslim convergence in child survival. Our study seeks to fill this critical gap in the literature, analyzing data from 1992 to 2016.

Data

The data for our analyses come from four rounds of the National Family Health Survey, conducted in 1992–1993 (NFHS 1), 1998–99 (NFHS 2), 2005–06 (NFHS 3), and 2015–2016 (NFHS 4) (IIPS & ORC Macro, 1995, 2000; IIPS & Macro International, 2007; IIPS & ICF, 2017). The NFHS is a nationally representative cross-sectional sample survey of randomly selected households with systematic sampling which gives information on each state and union territory. The NFHS data are the only available Indian data set that contains detailed unit-level information on under-five mortality, full birth histories of children collected from women, and also information on the socio-economic and demographic characteristics of the respondents and their households. The response rate for the households interviewed in all four rounds of the survey ranges from 96 to 98%, and for the Women's questionnaire, it varies between 95 and 97%.

We use data from the full birth histories of 295,366 children collected from 89,777 ever-married women (13–49 years) for NFHS 1; 291,065 samples from 89,199 ever-married women (15–49 years) for NFHS 2; 289,813 samples from 124,385 eligible women (15–49 years) for NFHS 3; 1,488,548 samples from 699,686 eligible women (15–49 years) for NFHS 4. After discounting for missing cases in some variables, the net pooled sample for the final analyses was 23,47,245 live births. Besides, this study used sample of 428,541 last births in the preceding 5 years of each of the four surveys (1992–1993: 60,625; 1998–1999: 56,734; 2005–2006: 51,555; 2015–2016: 259,627) for estimating childhood mortality rates and their correlates. We use denormalized women's sample weights [dweight = women weight × (ever-married women population/ever-married women sample)] in each round of the survey to make estimates nationally and over-time representative.

Variables

Dependent variable

The main dependent variable is constructed using self-reported responses from ever-married women. In NFHS, women were asked if they have had a live child in the last 5 years and if that birth dies during these 5 years. The dummy variable takes on a value of 1 if a child was born alive and died Under-5 years of age, 0 otherwise. Across all four rounds, there were 54,853 Under-five deaths representing 12.8% of the total sample (Table 2).

We have estimated childhood mortality rates across states for Hindus and Muslims over the period 1992–1993 to 2015–2016 using the procedure of synthetic cohort probability of dying over the 5 years preceding the month of the interview. Furthermore, to implement this approach, we used the '*syncmrates*' program in STATA 14.0. The DHS

program also employs 5-year birth history for the construction of synthetic cohorts (Masset, 2016; Rutstein & Rojas, 2003).

Explanatory variables

To study Hindu–Muslim differentials in child mortality, we categorized religions into three: Hindus, Muslims, and Others.[2] The main analysis includes 21 socio-economic and demographic variables as explanatory variables, and among these 11 variables either remained or turned in favor of Hindus, while 10 variables favored Muslims. As said earlier, this analytical framework is borrowed from *the characteristics hypothesis* of Goldscheider (1971) and the empirical approach of Guillot and Allendorf (2010). Moreover, a detailed methodology for the identification of "advantageous" and "disadvantageous" characteristics for each of the religious groups is given in the next section, and also see Appendix Table 6. Hindu advantage variables are child sex, birth order, education and mass media exposure of the respondent, child sex preference, age and education of the household head, wealth quintile, household size, years lived in the place of residence, and Hindu advantage states in U5MR. Muslim advantage factors include birth interval, age at marriage (the age when the respondent started to cohabit with her husband/gauna performed), age at first birth, respondents' occupation, toilet facility, source of drinking water, type of fuel used, place of residence, and states with a child survival advantage for Muslims.

The descriptive statistics of the variables are presented in Table 2. Among the explanatory variables, the wealth index construction and state classification need greater clarification. The wealth index used in this study uses the DHS construct of a standardized measure, whereby asset scores are calculated for each household using Principal Component Analyses (PCA). Using these wealth scores, households are divided into five wealth quintiles-poorest, poorer, middle, richer, and richest.

With regard to geographical factors, we focus on the major Indian states. Accordingly, the states of Assam, Manipur, Mizoram, Tripura, Nagaland, Sikkim, Meghalaya, and Arunachal Pradesh have been classified under the category of north-eastern states. The state variable is categorized into (1) Hindu advantage states: those states that shifted from being Muslim advantage to Hindu advantage or remained Hindu advantage in terms of child survival in 2015–2016; (2) Muslim advantage states include those that shifted from Hindu advantage to Muslim advantage or remained Muslim advantage in terms of child survival in 2015–2016.

However, for the four important factors that influence child mortality (duration of breastfeeding, child weight at birth, partner's education, and partner's occupation), the survey either not administered or obtained information from all the women and births in the study group. Thus, data not available account for 50% and above for these variables. The inclusion of variables with high missing values in the analysis may lead to inaccurate estimation and an erroneous explanation of the association between explanatory and outcome variables. While these variables are excluded from the main analyses, they are included in the robustness checks.

[2] The share of other religious groups in India together constitutes just 5.97% (Office of RGI and Census Commissioner, 2011).

Socio-economic status (SES) and Maternal and Child Health (MCH) scores are derived using the methodology that is used to construct Human Development Index (HDRO, 2020). SES score includes the denormalized and Geometric mean score of three socio-economic indicators: economic status derived from wealth status, educational status, and age at marriage, whereas MCH score is the denormalized and Geometric mean score of four maternal health care variables: 4 or more antenatal care, institutional delivery, and postnatal care and children full immunization. Both SES and MCH scores are estimated at the state level for Hindu and Muslim categories.

Definition of advantage and disadvantage factors

We include a wide range of socio-economic and demographic characteristics in the empirical analyses to identify key factors influencing religious differences in childhood mortality following previous literature (Bhat & Zavier, 2005; Bhalotra et al., 2010; Guillot & Allendorf, 2010). Following the analytical framework proposed by Guillot and Allendorf (2010), we have classified these explanatory variables into two categories: Hindu advantage and Muslim advantage factors. *Hindu advantage factors* are those factors in which the progress in socio-economic characteristics of children shifted from Muslim advantage to Hindu advantage or remained Hindu advantage during 1992–1993 to 2015–2016. *Muslim advantage factors* are those which shifted from Hindu advantage to Muslim advantage or remained Muslim advantage in the same period (see Appendix Table 6).

For deriving factors that are working as Hindu or Muslim advantageous in child survival, we used a two-step approach: first, we have looked at who are in advantageous position for a particular variable in 1992–1993 based on the predictor variable relationship with U5MR (Appendix Table 7). For example, in the case of birth spacing, it is negatively associated with U5MR (Appendix Table 7), thus we accept that longer birth spacing will ensure greater child survival. In Appendix Table 6, we also observed that it was Hindus (22.2%) who were having greater birth spacing compared to Muslims (20.7%) in 1992–1993. However, by 2015–2016, we can notice it has upturned: Hindus' share in 3 or more years of spacing reduced to 20.87%, while for Muslims it has increased to 22%. Thus, in this case, we have denoted the variable as "Muslim advantage". In the second step, we also calculated the percentage difference in change of 3 years and above birth spacing in 1992–1993 (Hindu–Muslims: 22.2–20.7 = 1.5) and 2015–2016 (Hindu–Muslims: 20.9–22.0 = – 1.1). The second step analysis also indicates that Hindus advantageous position in birth spacing not only reduced but also replaced by "Muslims" as an advantageous category. At an outset, in the process of defining Hindu or Muslim advantageous factors, we have mostly relied on examining the percentage change in Hindu–Muslim difference in socio-demographic factors over the period rather than absolute percentage levels of a variable for Hindu or Muslim in the end year.

Based on trend analyses of characteristics of children, we observe that over the period 1992–1993 to 2015–2016, there is a greater reduction in under-5 deaths among Hindu children relative to Muslims. Although the reported proportion of under-5 deaths in 2015–2016 is still slightly higher among Hindus relative to Muslims, the gap has decreased (Table 1). Previously, son preference was considered to be one of the key defining factors of excess female child mortality and was practiced

Table 1 Trends in U5MR in India by religion from 1992–1993 to 2015–2016

Religion	1992–1993 (1)	1998–1999 (2)	2005–2006 (3)	2015–2016 (4)	Change (1–4)
Hindu	113.2 (0.0016)	99.4 (0.0018)	75.9 (0.0018)	50.5 (0.0006)	62.7
Muslim	102.1 (0.0035)	80.3 (0.0031)	70.0 (0.0038)	49.9 (0.0012)	52.2
Others	70.5 (0.0048)	66.5 (0.0041)	61.9 (0.0050)	36.1 (0.0022)	34.4
Total	113.3 (0.0024)	99.3 (0.0020)	74.8 (0.0020)	50.0 (0.0008)	63.3
Hindu–Muslim	11.1	19.1	5.9	0.6	10.5

Standard Errors are reported in parenthesis; Estimates are based on the last births sample

more among Hindus than Muslims (Bhat & Zavier, 2005; Bhalotra et al., 2010; Guillot & Allendorf, 2010). However, from 2005 to 06 onward, we observe that the son preference gap between Hindus and Muslims has reduced, thus it is considered as a Hindu advantage factor. Higher birth order is associated with higher child mortality (Borooah et al., 2010), thus, in this case, Hindus are in an advantageous situation as they have lower birth order than Muslims throughout the period. Although Hindus have better birth intervals than Muslims, this variable favors Muslims over the period as lower birth interval has decreased more among Muslims than Hindus from 1992–1993 to 2015–2016 (Appendix Table 6).

Low age at marriage and age at first birth are negatively associated with child survival (Neal et al., 2018). Although Hindus have a lower percentage of early age marriage and childbirths in 2015–2016, the age at marriage and age at first birth has improved more among Muslims in comparison with Hindus during 1992–1993 to 2015–2016. Thus, they are turning out to be advantageous for Muslims over the period. Non-working status of mothers is associated with the lesser resource in their hands, thus leading to reduced child survival (Luke & Munshi, 2011). Although women who are currently not working is consistently higher among Muslims, their percentage decreased more among Muslims than Hindus over time, thus turning advantageous for them. The increase in mothers' education levels and mass media exposure is associated with greater child survival (Gakidou et al., 2010; Head et al., 2015). During 1992–1993 to 2015–2016, the progress in mother's education and mass media exposure turned greater advantage for Hindus than Muslims as they have improved more among the former than their latter counterpart (Appendix Table 6).

Household head's age and education are negatively associated with child mortality (Singh-Manoux et al., 2008). For both these indicators, Hindus are in an advantageous position compared to Muslims. Hygiene and the household environment are established to be negatively associated with child mortality (Geruso & Spears, 2014; Vyas and Spears, 2018). In terms of household environmental indicators, such as toilet facility, source of drinking water, and type of fuel used, Muslims are better compared to Hindu counterparts throughout the period of 1992–1993 to 2015–2016. Household wealth status and duration of stay at the place of residence are negatively associated with child mortality, while the evidence on the relationship between household size and child mortality is mixed or unclear (Guillot & Allendorf, 2010; Harttgen et al., 2019). In terms of all these three indicators, the situation improved more among Hindus than Muslims from 1992–1993 to 2015–2016 (Appendix Table 6). Akin to

Table 2 Sample distribution of study population (N = 23,47,245 live births) by background characteristics, 1992 to 2016

Variable	Prop	95% CI	
		LL	UL
Under-five deaths			
No	0.872	0.872	0.872
Yes	0.128	0.128	0.128
Religion			
Hindu	0.801	0.801	0.801
Muslim	0.148	0.148	0.148
Others	0.051	0.051	0.051
Child Sex			
Male	0.519	0.519	0.519
Female	0.481	0.481	0.481
Birth order			
1	0.302	0.302	0.302
2	0.254	0.254	0.254
3	0.178	0.178	0.178
3 +	0.266	0.266	0.266
Births spacing			
Less than 3 years	0.486	0.486	0.486
3 years and above	0.211	0.211	0.211
Do not know/missing	0.304	0.304	0.304
Current age of mother			
Below 18	0.004	0.004	0.004
18–29 years	0.274	0.274	0.274
30–39 years	0.394	0.394	0.394
40–49 years	0.328	0.328	0.328
Mother's age at first marriage			
Below 18	0.693	0.693	0.693
18–21 years	0.248	0.248	0.248
21 above	0.056	0.056	0.056
Mother's age at first birth			
Below 18	0.425	0.425	0.425
18–21 years	0.421	0.421	0.421
21 above	0.154	0.154	0.154
Mother's education			
No	0.628	0.628	0.628
Yes	0.372	0.372	0.372
Mother's occupation			
Not working	0.576	0.576	0.576
Working	0.424	0.424	0.424
Mother's sex preference			
Son preference	0.344	0.344	0.344
Others	0.656	0.656	0.656
Mother's mass media exposure			
No	0.534	0.534	0.534
Yes	0.466	0.466	0.466
Head of the household's age			
Below 21	0.005	0.005	0.005
21–29 years	0.065	0.065	0.065

Table 2 (continued)

Variable	Prop	95% CI	
		LL	UL
30–39 years	0.263	0.263	0.263
40–49 years	0.337	0.337	0.337
50 above	0.330	0.330	0.330
Do not know/missing	0.000	0.000	0.000
Education of the head of household			
Illiterate	0.406	0.406	0.406
Primary	0.233	0.233	0.233
Secondary	0.290	0.290	0.290
Higher	0.070	0.070	0.070
Household wealth status			
Poorest	0.225	0.225	0.225
Poorer	0.216	0.216	0.216
Middle	0.204	0.204	0.204
Richer	0.191	0.191	0.191
Richest	0.165	0.165	0.165
Household size			
Below 3	0.019	0.019	0.019
3	0.057	0.057	0.057
4	0.136	0.136	0.136
5 +	0.787	0.787	0.787
Do not know/missing	0.000	0.000	0.000
Household's toilet facility			
Unimproved	0.692	0.692	0.692
Improved not shared	0.300	0.300	0.300
Do not know/missing	0.008	0.008	0.008
Household's source of drinking water			
Unimproved	0.109	0.109	0.109
Improved	0.784	0.784	0.784
Do not know/missing	0.107	0.107	0.107
Household's cooking fuel			
Polluting	0.831	0.831	0.831
Clean	0.161	0.161	0.161
Place of residence			
Urban	0.257	0.257	0.257
Rural	0.743	0.743	0.743
Years lived in the place of residence			
Below 5 years	0.085	0.085	0.085
5–10 years	0.178	0.178	0.178
11 years and above	0.737	0.737	0.737
States			
Muslim Advantage States			
Remained Muslim advantage	0.504	0.504	0.504
Shifted from Hindu to Muslim advantage	0.145	0.145	0.145
Hindu Advantage States			
Remained Hindu advantage	0.141	0.141	0.141
Shifted from Muslim to Hindu advantage	0.209	0.209	0.209
Year of survey			
1992–1993	0.282	0.282	0.282

Table 2 (continued)

Variable	Prop	95% CI	
		LL	UL
1998–1999	0.282	0.282	0.282
2005–2006	0.370	0.370	0.370
2015–2016	0.066	0.066	0.066

Denormalized weighted proportion; unweighted sample (*n*)

previous literature, our analyses also suggest that the percentage of Muslims living in urban areas is more than Hindus and urban location is advantageous for child survival (Bhat and Zavier, 2005; Guillot & Allendorf, 2010).

Empirical strategy

The empirical analyses are conducted in four stages. (i) We assessed the gross differences in Hindu–Muslim child survival gaps from 1992–1993 to 2015–2016, using Kaplan–Meier (KM) survival probability plots (details widely reported in the literature, see Kaplan & Meier, 1958) and childhood mortality estimates. (ii) Pyatt's Gini decomposition model (Pyatt, 1976) was used to assess within-inequality in under-five mortality among the Hindus and Muslims over the time from 1992–1993 to 2015–2016. (iii) To assess the factors contributing to a reduction in Hindu–Muslim child survival gaps, we estimated Cox proportional hazard regression models using pooled data based on four rounds of the NFHS survey. For this model, all the respondents with a live birth in the previous 5 years to the survey have been included. In the first model, we measure the gross effect of religion on under-5 mortality. While in the second and third models, we have treated the models for Hindu and Muslim advantage factors, respectively. By doing so, we have derived the difference in relative risk of death between Hindu–Muslim net of Hindu advantage factors in model 2 and Muslim advantage factors in model 3. The fourth model estimates the relative risk of under-5 mortality for Hindus and Muslims net of all socio-economic variables. As we have not included variables with a significant number of missing cases in the main models, we have performed additional robustness checks to assess the validity of our main estimates. (iv). To empirically quantify the convergence process in child survival, we used absolute and conditional β-convergence models. By doing a macro-level regression model like this, we have also considered the maternal health care variable which is otherwise not possible to consider in the unit-level analysis owing to data-related limitations. As these questions are asked for only the last birth, they have huge missing cases. However, in a macro-level regression with states as a unit of analysis for both Hindus and Muslims (states*religion), it is possible to consider them in the form of state-level average maternal health care estimates.

Pyatt's Gini decomposition model

Pyatt (1976) has given the decomposition model of the Gini coefficient. Gini index was used to calculate the change in inequality in SES inequality among Hindu and Muslim women. Furthermore, the Gini index was decomposed to derive the contribution

of between and within group inequalities across Hindus and Muslims. However, in this study, we have focused more on 'within-group' inequality in Hindus and Muslims in children's survival. Our hypothesis is: a greater decline in 'within Hindu' inequality in child survival helps in overall progress in Hindu child survival, thereby catching up with Muslims. Below, we have given the mathematical procedure of Pyatt's decomposition model. Let a population of 'n' children, with probability of dying of vector $(y_{1,}\, y_{2,}\, y_{3.....}\, y_n)$ and mean probability of dying $\overline{y}$ is desegregated in 'k' subgroups (i.e., Hindus and Muslims), with $n = \sum_{j=1}^{k} n_j$ and subgroup mean is $\overline{y_j}$.

The Gini index between two subgroups j (Hindus) and h (Muslims) can be expressed as

$$G_{jh} = \frac{1}{n_j n_h \left(\overline{y_j} + \overline{y_h}\right)} \sum_{i=1}^{n_j} \sum_{r=1}^{n_h} \left| y_{ji} - y_{hr} \right|.$$

If $F(y)$ be the cumulative distribution function of probability of dying, then the expected probability of dying difference between group j and h can be defined as

$$d_{jh}^{1} = \int_{0}^{\alpha} dF_j(y) \int_{0}^{y} (y - x) dF_h(x), \text{ for } y_{ji} > y_{hr} \text{ and } \overline{y_j} > \overline{y_h}.$$

$$d_{jh}^{2} = \int_{0}^{\alpha} dF_h(y) \int_{0}^{y} (y - x) dF_j(x), \textit{ for } y_{ji} < y_{hr} \text{ and } \overline{y_j} > \overline{y_h}.$$

The relative disadvantage in death is defined as

$$D_{jh} = \frac{d_{jh}^{1} - d_{jh}^{2}}{d_{jh}^{1} + d_{jh}^{2}}.$$

If the population shares in subgroup j is $p_j = \frac{n_j}{n}$ and deaths share in subgroup j is $s_j = \frac{p_j \overline{y}_j}{\overline{y}}$, then the contribution to total inequality attributable to the difference between the k population sub-group is defined as

$$G_b = \sum_{j=1}^{k} \sum_{h=1 j \neq h}^{k} G_{jh} D_{jh} \left(p_j s_h + p_h s_j \right).$$

The Gini index for subgroup j is given by

$$G_{jj} = \frac{\sum_{i=1}^{n_j} \sum_{r=1}^{n_j} \left(y_{ij} - y_{rj} \right)}{2 n_j^2 \overline{y}_j}.$$

The within group inequality index is the sum of Gini indices for all subgroups weighted by the product of population shares and deaths shares of the subgroups:

$$G_w = \sum_{j=1}^{k} G_{jj} p_j s_j.$$

If subgroups are not overlapping, total inequality can be expressed as the sum of within group and between group indices. However, if subgroups are overlapping, we can add another component which is a part of between-group disparities issued from the overlap between the two distributions which measures the contribution of the intensity of transvariation. The contribution of the transvariation between the subpopulations to G is

$$G_t = \sum_{j=1}^{k} \sum_{h=1 j \neq k}^{k} G_{jh}\left(1 - D_{jh}\right)\left(p_j s_h + p_h s_j\right).$$

Thus, the Gini index can be decomposed into three components: within group inequality, between group inequality and inequality due to group overlapping:

$$G = G_w + G_b + G_t.$$

Cox proportional hazard regression model

The Cox proportional hazard regression model (Cox & Oakes, 1984) is used to estimate adjusted hazard ratios of under-five deaths by religion after controlling for other relevant socio-demographic factors.

The mathematical form of the hazard model is expressed in the following equation:

$$\boldsymbol{h(t,X) = h_0(t) exp\left(\beta_1 X_1 + \beta_2 X_2 \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \beta_k X_k\right)}, \tag{1}$$

where the term X_i refers to the covariates (e.g., religion and other socio-demographic factors in this study, see Table 2). The term $h_0(t)$ is the baseline or underlying hazard function and corresponds to the probability of dying when all explanatory variables are zero. The regression coefficient β_{religion} gives the proportional change that can be expected in the hazard, related to the category of the explanatory variable (e.g., Hindu/Muslim/Others). The Cox proportional regression model assumes that the hazard of childhood death at time '*t*' (age) for Hindu women (*z*) is proportional to the hazard of Muslim women (*y*) by the same factor ψ at every time *t*. This can be mathematically expressed as the following equation:

$$\boldsymbol{h_z(t) = \psi h_y(t)}, \tag{2}$$

where h_z *and* h_y, are the hazards (probabilities of childhood deaths), for the two groups of women and ψ is the hazard ratio. If $\psi > 1$, the hazard of childhood deaths is larger for Hindu women than for Muslim women, so the absence of Hindu religion reduces the chance of child deaths. If $\psi < 1$ or $\psi = 1$, the hazard of childhood deaths is smaller or equal for both women living in Muslim and Hindu households. This indicates that religious affiliation has no effect ($\psi = 1$) or is negatively related to childhood deaths. The proportional hazard assumption is tested using *phtest,* and the results clearly suggest that our models does not deviate from proportional hazard assumption.

Conditional β-convergence

We estimate conditional β-convergence by adding the SES and MCH scores of the states as additional covariates to the β-convergence model (Barro & Sala-i-Martin, 1992) to find out the role of the SES and MCH scores in the Hindu and Muslim convergence in child survival. The equation of this model can be written as

$$\mathrm{In}\left[\frac{Y_{i,t+k}}{Y_{i,t}}\right] = \alpha + \beta.\ln\left(Y_{i.t} + x_{1,i.t+}x_{2,i.t}\right) + \varepsilon_{it},$$

where $\mathrm{In}\left[\frac{Y_{i,t+k}}{Y_{i,t}}\right] =$ is the mean annualized rate of progress in child survival across the Hindus and Muslims '*Y*' in the state *i* in the period (*t*, *t*+*T*). $Y_{i.t}$ is the child survival across the Hindus and Muslims in the initial time t and ε_{it} are the corresponding residuals. Similarly, x_1 is the SES score in the state *i* in the period (*t*, *t*+*T*) and x_2 is the MCH score in the state *i* period (*t*, *t*+*T*).

Non-parametric test of convergence: kernel density plots

We used kernel density plots as a non-parametric test of convergence. Among non-parametric convergence metrics kernel density estimates are widely used method. Kernel density estimates allow a closer look at changes in the distribution in relative terms. They allow data to be modelled without presuming that the data follow a normal distribution and identify the short-term divergent paths, which may occur in long convergence process (Quah, 1993). This study used the Epanechnikov kernel which is an optimal in a minimum variance sense (Epanechnikov, 1969). A general form of kernel densities is estimated using the following equation:

$$\widehat{f}(x) = \frac{1}{hn}\sum_{i=1}^{n} k\left(\frac{x - X_i}{h}\right),$$

where $\widehat{f}(x)$ is the density estimation of the variable *x*, *n* is the number of observations, '*h*' is the bandwidth (smoothing parameter) and *K* (.) is the smooth and symmetric kernel function integrated to unity.

Main findings

Convergence in Hindu–Muslim child survival

The under-five mortality rate estimates for all four rounds of the NFHS show that they have declined among both Hindus and Muslims: from 113.2 and 102.1 in 1992–1993 to 50.5 and 49.9 in 2015–2016, respectively, with a clear inclination toward Hindu–Muslim convergence in child survival (Table 3). The Hindu–Muslim gap in U5MR is nearly zero in 2015–2016 (Fig. 1).

In Fig. 2, using Kaplan–Meir survival curves we present trends in survival probability of under-5 children from 1992–1993 to 2015–2016, disaggregated by Hindu–Muslim religious affiliation. The Kaplan–Meir survival trends by religion show that the probability of under-5 children survival among Hindus was lower compared to Muslims and other religions in 1992–1993. However, over time, the probability of child survival has increased for all religions, with Hindus catching up with Muslims by 2015–2016.

Table 3 Trends in under-5 mortality rates (per 1000 live births) across major states in India by religion from 1992–1993 to 2015–2016

States	1992–1993			1998–1999			2005–2006			2015–2016			Diff in diff
	Hindu	Muslim	D1	Hindu	Muslim	D2	Hindu	Muslim	D3	Hindu	Muslim	D4	D1 − D4
India	113.3	102.3	11.0	99.3	80.3	19.0	75.9	69.9	6.0	50.5	49.9	0.6	
Continue to Hindu advantage													
Goa	42.0	47.6	− 5.6	42.6	0.0	42.6	20.9	34.6	− 13.7	19.4	0.0	19.4	− 24.9
Haryana	96.9	143.9	− 47.0	77.8	79.0	− 1.2	50.5	64.9	− 14.4	36.3	73.9	− 37.6	− 9.4
Jammu & Kashmir	58.8	66.5	− 7.7	78.8	82.4	− 3.6	63.7	45.5	18.2	26.7	41.9	− 15.7	8.0
West Bengal	93.4	115.1	− 21.7	64.1	74.8	− 10.7	49.6	77.7	− 28.1	30.9	31.7	− 0.8	− 20.9
North-Eastern States	126.9	152.4	− 25.5	77.7	99.7	− 22.0	73.5	94.3	− 20.8	50.1	58.2	− 8.1	− 17.4
Continue to Muslim advantage													
Andhra Pradesh	96.6	53.4	43.2	89.4	42.2	47.2	63.2	55.2	8.0	38.9	27.9	11.0	32.2
Gujarat	110.5	56.4	54.1	91.1	41.2	49.9	63.9	36.0	27.9	43.9	41.7	2.2	51.9
Karnataka	88.8	82.7	6.1	71.7	67.7	4.0	58.6	38.1	20.5	32.2	28.0	4.2	1.9
Madhya Pradesh	135.3	75.7	59.6	139.8	94.0	45.8	95.8	59.4	36.4	65.2	55.7	9.5	50.1
Odisha	131.1	121.5	9.6	106.4	52.7	53.7	90.3	65.3	25.0	48.3	23.6	24.7	− 15.1
Punjab	73.1	63.5	9.6	69.3	88.6	− 19.3	51.2	37.0	14.2	29.9	6.5	23.4	− 13.8
Uttar Pradesh	147.0	119.8	27.2	128.1	101.1	27.0	99.1	80.9	18.2	77.7	73.5	4.2	23.0
Muslim to Hindu advantage													
Maharashtra	76.1	45.4	30.7	62.5	47.4	15.1	51.1	17.1	34.0	26.8	37.9	− 11.1	41.8
Delhi	85.9	85.7	0.2	58.1	53.8	4.3	41.9	77.7	− 35.8	33.4	83.7	− 50.3	50.5
Rajasthan	106.2	71.1	35.1	114.4	127.6	− 13.2	88.2	71.1	17.1	50.4	53.6	− 3.2	38.3
Tamil Nadu	89.1	56.6	32.5	62.5	53.5	9.0	39.6	0.0	39.6	27.1	30.8	− 3.7	36.2
Hindu to Muslim advantage													
Bihar	123.0	139.5	− 16.5	107.9	95.0	12.9	81.0	97.7	− 16.7	57.5	54.6	2.9	− 19.4
Himachal Pradesh	69.9	89.8	− 19.9	41.7	0.0	41.7	40.5	19.9	20.6	37.7	27.5	10.2	− 30.1
Kerala	23.8	44.0	− 20.2	28.2	8.8	19.4	12.1	22.5	− 10.4	7.8	5.3	2.5	− 22.7

In *syncmrates* programme 0 is emerging due to the very low sample size for that particular cell. NFHS 2 Goa Muslim ($n = 173$), Himachal Pradesh Muslim ($n = 308$), NFHS 3 Tamil Nadu Muslim ($n = 90$), NFHS 4 Goa Muslim (n$n = 111$). "D" signifies the difference between Hindu and Muslim under-5 mortality rates (per 1000 live births). Estimates are based on the last births sample

Fig. 1 Trends in Hindu–Muslim gap in under-five mortality rate from 1992–1993 to 2015–2016

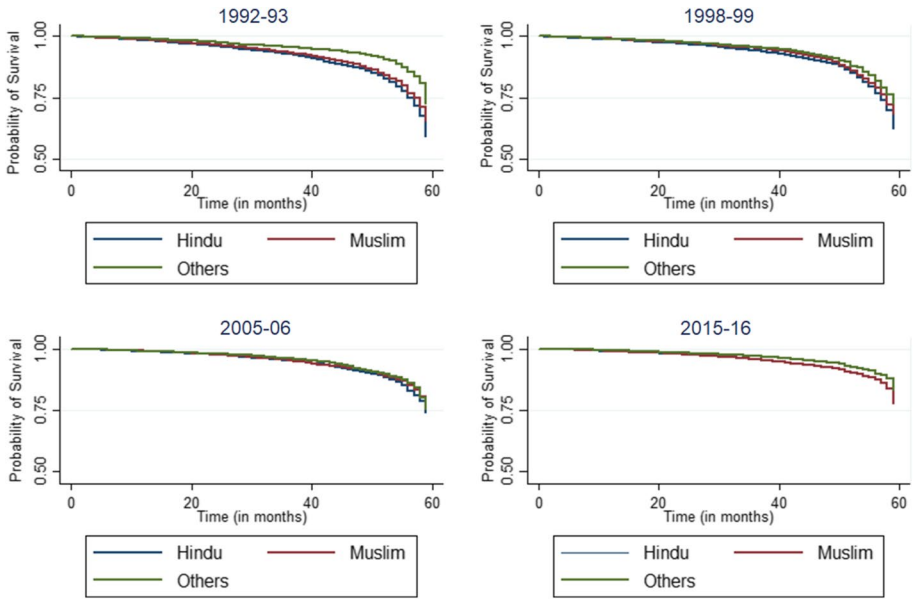

Fig. 2 Trends in the probability of surviving by religion from 1992–1993 to 2015–2016

This indicates that the difference in Hindu–Muslim under-5 child survival probability observed in the initial period has gradually disappeared in recent years.

However, there is heterogeneous progress in terms of reduction in Hindu–Muslim child survival gaps across Indian states. Based on the direction and nature of progress in child survival across states during 1992–1993 to 2015–2016, we have classified the states into four groups. These include states that continue to exhibit a Hindu advantage (Goa, Haryana, Jammu and Kashmir, West Bengal, and North-eastern states), states that continue to have a Muslim advantage (Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Odisha, Punjab, and Uttar Pradesh), states that turned from being Muslim

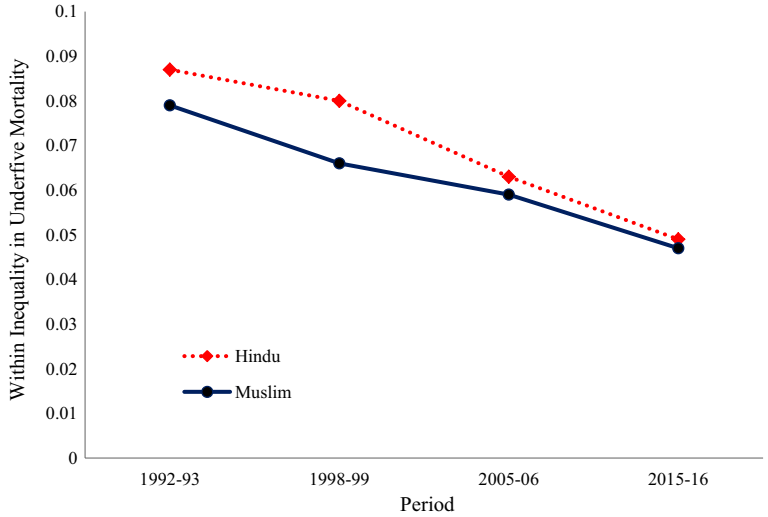

Fig. 3 Trends in inequality in under-five mortality among Hindus–Muslims from 1992–1993 to 2015–2016

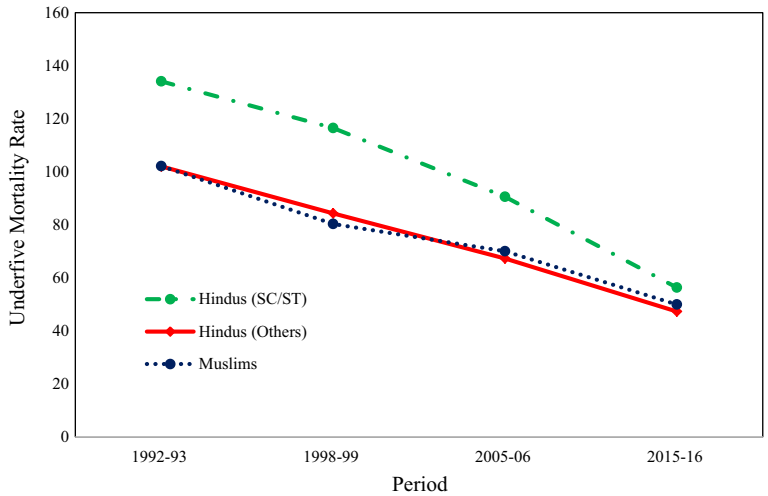

Fig. 4 Trends in under-five mortality among Hindus (by Castes) and Muslims from 1992–1993 to 2015–2016

to Hindu advantage over time (Maharashtra, Delhi, Rajasthan, and Tamil Nadu), and finally, states that flipped from being Hindu to Muslim advantage from 1992–1993 to 2015–2016 (Bihar, Himachal Pradesh, and Kerala). A majority of the larger states have either turned from being Muslim to Hindu advantage or have experienced a considerable decline in the Hindu–Muslim child survival gap, which might have contributed to an overall convergence in Hindu–Muslim U5MR at the all-India level (Table 3).

Figure 3 presents within-Hindu and within-Muslim inequalities in U5MR from 1992–1993 to 2015–2016. We observe that until 1998–99, the within-group inequalities among Hindus were higher than what was observed among Muslims, so a greater advantage in child survival was observed among Muslims. However, from 1998–99 there has been a decreasing trend of within-group inequality in under-five mortality. The speed of decline

within-Muslim inequality in child mortality has decelerated, while it has increased in Hindus over time which leads to a gradual disappearance in the Hindu–Muslim gap in child survival by 2015–2016. Furthermore, to understand the decline in within-Hindu inequality in childhood survival probabilities, we have drawn trends in U5MR by caste status using the Hindu sample. The results in Fig. 4 indicate that within-Hindu convergence in child survival probabilities is driven by greater progress in the traditionally disadvantaged Schedule castes and tribes (SCs and STs).[3] The differences in child mortality by castes reported in previous studies (Dommaraju et al., 2008) appear to be narrowing in recent years. The results also indicate that Hindu children from General castes (upper castes/other castes) have always had better child survival rates compared to Muslims (Fig. 4).

Defining factors of convergence in Hindu–Muslim child survival

In this section, we identify factors associated with the convergence process in Hindu–Muslim child survival using the approach proposed by Guillot and Allendorf (2010). Table 4 presents hazard ratio estimates from the Cox proportional hazard regression model, which explains the differences in U5MR among children from Hindu and Muslim affiliations, after treating for the effects of Hindu (sex of child, birth order, mother's education, mass media exposure, sex preference, household head's age, education, wealth status, household size, years lived in the place of residence) and Muslim (birth spacing, mothers' current age, age at first marriage and first birth, mother's occupation, household toilet type, source of drinking water, type of cooking fuel, urban place of residence) advantageous factors separately. The results of the main analysis are provided in Models 1–4. Model 1 illustrates the relative risk of death among children by their religious affiliation without controlling for other predictors. This baseline model reveals that the relative risk of mortality for Muslim children (hazard ratio = 0.939; $p < 0.01$) is 6 points less compared to Hindu counterparts (hazard ratio = 1). Models 2 and 3 present the relative risk of death among children by their religious affiliation after adjusting for Hindu and Muslim advantage factors in childhood survival, respectively. In model 2, after adjusting for Hindu advantage factors the relative risk of child mortality is expected to take away Hindu advantageousness in their child survival. Thus, this is expected to contribute to an increase in the under-five mortality gap between Hindus-Muslims. The results in Model 2 support our hypothesis: Hindu–Muslim differences in terms of the relative risk of under-five deaths (Muslims: hazard ratio = 0.899; $p < 0.01$; others: hazard ratio = 0.873; $p < 0.01$) are increasing significantly (10 points) in comparison with Model 1 (6 points).

Conversely, when we control for Muslim advantageous factors, we would expect that the relative advantage of child survival for Muslims will decrease, thus contributing to a decrease in the child mortality gap between Hindus–Muslims. Again, the results in Model 3 support our assumption that the Hindu–Muslim differences in relative risk of under-five deaths (Muslims: hazard ratio = 0.953; $p < 0.10$; others: hazard ratio = 0.882; $p < 0.01$) are decreasing (5 points) compared to Model 2 (10 points), and also remain statistically significant. Model 4 shows estimates of the relative risk of under-five mortality

[3] Scheduled caste and tribes are socially disadvantaged groups (Dommaraju, et al. 2008).

Table 4 Cox proportional hazard model: relative risk of under-five mortality by religion

Predictor variables	Model 1			Model 2			Model 3			Model 4		
	Gross effects			Net of Hindu advantage factors			Net of Muslim advantage factors			Net of Hindu–Muslim advantage factors		
	Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI	
		LL	UL		LL	UL		LL	UL		LL	UL
Religion												
Hindu[a]												
Muslim	0.939***	0.906	0.973	0.899***	0.951	0.851	0.953	0.894	1.015	0.932**	0.871	0.996
Others	0.711***	0.680	0.744	0.873***	0.957	0.796	0.882**	0.799	0.974	0.936	0.841	1.041
Child sex												
Male[a]												
Female				1.057***	1.098	1.017				1.07***	1.024	1.118
Birth order												
1[a]												
2				1.075***	1.137	1.015				3.865***	3.135	4.764
3				1.367***	1.464	1.277				5.119***	4.105	6.384
3+				1.898***	2.039	1.767				8.101***	6.488	10.114
Mother's education												
No[a]												
Yes				0.703***	0.739	0.669				0.746***	0.703	0.793
Mother's mass media exposure												
No[a]												
Yes				0.875***	0.915	0.837				0.909***	0.863	0.958
Mother's sex preference												
Son preference[a]												
Daughter or no preference				0.871***	0.907	0.836				0.891***	0.851	0.934
Household head's age												
Below 21[a]												
21–29 years				0.95	1.209	0.746				1.251	0.935	1.674

Table 4 (continued)

Predictor variables	Model 1			Model 2			Model 3			Model 4		
	Gross effects			Net of Hindu advantage factors			Net of Muslim advantage factors			Net of Hindu–Muslim advantage factors		
	Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI	
		LL	UL		LL	UL		LL	UL		LL	UL
30–39 years				0.891	1.135	0.699				1.275	0.951	1.708
40–49 years				1.134	1.451	0.886				1.811***	1.345	2.44
50 above				1.483***	1.893	1.162				2.093***	1.559	2.809
Household head's education												
Illiterate[a]												
Primary				1.08***	1.135	1.029				1.073***	1.016	1.134
Secondary				0.917***	0.969	0.869				0.97	0.91	1.034
Higher				0.76***	0.849	0.68				0.879**	0.774	0.998
Household head's wealth quintiles												
Poorest[a]												
Poorer				0.99	1.041	0.94				0.963	0.908	1.021
Middle				0.941**	0.997	0.889				0.913***	0.854	0.976
Richer				0.744***	0.797	0.695				0.794***	0.732	0.861
Richest				0.58***	0.637	0.529				0.800***	0.704	0.908
Household size												
Below 3[a]												
3				0.273***	0.31	0.241				0.274***	0.236	0.318
4				0.134***	0.151	0.118				0.139***	0.12	0.16
5+				0.074***	0.084	0.066				0.07***	0.061	0.081
Years lived in place of residence												
Below 5 years[a]												
5–10 years				0.553***	0.582	0.525				0.551***	0.516	0.588
11 years and above				0.464***	0.493	0.437				0.498***	0.463	0.535

Table 4 (continued)

Predictor variables	Model 1			Model 2			Model 3			Model 4		
	Gross effects			Net of Hindu advantage factors			Net of Muslim advantage factors			Net of Hindu–Muslim advantage factors		
	Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI	
		LL	UL		LL	UL		LL	UL		LL	UL
Births spacing												
Less than 3 years[a]												
3 years and above							0.726***	0.684	0.77	0.775***	0.728	0.824
Mother's current age												
Below 18[a]												
18–29 years							0.212***	0.185	0.242	0.262***	0.224	0.306
30–39 years							0.179***	0.154	0.207	0.169***	0.142	0.201
40–49 years							0.215***	0.18	0.257	0.143***	0.116	0.177
Mother's age at first marriage												
Below 18[a]												
18–21 years							0.818***	0.77	0.868	0.862***	0.809	0.918
21 above							0.783***	0.698	0.878	0.864***	0.764	0.977
Mother's age at first birth												
Below 18[a]												
18–21 years							1.033	0.979	1.089	1.127***	1.064	1.193
21 above							1.207***	1.108	1.314	1.331***	1.213	1.46
Mother's occupation												
Not working[a]												
Working							0.951**	0.909	0.995	0.877***	0.836	0.92
Household's toilet type												
Unimproved[a]												
Improved (not shared)							0.671***	0.627	0.718	0.801***	0.742	0.865
Household's source of drinking water												
Unimproved[a]												

Table 4 (continued)

Predictor variables	Model 1			Model 2			Model 3			Model 4		
	Gross effects			Net of Hindu advantage factors			Net of Muslim advantage factors			Net of Hindu–Muslim advantage factors		
	Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI	
		LL	UL		LL	UL		LL	UL		LL	UL
Improved							0.991	0.936	1.05	1.014	0.955	1.077
Household's type of cooking fuel												
Unclean[a]												
Clean							0.592***	0.538	0.651	0.694***	0.621	0.777
Place of residence												
Urban[a]												
Rural							1.088***	1.024	1.157	1.059	0.99	1.134
States												
States with type of child survival advantage												
Muslim advantage[b]												
Remained Hindu advantage				0.843***	0.894	0.796				1.073	0.983	1.171
Shifted from Muslim to Hindu advantage				0.84***	0.886	0.797				1.106***	1.016	1.204
Hindu advantage[c]												
Remained Muslim advantage							1.241***	1.184	1.3	1.295***	1.206	1.39
Shifted from Hindu to Muslim advantage[d]							1.005	0.936	1.08	0.932**		
No. of observations	2,347,245			2,212,626			1,164,970			1,091,383		
Wald Chi2	68.68			5252.86			1843.05			4901.65		
Prob > Chi2	0.000			0.000			0.000			0.000		

[a] Reference category

[b] Reference category only for model 2

[c] Reference category only for model 3

[d] Reference category only for Model 4

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

by religion after adjusting for the effects of both Hindu and Muslim advantageous socio-economic and demographic factors that are known to influence the chances of under-five child mortality. The results in model 4 suggest that Hindu–Muslim differences in relative risk of under-five deaths (Muslims: hazard ratio = 0.932; $p < 0.01$; others: hazard ratio = 0.936; $p < 0.10$) fall in between the Hindu–Muslim differences observed in Models 2 and 3.

Previous literature found that unobservable religious behavior or relative isolation of Muslims may be replacing the influence of socio-economic status in the religious difference in child survival (Basu et al., 2007; Bhalotra et al., 2010). Our findings identify the specific socio-economic and demographic factors (namely, reduction in fertility and household size, and progress in wealth status, maternal education, and mass media exposure) behind the narrowing gap in under-five mortality among Hindu–Muslim children.

Additional results

Furthermore, our analysis points to a linear association between the child's birth order and risk of child mortality, with higher birth order children facing a greater risk of child mortality (Model 4). Among other statistically significant factors, having better-educated mothers, household heads and exposure to mass media significantly reduces the hazard of child death. The risk of child mortality is significantly lower among those respondents who have no son preference (hazard ratio = 0.891; $p < 0.01$). Economic factors also play a role in determining child survival probabilities. Relative to children born in the poorest wealth quintile, the risk of under-five death is significantly lower among children from the middle (hazard ratio = 0.913; $p < 0.10$), richer (hazard ratio = 0.794; $p < 0.01$), and richest (hazard ratio = 0.800; $p < 0.01$) wealth quintiles. In keeping with the findings from Model 2, an increase in household size decreases the risk of child death significantly. In relation to Muslim advantage states, the hazard of dying is significantly high for children who were born in states which remained Hindu advantage (hazard ratio = 1.073; $p < 0.01$) and shifted from Muslim to Hindu advantage (hazard ratio = 1.295; $p < 0.01$).

The risk of death is lower for the children who were born at birth intervals greater than 3 years (hazard ratio = 0.775; $p < 0.01$) compared to those born with less than 3 years of birth interval. The results also show a significant decrease in the risk of death among children whose mothers married after 18 years. An increase in age at the first birth of the mothers significantly increases the hazard of death among children. Children of working mothers have a significantly lower risk of child death (hazard ratio = 0.877; $p < 0.01$) compared to non-working mothers. Children in households with better toilet facilities (hazard ratio = 0.801; $p < 0.01$) and clean fuel usage (hazard ratio = 0.694; $p < 0.01$) are significantly less likely to die. Our findings are in tune with previous literature that identified socio-economic and demographic factors of child

Table 5 Absolute and conditional β-convergence analyses of SES and MCH scores across Hindus and Muslims in India

	(1)	(2)	(3)	(4)
	Annual rate of change during1992 to 2016			
Variables	**U5MR**	**SES score**	**MCH score**	**U5MR**
U5MR 1992–1993	− 0.0002* (0.009)			− 0.0021* (0.011)
SES score _1992–1993		− 0.443* (0.220)		− 0.663* (0.748)
MCH score _1992–1993			− 1.502*** (0.132)	0.108** (0.628)
Constant	− 3.65*** (0.935)	1.871*** (0.407)	3.951*** (0.203)	− 2.96** (1.273)
Observations	38	38	38	38
R-squared	0.286	0.101	0.782	0.24

Model 1–3 are absolute β-Convergence models, model 4 is conditional β-Convergence model

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

survival in India (Bhat & Zavier, 2005; Guillot & Allendorf, 2010; Geruso & Spears, 2014; Borooah et al., 2010).

Since we could not analyze the effect of maternal and child care variable role in reducing childhood mortality rates using micro-data as a result of data-related limitations,[4] we have constructed two indices: SES scores and MCH scores and derived values of the same for Hindus and Muslims across states of India. Using these indicators at the state level, we have constructed a macro data set to test the convergence hypothesis in Hindu–Muslim child survival and its correlation with SES scores and MCH scores using the absolute and conditional β-convergence models, respectively. The results from absolute β-convergence models in Table 5 confirm the emergence of a Hindu–Muslim convergence in socio-economic status ($\beta = -0.443$, $p<0.05$) and maternal and child health care utilization ($\beta = -1.502$, $p<0.01$) across Indian states. Conditional β-convergence model reveals that after controlling for SES and MCH scores, the level of Hindu–Muslim child survival convergence across the states increases drastically. This suggest that inter-state convergence in socio-economic status and maternal health care of Hindus and Muslims significantly contributed to child survival convergence. Non-parametric convergence tests such as kernel density plots also support our results in absolute convergence model. The results from kernel density plots suggest that over the period the distribution of U5MR is narrowing along with contraction in the distribution of SES and MCH scores (Fig. 5).

Discussion

Our study extends the findings from previous studies that investigated Hindu–Muslim differences in child survival in India (Bhat & Zavier, 2005; Basu et al., 2007; Bhalotra et al., 2010; Borooah et al., 2010; Geruso & Spears, 2014; Guillot & Allendorf, 2010; Shariff, 1995). In particular, many of these studies have investigated the factors behind the puzzle of Muslim advantage in child survival over Hindus despite being in

[4] NFHS asks questions related to maternal and child health care only for last births, thus using these questions in micro data analyses leads to a large number of missing cases.

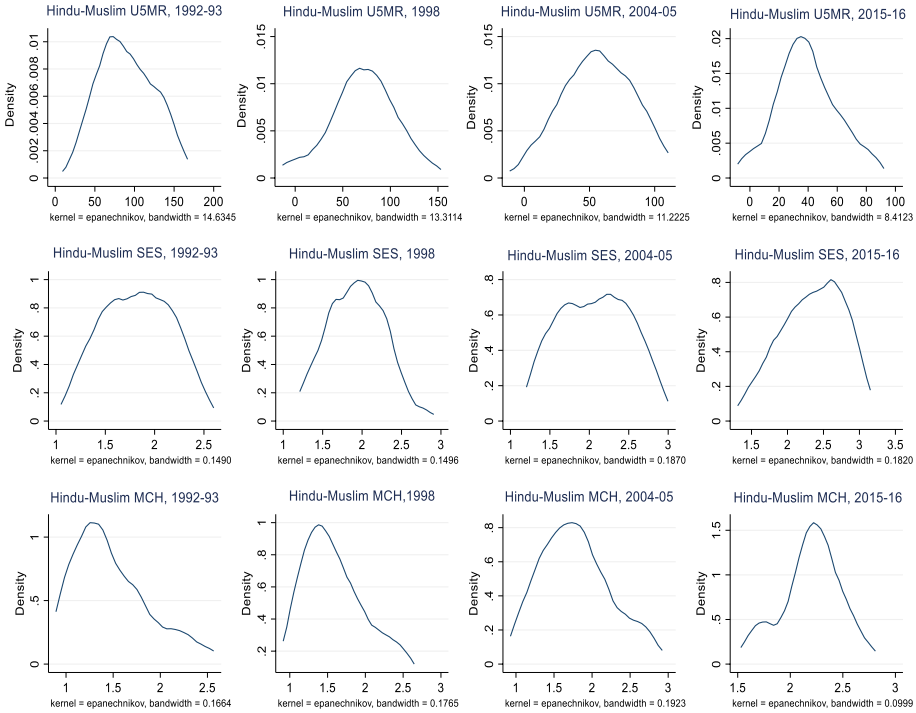

Fig. 5 Non-parametric test of convergence: kernel density plots of showing the distribution of Hindu–Muslim U5MR from 1992–1993 to 2015–2016

socio-economically disadvantageous conditions. On the other hand, our study sheds light on the gradual catching-up process of Hindus with Muslim child survival and the factors that are associated with Hindu–Muslim convergence in child survival probabilities. Furthermore, our study is the first to report changes in within-inequality in child mortality separately for Hindus and Muslims, where we report a faster drop in within-Hindu inequality in child survival compared to Muslims; thus, leading to convergence in Hindu–Muslim child survival probabilities. The faster decline in within-Hindu heterogeneity in child mortality is led by an acceleration in progress among traditionally disadvantaged groups, such as SCs and STs who were traditionally reported to have higher mortality compared to General castes. Our study suggests that among Hindus, General castes have always had better child survival rates compared to Muslims. According to our study, one of the reasons behind the earlier observed Muslim child advantage in survival probability is the greater heterogeneity (especially by social class) within Hindu populations.

Furthermore, this study has identified the covariates that attribute to diminishing Muslim advantage in child survival in India. Following the *characteristics hypothesis* (Goldscheider, 1971; Goldscheider & Mosher, 1988) and using the analytical framework of Guillot and Allendorf (2010) for implementing a classic survival model (i.e., Cox proportional hazard regression model), we identify the factors associated with the convergence in Hindu–Muslim child survival probabilities. Using robust empirical evidence our study not only supports some of the previous hypotheses proposed to explain Muslim advantage in child mortality in India but also extends our knowledge on the subject to better understand the recent catch-up of Hindus with Muslim children in survival

probabilities. First, with regard to urban locational advantage for Muslim child survival as hypothesized by Bhat and Zavier (2005), our findings confirm that the urban location of Muslims is still improving the child survival through better access to health care, water, and sanitation which further results in a hygienic environment relative to their Hindu counterparts. Second, it also confirms the hypothesis of hygienic practice advantage for Muslim child survival. Our findings are in tune with earlier research that inferred the importance of hygienic practice in explaining Muslim advantage in child health and survival (Brainerd & Menon, 2015; Coffey & Spears, 2017; Geruso & Spears, 2014). In extension, our study also reveals that better toilet facilities and the use of clean cooking fuel is an advantage for Muslims over Hindus in terms of extending under-five survival probabilities. Third, our study reports a slowly diminishing role of the age-old tradition of son preference among Hindus which has been considered as a reason behind Muslim advantage in child survival in other studies (Bhalotra et al., 2010). Thus, consistent with the finding of Guillot and Allendorf (2010), our study re-affirms that from 2005 to 2006 onward, the practice of son preference among Muslims is outweighing Hindus and cannot be considered as a Muslim advantage factor anymore.

Fourth, in keeping with the findings from previous studies, we show that reducing birth order, rising mother's education and mass media exposure, diminishing sex preference for the child, rising age and education of the household head, improving wealth status, and smaller household size are some of the variables improving Hindu children's survival. Notably, these findings will widen the scope for future research to explore the prospective trend of religious disparities in child mortality with the progress in socio-economic and demographic characteristics of Hindus and Muslims.

Conclusions

The trends in religious difference in child survival in India have changed considerably in recent years, but have received limited attention in demographic research in India. At this critical juncture of mortality transition across religious groups in India, our study identifies Hindu–Muslim convergence in child survival and also addresses the issue of progress in socio-economic and demographic factors that facilitated this process using robust statistical modelling based on pooled data from four rounds of NFHS during 1992 to 2016. This study finds that the Hindu–Muslim gap in childhood survival probabilities is diminishing due to a greater decline within Hindu inequalities. The progress in the set of Hindu advantage factors identified in this study (i.e., having fewer higher order births, rise in mother's education and mass media exposure, diminishing son preference, rise in household head's age and education, improving wealth status, reducing household size) is the major contributor explaining the convergence in Hindu–Muslim child survival chances in India. From a policy perspective, addressing some of the socio-economic differences identified in our study and improving access to health services can contribute to further improvement in child survival probability across the country.

Appendix

See Tables 6, 7 and 8.

Table 6 Change in socio-economic, demographic and health characteristics of Hindu and Muslim religions in India from 1992–1993 to 2015–2016

Predictor variables	1992–1993		1998–99		2005–06		2015–2016		Relationship with under 5 mortality	Advantage for #
	Hindu	Muslim	Hindu	Muslim	Hindu	Muslim	Hindu	Muslim		
Under 5 deaths										
No	84.29	86.76	86.15	89.18	87.89	89.61	92.83	93.55		Hindu
Yes	15.71	13.24	13.85	10.82	12.11	10.39	7.17	6.45		
Child sex										
Male	51.83	51.04	52.06	51.97	51.98	51.64	52.66	52.36		Hindu
Female	48.17	48.96	47.94	48.03	48.02	48.36	47.34	47.64		
Birth order									0.029***	
1	28.86	24.65	30.31	25.48	32.26	26.91	38.52	32.22		Hindu
2	23.99	20.82	25.40	21.63	26.77	23.08	30.62	26.28		
3	17.96	16.71	18.15	16.87	17.69	17.30	16.29	17.64		
3+	29.19	37.82	26.14	36.02	23.27	32.71	14.57	23.86		
Births spacing										
Less than 3 years	48.79	54.51	49.03	55.29	46.76	51.84	40.39	45.59		Muslim
3 years and above	22.22	20.69	20.53	19.10	20.82	21.13	20.87	22.00		
Do not know/missing	28.98	24.8	30.44	25.61	32.43	27.03	38.74	32.41		
Mother's current age									0.002	
Below 18	0.53	0.62	0.52	0.69	0.27	0.34	0.06	0.09		Muslim
18–29 years	29.84	30.38	29.72	28.75	27.42	28.52	23.69	24.08		
30–39 years	38.17	39.48	38.38	39.59	39.37	41.61	38.12	38.42		
40–49 years	31.46	29.52	31.38	30.97	32.94	29.54	38.12	37.41		
Mother's age at marriage									− 0.067***	
Below 18	73.61	76.49	73.03	73.11	69.40	70.1	50.57	52.35		Muslim
18–21 years	22.33	20.55	22.59	24.05	25.01	26.22	32.03	32.11		
21 above	4.06	2.96	4.38	2.84	5.58	3.67	11.86	10.71		
Do not know/missing	1.10	1.52	0.00	0.00	0.01	0.00	5.53	4.81		

Table 6 (continued)

Predictor variables	1992–1993		1998–99		2005–06		2015–2016		Relationship with under 5 mortality	Advantage for #
	Hindu	Muslim	Hindu	Muslim	Hindu	Muslim	Hindu	Muslim		
Mother's age at first birth									− 0.053***	
Below 18	44.93	52.21	46.62	49.05	40.33	45.76	25.75	28.90		Muslim
18–21 years	41.82	37.58	39.98	40.85	43.54	42.49	46.89	47.19		
21 above	13.25	10.19	13.40	10.09	16.14	11.75	27.29	23.86		
Do not know/Missing	1.10	1.52	0.00	0.00	0.00	0.00	0.07	0.05		
Mother's education									− 0.107***	
No	70.11	72.56	63.81	65.62	59.91	66.52	45.68	51.37		Hindu
Yes	29.89	27.44	36.19	34.38	40.09	33.48	54.31	48.62		
Mother's occupation									0.034***	
Not working	62.06	81.89	54.34	78.08	47.14	71.13	62.28	80.96		Muslim
Working	37.93	18.10	45.66	21.92	52.86	28.87	37.71	19.04	− 0.007***	
Mother's sex preference										
Son preference	41.24	35.80	36.39	31.40	30.97	32.69	26.45	29.55		Hindu
Others	58.78	64.20	63.61	68.60	69.03	67.31	73.55	70.45		
Mother's mass media exposure									− 0.086***	
No	62.91	63.82	51.87	52.21	49.43	55.29	43.40	50.31		Hindu
Yes	37.09	36.18	48.13	47.79	50.57	44.71	56.60	49.69		
Household's head age									0.000	
Below 21	0.79	0.60	0.61	0.65	0.34	0.63	0.14	0.26		Hindu
21–29 years	6.67	6.68	6.62	6.00	6.33	7.56	5.74	6.310		
30–39 years	25.14	26.25	25.55	25.14	24.02	27.48	23.31	24.10		
40–49 years	31.45	32.37	32.58	32.64	34.89	33.65	35.25	35.32		
50 above	35.91	34.08	34.60	35.57	31.41	30.67	35.55	33.99		
Do not know/missing	0.04	0.02	0.04	0.00	0.00	0.00	0.01	0.01		

Table 6 (continued)

Predictor variables	1992–1993		1998–99		2005–06		2015–2016		Relationship with under 5 mortality	Advantage for #
	Hindu	Muslim	Hindu	Muslim	Hindu	Muslim	Hindu	Muslim		
Household head education									− 0.051***	
Illiterate	44.32	49.27	38.02	43.34	39.55	50.21	32.04	41.90		Hindu
Primary	28.22	30.03	23.97	25.95	19.28	20.27	18.95	22.57		
Secondary	22.01	17.71	27.33	24.38	34.75	26.32	41.20	31.48		
Higher	5.45	2.99	10.68	6.33	6.42	3.21	7.81	4.06		
Household's wealth status									− 0.105***	
Poorest	23.47	17.87	23.79	18.41	23.76	21.36	24.21	20.79		Hindu
Poorer	21.53	20.98	22.50	19.93	22.72	22.11	21.94	21.93		
Middle	20.97	18.65	20.82	19.17	20.35	20.88	20.36	20.04		
Richer	18.26	23.53	17.57	24.36	17.91	21.39	18.08	21.52		
Richest	15.78	18.97	15.32	18.13	15.26	14.25	15.41	15.72		
Household size									− 0.106***	
Below 3	1.32	0.74	1.55	0.63	2.57	1.51	2.73	1.48		Hindu
3	4.46	2.75	5.01	2.79	7.23	3.91	8.56	5.53		
4	10.49	6.49	1.31	7.07	16.03	10.83	20.83	14.18		
5 +	83.72	90.01	80.29	89.52	74.14	83.76	67.82	78.76		
Do not know/missing	0.01	0.02	0.00	0.00	0.00	0.00	0.07	0.05		
Toilet facility									− 0.086***	
Unimproved	83.56	76.01	73.55	46.40	66.27	53.04	52.89	35.85		Muslim
Improved not shared	16.43	23.98	26.44	53.59	30.11	43.58	47.04	64.10		
Do not know/missing	0.01	0.02	0.01	0.01	3.62	3.38	0.07	0.05		
Source of drinking water									0.001	
Unimproved	5.68	5.23	21.65	14.64	13.44	7.34	10.13	6.53		Muslim
Improved	94.31	94.75	78.33	85.36	83.02	89.37	87.34	90.97		
Do not know/missing	0.01	0.02	0.01	0.00	3.52	3.29	2.53	2.50		

Table 6 (continued)

Predictor variables	1992–1993		1998–99		2005–06		2015–2016		Relationship with under 5 mortality	Advantage for #
	Hindu	Muslim	Hindu	Muslim	Hindu	Muslim	Hindu	Muslim		
Cooking fuel									− 0.080***	
Polluting	90.89	93.18	86.51	87.19	77.82	80.44	62.65	59.60		Muslim
Clean	9.10	6.81	13.48	12.78	18.66	16.23	34.82	37.90		
Do not know/missing	0.01	0.02	0.01	0.02	3.52	3.34	2.53	2.50		
Place of residence									0.070***	
Urban	21.59	35.44	21.38	33.90	25.29	35.48	27.41	41.94		Muslim
Rural	78.41	64.56	78.62	66.10	74.71	64.52	72.59	58.06		
Years lived in place of residence									0.021***	
Below 5 years	7.63	7.27	7.32	7.68	8.84	8.59	12.73	13.92		Hindu
5–10 years	17.46	15.94	17.95	17.41	17.54	16.36	20.44	20.15		
11 years and above	74.90	76.78	74.74	74.91	73.62	75.05	66.83	65.93		

Weighted proportion; # "Advantage for" signifies improvement in the disadvantage category of the variable over the period. *Others includes "girl preference" and "no preference"

Table 7 Correlation matrix of study variables

Variables	Under 5 deaths	Religion	Birth order	Mother's education	Mother's mass media exposure	Mother's sex preference	Household's head age	Household's head education	Household's head wealth quintiles	Household size	Years lived in place of residence	Remained Hindu advantage
Under 5 deaths	1.000											
Religion	− 0.022***	1.000										
Birth order	0.029***	0.068***	1.000									
Mother's education	− 0.107***	− 0.022***	− 0.153***	1.000								
Mother's mass media exposure	− 0.086***	− 0.012***	− 0.101***	0.361***	1.000							
Mother's sex preference	− 0.007***	0.039***	− 0.012***	0.085***	0.055***	1.000						
Household's head age	0.000	0.000	0.070***	0.034***	0.029***	0.000	1.000					
Household's head education	− 0.051***	− 0.041***	− 0.079***	0.263***	0.191***	0.045***	0.010***	1.000				
Household's head wealth quintiles	− 0.105***	0.035***	− 0.089***	0.353***	0.398***	0.044***	0.040***	0.164***	1.000			
Household size	− 0.106***	0.060***	0.124***	− 0.028***	− 0.010***	− 0.045***	0.107***	− 0.046***	0.008***	1.000		
Years lived in place of residence	0.021***	0.001	0.078***	− 0.101***	− 0.062***	− 0.022***	0.057***	− 0.091***	− 0.082***	0.071***	1.000	
Remained Hindu advantage	− 0.031***	0.088***	0.002	0.080***	0.036***	− 0.002	0.010***	− 0.001	0.041***	0.018***	− 0.035***	1.000
Shifted from Muslim to Hindu advantage	− 0.032***	− 0.042***	− 0.035***	0.031***	0.059***	0.033***	− 0.006**	0.015***	0.101***	− 0.019***	0.008***	− 0.248***
Birth spacing	− 0.113***	− 0.023***	− 0.013***	0.000	− 0.007***	0.008***	0.016***	0.026***	− 0.018***	− 0.040***	0.011***	− 0.005**
Mother's current age	0.002	− 0.005**	0.022***	0.004*	0.006**	0.000	0.036***	0.006**	0.007***	0.010***	0.050***	− 0.002

Table 7 (continued)

Variables	Under 5 deaths	Religion	Birth order	Mother's education	Mother's mass media exposure	Mother's sex preference	Household's head age	Household's head education	Household's head wealth quintiles	Household size	Years lived in place of residence	Remained Hindu advantage
Mother's age at marriage	− 0.067***	− 0.036***	− 0.114***	0.239***	0.152***	0.032***	0.051***	0.141***	0.169***	− 0.031***	− 0.061***	0.050***
Mother's age at first birth	− 0.053***	− 0.068***	− 0.095***	0.154***	0.094***	− 0.002	0.067***	0.104***	0.111***	− 0.017***	− 0.035***	− 0.012***
Mother's occupation	0.034***	− 0.140***	0.011***	− 0.167***	− 0.104***	0.008***	− 0.001	− 0.085***	− 0.123***	− 0.064***	0.057***	− 0.049***
Type toilet facility at household	− 0.086***	0.072***	− 0.092***	0.403***	0.329***	0.095***	0.039***	0.276***	0.378***	− 0.023***	− 0.112***	− 0.036***
Household's source of drinking water	0.001	− 0.003	0.001	0.033***	0.044***	− 0.003	0.009***	0.045***	0.054***	0.011***	− 0.011***	− 0.090***
Type of cooking fuel used at household	− 0.080***	− 0.042***	− 0.106***	0.378***	0.326***	0.073***	0.047***	0.354***	0.276***	− 0.035***	− 0.078***	0.026***
Place of residence	0.070***	− 0.088***	0.067***	− 0.295***	− 0.331***	− 0.073***	− 0.026***	− 0.209***	− 0.394***	0.018***	0.120***	− 0.013***
Remained Muslim advantage	0.068***	− 0.081***	0.039***	− 0.133***	− 0.050***	− 0.027***	− 0.005**	− 0.021***	− 0.112***	0.007***	0.026***	− 0.480***
Shifted from Hindu to Muslim advantage#	− 0.025***	0.060***	− 0.019***	0.062***	− 0.036***	0.004	0.002	0.015***	− 0.001	− 0.010***	− 0.004	− 0.212***

Table 7 (continued)

Variables	Shifted from Muslim to Hindu advantage	Birth spacing	Mother's current age	Mother's age at marriage	Mother's age at first birth	Mother's occupation	Type toilet facility at household	Household's source of drinking water	Type of cooking fuel used at household	Place of residence	Remained Muslim advantage	Shifted from Hindu to Muslim advantage
Under 5 deaths												
Religion												
Birth order												
Mother's education												
Mother's mass media exposure												
Mother's sex preference												
Household's head age												
Household's head education												
Household's head wealth quintiles												
Household size												
Years lived in place of residence												
Remained Hindu advantage												
Shifted from Muslim to Hindu advantage	1.000											
Birth spacing	− 0.002	1.000										

Table 7 (continued)

Variables	Shifted from Muslim to Hindu advantage	Birth spacing	Mother's current age	Mother's age at marriage	Mother's age at first birth	Mother's occupation	Type toilet facility at household	Household's source of drinking water	Type of cooking fuel used at household	Place of residence	Remained Muslim advantage	Shifted from Hindu to Muslim advantage
Mother's current age	− 0.002	0.012***	1.000									
Mother's age at marriage	0.005*	− 0.005*	0.016***	1.000								
Mother's age at first birth	0.007***	0.010***	0.029***	0.533***	1.000							
Mother's occupation	0.050***	0.009***	0.002	− 0.053***	− 0.047***	1.000						
Type toilet facility at household	0.139***	0.003	0.011***	0.174***	0.109***	− 0.185***	1.000					
Household's source of drinking water	0.063***	0.000	0.001	− 0.008***	− 0.009***	− 0.111***	0.098***	1.000				
Type of cooking fuel used at household	0.095***	0.009***	0.008***	0.198***	0.138***	− 0.140***	0.505***	0.079***	1.000			
Place of residence	− 0.130***	0.006**	− 0.008***	− 0.155***	− 0.089***	0.181***	− 0.542***	− 0.101***	− 0.438***	1.000		
Remained Muslim advantage	− 0.439***	− 0.009***	− 0.001	− 0.074***	− 0.021***	− 0.012***	− 0.128***	0.060***	− 0.061***	0.081***	1.000	
Shifted from Hindu to Muslim advantage#	− 0.194***	0.022***	0.005**	0.041***	0.036***	0.019***	0.071***	− 0.051***	− 0.049***	0.044***	− 0.375***	1.000

****p* < 0.01, ***p* < 0.05, **p* < 0.1*

Table 8 Robustness check for results in Table 5 using additional predictor variables and the last birth sample: Cox proportional hazard model showing the relative risk of under-five mortality by religion

Predictor variables	Model 1			Model 2			Model 3			Model 4		
	Gross effects			Net of Hindu advantage factors			Net of Muslim advantage factors			Net of both Muslim and Hindu advantage factors		
	Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI	
		LL	UL		LL	UL		LL	UL		LL	UL
Religion												
Hindu[a]												
Muslim	0.932***	0.899	0.966	0.825***	0.78	0.874	0.866***	0.812	0.924	0.891***	0.827	0.96
Others	0.709***	0.678	0.742	0.861***	0.773	0.959	0.89**	0.806	0.982	0.883**	0.78	1.001
Child sex												
Male[a]												
Female				1.066***	1.024	1.11				1.069***	1.016	1.124
Duration of breastfeeding												
Less than 6 months[a]												
More than 6 months				0.03***	0.028	0.033				0.026***	0.024	0.028
Birth order												
1[a]												
2				1.096***	1.034	1.162				1.878***	1.431	2.464
3				1.417***	1.324	1.516				2.429***	1.832	3.22
3+				1.956***	1.818	2.106				3.635***	2.74	4.823
Mother's education												
No[a]												
Yes				0.655***	0.623	0.688				0.816***	0.765	0.87
Mother's mass media exposure												
No[a]												
Yes				0.862***	0.821	0.904				0.951	0.895	1.011
Mother's sex preference												
Son preference[a]												

Table 8 (continued)

Predictor variables	Model 1			Model 2			Model 3			Model 4		
	Gross effects			Net of Hindu advantage factors			Net of Muslim advantage factors			Net of both Muslim and Hindu advantage factors		
	Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI	
		LL	UL		LL	UL		LL	UL		LL	UL
Daughter or no preference				0.839***	0.802	0.877				0.871***	0.826	0.919
Household's head age												
Below 21[a]												
21–29 years				0.771**	0.605	0.984				0.918	0.683	1.233
30–39 years				0.697***	0.548	0.886				0.942	0.704	1.261
40–49 years				0.844	0.661	1.078				1.271	0.944	1.711
50 above				1.031	0.809	1.314				1.426**	1.062	1.915
Household's head education												
Illiterate[a]												
Primary				1.062**	1.008	1.118				1.09**	1.006	1.182
Secondary				0.836***	0.791	0.882				1.031	0.94	1.132
Higher				0.779***	0.696	0.873				1.227**	1.017	1.481
Household's head wealth quintiles												
Poorest[a]												
Poorer				1.062**	1.005	1.122				1.006	0.937	1.079
Middle				1.045	0.985	1.11				1.017	0.944	1.096
Richer				0.823***	0.767	0.882				0.896**	0.817	0.982
Richest				0.65***	0.592	0.713				0.994	0.867	1.139
Household size												
Below 3[a]												
3				0.528***	0.449	0.62				0.592***	0.483	0.727
4				0.317***	0.271	0.37				0.399***	0.329	0.484
5+				0.21***	0.18	0.245				0.248***	0.205	0.3
Years lived in place of residence												

Table 8 (continued)

Predictor variables	Model 1			Model 2			Model 3			Model 4		
	Gross effects			Net of Hindu advantage factors			Net of Muslim advantage factors			Net of both Muslim and Hindu advantage factors		
	Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI	
		LL	UL		LL	UL		LL	UL		LL	UL
Below 5 years[a]												
5–10 years				0.561***	0.53	0.593				0.545***	0.504	0.588
11 years and above				0.49***	0.459	0.522				0.52***	0.477	0.566
Birth weight												
Low[a]												
High							0.407***	0.356	0.465	0.605***	0.52	0.704
Not weighted							1.168***	1.046	1.303	1.37***	1.2	1.564
Birth spacing												
Less than 3 years[a]												
3 years and above							0.717***	0.675	0.761	0.949	0.887	1.016
Mother's current age												
Below 18[a]												
18–29 years							0.251***	0.22	0.288	0.329***	0.28	0.387
30–39 years							0.206***	0.177	0.239	0.218***	0.181	0.263
40–49 years							0.234***	0.195	0.281	0.177***	0.14	0.225
Mother's age at marriage												
Below 18[a]												
18–21 years							0.849***	0.799	0.902	0.857***	0.799	0.919
21 above							0.88**	0.784	0.988	0.87**	0.762	0.994
Mother's age at first birth												
Below 18[a]												
18–21 years							1.044	0.988	1.102	1.141***	1.067	1.219
21 above							1.256***	1.153	1.369	1.286***	1.153	1.436

Table 8 (continued)

Predictor variables	Model 1			Model 2			Model 3			Model 4		
	Gross effects			Net of Hindu advantage factors			Net of Muslim advantage factors			Net of both Muslim and Hindu advantage factors		
	Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI	
		LL	UL		LL	UL		LL	UL		LL	UL
Mother's occupation												
Not working[a]												
Working							0.878**	0.838	0.92	0.902***	0.853	0.954
Partner's education												
Illiterate[a]												
Primary							0.967	0.913	1.023	0.964	0.883	1.052
Secondary							0.767***	0.727	0.81	0.84***	0.768	0.92
Higher							0.702***	0.634	0.776	0.74***	0.625	0.876
Partner's occupation												
Not working[a]												
White collar							0.866	0.732	1.024	0.942	0.776	1.142
Agricultural worker							0.955	0.812	1.122	1.067	0.885	1.286
Service/manual worker							0.831**	0.705	0.978	0.877	0.725	1.06
Type toilet facility at household												
Unimproved[a]												
Improved (not shared)							0.788***	0.735	0.844	0.85***	0.781	0.925
Household's source of drinking water												
Unimproved[a]												
Improved							0.966	0.911	1.024	0.878***	0.82	0.941
Type of cooking fuel used at household												
Unclean[a]												
Clean							0.724***	0.655	0.801	0.664***	0.591	0.745

Table 8 (continued)

Predictor variables	Model 1			Model 2			Model 3			Model 4		
	Gross effects			Net of Hindu advantage factors			Net of Muslim advantage factors			Net of both Muslim and Hindu advantage factors		
	Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI		Hazard ratios	95% CI	
		LL	UL		LL	UL		LL	UL		LL	UL
Place of residence												
Urban[a]												
Rural							0.998	0.937	1.063	1.052	0.972	1.137
States with type of child survival advantage												
Muslim advantage[b]												
Remained Hindu advantage				0.931**	0.879	0.986				1.176***	1.064	1.3
Shifted from Muslim to Hindu advantage				0.894***	0.844	0.948				1.201***	1.085	1.329
Hindu advantage[c]							1.175***	1.12	1.232	1.31***	1.203	1.428
Remained Muslim advantage							0.938*	0.872	1.009			
Shifted from Hindu to Muslim advantage[d]							0.898***	0.84	0.961			
No. of observations	425,253			400,864			211,059			197,727		
Wald Chi^2	227.28			19,919.54			3377.75			16,216.65		
Prob > Chi^2	0.000			0.000			0.000			0.000		

[a] Reference category

[b] Reference category only for model 2

[c] Reference category only for model 3

[d] Reference category only for Model 4

***$p < 0.01$; **$p < 0.05$; *$p < 0.10$

Acknowledgements
We thank the Population Association of America for giving us the opportunity to present the earlier version of this paper at the Annual Meeting 2022. We have immensely benefited from the comments of the chair and other participants of the session 'Social Institutions and Population Health'.

Author contributions
Conception and design of the study: DG, SG, and AR. Acquisition of data: DG. Analysis: DG and SG. Interpretation of data and drafting the manuscript: DG. Reading and revising the manuscript critically for important intellectual content: DG, SG, and AR. All authors read and approved the final manuscript.

Funding
None to declare.

Availability of data and materials
The data sets used and/or analysed for the current study are available from National Family Health Surveys conducted during 1992 to 2016. All the data are publicly accessible at https://dhsprogram.com/data/available-datasets.cfm.

Declarations

Competing interests
The authors declare that they have no known competing interests.

Received: 9 January 2022 Accepted: 2 September 2022
Published online: 27 September 2022

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