

BMJ Open Gender differences in infant survival: a secondary data analysis in rural North India

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ABSTRACT

Objective To examine gender differences in infant survival on the first day of life, in the first week of life, and in the neonatal and post-neonatal periods by socio-demographic and economic variables.

Design Secondary data analysis was performed on data from a cluster randomised trial on the effect of implementation of the Integrated Management of Neonatal and Childhood Illness programme, India.

Settings The study setting was Palwal and Faridabad, districts of Haryana, a state in North India.

Measures Multiple logistic regression models taking the cluster design into account were used to estimate gender differences in mortality in different periods of infancy.

Results A total of 60 480 infants were included in these analyses. Of 4060 infant deaths, 2054 were female (7.2% of all females born) and 2006 were male (6.3% of all males born). The death rate was significantly higher in females in the post-neonatal period but not during the neonatal period. The odds of death at 29–180 days and at 181–365 days were 1.4 (95% CI 1.3 to 1.6) and 1.7 (95% CI: 1.4 to 2.0) higher in females compared with males, respectively. This increase was seen across all socio-demographic and economic strata.

Conclusion Gender differences during the post-neonatal period are a major threat to the survival and health of female infants in India. Programmes need to identify measures that can specifically reduce female mortality.

Trial registration Clinical trials NCT00474981

INTRODUCTION

Child health outcomes continue to be poor in developing countries despite advances in healthcare technology and a strong commitment among national stakeholders.¹ There has been a considerable reduction in under-five mortality over the past decade, but inequalities in the mortality rate persist among population subgroups.^{1–2} Differences in infant and child mortality by both socio-economic status and gender have been documented in India and other middle-income countries.^{3–7} These differences are to a large extent responsible for the observed health inequities seen within and between countries.⁸ Males have higher mortality

Strengths and limitations of this study

- The data came from a well-conducted epidemiological study; the large sample size and low attrition rate are representative of the target population.
- A limitation of this study was that we were not able to consider gender differentials in care-seeking behaviours for common illnesses.
- The complex interplay of caste, wealth and maternal education and occupation could be different in other parts of India.

than females during infancy in developed countries, but females have higher mortality during infancy in India.^{9–10} This variation is attributed to biological, social and environmental conditions.⁹

Data from the National Family Health Survey show that southern states of India, such as Kerala and Tamil Nadu, have about 3–5 times lower gender differentials in child mortality as compared with northern states like Haryana and Punjab.¹¹ Haryana, which is our study setting, is one of the most prosperous states in India and yet has some of the worst statistics for gender-based discrimination.¹² Thus, the overall economic performance of the state is not necessarily reflected in gender equality in health.

How this gender difference in mortality varies throughout infancy is unclear and should be examined using individual-based data. This information would enable us to estimate gender differences in different periods of infancy and various subgroups of the population. This study describes gender differences in infant survival during different periods of infancy (the first day of life, the first week of life, and the neonatal and post-neonatal periods), by socio-demographic and economic variables as measured by caste, mother's education, occupation, household assets and religion.



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METHODS

A secondary data analysis was conducted using data obtained from a cluster randomised trial that examined the effect of implementation of the Integrated Management of Neonatal and Childhood Illness (IMNCI) programme in an area in Haryana with a total population of 1.1 million. The predefined outcomes of the study were neonatal and infant mortality, newborn care practices, and treatment-seeking for neonatal and infant illness.^{13 14} The methods have been described in detail previously.^{13 14} Briefly, 18 primary health centres (PHC) in the district of Faridabad were randomised into intervention and control clusters. The intervention was developed according to the IMNCI guidelines defined by the Government of India. It included training of community health workers (CHW) in various components of IMNCI and strengthening health systems to implement IMNCI, that is, conducting supervision of CHW, providing task-based incentives for IMNCI activities, and ensuring an adequate supply of medicines. Workers independent of intervention implementation visited households with live births on day 29 after the infant's birth and at ages 3, 6, 9 and 12 months to document the vital status of the infant. The follow-up procedures were identical in all clusters. The aim of the present analysis was to estimate the association between neonatal and post-neonatal mortality and gender measured at several intervals throughout the first year of life.

The trial was conducted from January 2008 through March 2010. In this setting, about half of the mothers had never been to school, 25% of the newborns had a low birth weight (<2500 g) and 60% of sick children sought care from medically unqualified private practitioners.^{15 16}

Definition of variables

The following socio-demographic and economic variables were included in the analyses: gender of the infant, mother's education, mother's occupation, caste and religion of the family, household assets, place of birth, and the distance from the PHC to the nearest point on the highway. Mother's education was classified as no (0 years of schooling), primary (1–5 years of schooling) or secondary schooling (6–10 years of schooling). Mother's occupation was classified as non-working or working outside the home. The religion of the family was classified as Hindu, Muslim, Sikh, Christian or others. The caste of the family was classified as Scheduled Caste or Tribe or others. Scheduled Castes and Scheduled Tribes are official designations given to various groups of historically disadvantaged people as per the Constitution of India.¹⁷ Place of birth was classified as home birth or facility birth. The wealth of an individual was determined by a wealth index created using principal component analysis based on all the assets owned by a household. The following variables were used to determine these assets: source of drinking water, use of electricity, type of sanitation, type of cooking fuel used, construction materials used for the roof, floor and walls of the house, ownership of items like

a mattress, a pressure cooker, a chair, a cot/bed, a table, an electric fan, a radio/transistor, a black and white television, a colour television, a sewing machine, a mobile telephone, any other telephone, a computer, a refrigerator, a watch or clock, a bicycle, a motorcycle or scooter, an animal-drawn cart, a car, a water pump, a thresher, a tractor and house ownership; number of household members per sleeping room; and ownership of a bank or post-office account.¹⁸ Using the score from the principal component analysis, the population was divided into five equal wealth quintiles, that is, poorest, very poor, poor, less poor and least poor. Distance from the PHC to the nearest point on the highway was classified as <14 km or ≥14 km based on the 75th percentile.

Statistical analysis

We analysed data using Stata version 13.2 (StataCorp, College Station, TX, USA). We estimated the gender differences in mortality on the first day of life, and in first week of life, neonatal period and post-neonatal period (29–180 days and 181–365 days) in multiple logistic regression models taking the cluster design into account using the 'xtlogit' command in Stata. We included the clusters (PHC) as a random effect in these models. All socio-demographic and economic variables (mother's education, mother's occupation, caste, wealth quintile, place of birth, religion, distance from the PHC to nearest point on the highway) were included as covariates. The associations between gender and other socio-demographic and economic variables with mortality at different periods of infancy were analysed by including interaction terms in the logistic regression models. We also assessed whether there was multicollinearity between the covariates by estimating the variance inflation factors.

RESULTS

A total of 60 702 live births were registered in 18 PHCs. Sixty-two (0.1%) of the infants left the area permanently between birth and 29 days, 156 (0.3%) were temporarily away and 4 (0.01%) refused to participate in the study. Therefore, 60 480 children were included in the gender and mortality analyses. The baseline characteristics of the population are presented in [table 1](#).

Almost 40% of the mothers of children included for analysis had never been to school and most of them (~96%) worked outside the home. Home births were common in this population and occurred in approximately 55% of male and 58% of female children. Most of the children came from Hindu (>80%) families and 25% of children belonged to Scheduled Castes or Tribes. Of 4060 infant deaths, 2054 were in females (7.2% of all females), while 2006 were in males (6.3% of all males). There were 2570 deaths during the neonatal period and of these, 1191 (46.3%) were in females and 1379 (53.7%) in males. The proportion of deaths was higher among males during the neonatal period and the first 7 days of life, but was higher among females during both

Table 1 Baseline characteristics of the study population by gender

Characteristics		Male (n=31 875)	Female (n=28 605)
Mother's education	No schooling (0 years of schooling)	12 524 (39.6)	11 542 (40.6)
	Primary (1–5 years of schooling)	4 913 (15.3)	4 517 (15.9)
	Secondary (6–10 years of schooling)	14 201 (44.9)	12 347 (43.4)
Mother's occupation	Not working	1 057 (3.3)	1 073 (3.8)
	Working outside the home	30 589 (96.7)	27 324 (96.2)
Caste	Others	24 074 (75.9)	21 200 (74.6)
	Scheduled Tribe or Caste	7 637 (24.1)	7 231 (25.4)
Wealth quintiles	Poorest	6 142 (19.4)	5 181 (20.4)
	Very poor	6 229 (19.6)	5 783 (20.3)
	Poor	6 312 (19.9)	5 733 (20.1)
	Less poor	6 413 (20.2)	5 666 (19.9)
	Least poor	6 649 (20.9)	5 476 (19.2)
Place of birth	Home	17 651 (55.4)	16 712 (58.4)
	Facility	14 224 (44.6)	11 893 (41.6)
Religion	Hindu	26 536 (83.6)	23 591 (82.9)
	Muslim	4 932 (15.5)	4 635 (16.3)
	Sikh	257 (0.8)	235 (0.8)
	Christian and others	12 (0.04)	11 (0.04)
Mean (SD) distance from primary health centre to the nearest point on the highway (km)		11.01 (9.8)	11.1 (9.9)

All values are n (%) unless otherwise indicated.

post-neonatal periods (29–180 days and 181–365 days) (table 2). There were 236 more deaths in females than in males during the entire post-neonatal period.

The differences in male and female deaths in different socio-demographic and economic strata are shown in tables 3 and 4. In both post-neonatal periods (i.e. 29–180

days and 181–365 days), females had significantly higher odds of death than males in all strata of maternal education and wealth quintiles. In both post-neonatal age groups, females had significantly higher odds of death than males when the mothers were working outside the home. This increased mortality risk in females was not seen in families where the mother was not working outside the home.

The results from multiple logistic regression for deaths in male and female infants in different age groups are shown in table 5.

A significant association was observed between gender and mortality at age 181–365 days, with females exhibiting significantly higher odds of death than males (OR 1.7, 95% CI 1.4 to 2.0). However, during the first week of life, females exhibited significantly lower odds of death than males (OR 0.8, 95% CI 0.66 to 0.97). There was a significant interaction ($p=0.02$) between gender and caste at age 29–180 days in predicting death.

Females showed significantly higher odds of death than males (OR-1.60, 95% CI 1.4-1.9) in children belonging to other castes than schedule castes or tribes but this increased risk of death in females compared to males was not statistically significant among those belonging to schedule castes or tribes (OR-1.2, 95% CI 1.0-1.5). Other than the interaction effect between caste and gender at

Table 2 Infant deaths by gender in different time periods

Death time period	Male (n=2006)	Female (n=2054)	Total (n=4060)
Neonatal deaths on the first day of life	539 (56.0)	423 (44.0)	962 (23.7)
Neonatal deaths in the first week of life (birth–7 days)	1 101 (54.8)	910 (45.2)	2 011 (49.5)
Neonatal deaths (birth –28 days)	1 379 (53.7)	1 191 (46.3)	2 570 (63.3)
Post-neonatal deaths (29–180 days)	455 (43.2)	598 (56.8)	1 053 (25.9)
Post-neonatal deaths (181–365 days)	172 (39.4)	265 (60.2)	437 (10.8)

All values are n (%) unless otherwise indicated.

Table 3 Post-neonatal deaths (from 29 to 180 days) by socio-demographic variables

Variables		Male (n=11 857)	Female (n=11 143)	Adjusted OR (95% CI)*
Mother's education	No schooling	249 (2.1)	312 (2.8)	1.4 (1.2 to 1.6)
	Primary	78 (1.7)	103 (2.4)	1.4 (1.1 to 1.9)
	Secondary	122 (0.9)	176 (1.5)	1.7 (1.3 to 2.1)
Mother's occupation	Home	24 (2.4)	28 (2.7)	1.1 (0.7 to 2.0)
	Outside the home	425 (1.5)	564 (2.2)	1.5 (1.3 to 1.7)
Caste	Others	292 (1.3)	417 (2.1)	1.6 (1.4 to 1.9)
	Scheduled Tribe or Caste	158 (2.2)	178 (2.6)	1.2 (0.9 to 1.5)
Wealth quintile	Poorest	145 (2.5)	185 (3.3)	1.4 (1.1 to 1.7)
	Very poor	104 (1.8)	147 (2.7)	1.5 (1.2 to 2.0)
	Poor	73 (1.2)	106 (1.9)	1.6 (1.2 to 2.2)
	Less poor	67 (1.1)	86 (1.6)	1.5 (1.1 to 2.0)
	Least poor	62 (1.0)	72 (1.4)	1.4 (1.0 to 2.0)
Place of birth	Home	283 (1.7)	380 (2.4)	1.4 (1.2 to 1.7)
	Facility	172 (1.3)	219 (1.9)	1.5 (1.2 to 1.9)
Religion	Hindu	349 (1.3)	468 (2.1)	1.5 (1.3 to 1.7)
	Muslim	103 (2.2)	128 (2.9)	1.3 (1.0 to 1.7)
Distance from the PHC to the nearest point on the highway	<14 km	307 (1.4)	398 (2.0)	1.5 (1.3 to 1.7)
	≥14 km	148 (1.7)	201 (2.5)	1.5 (1.2 to 1.8)

All values are n (%) unless otherwise indicated.

*Adjusted for cluster design and intervention group.

PHC, primary health centre.

age 29–180 days, none of the other sub-group variables presented in tables 3 and 4 significantly modified the association between gender and mortality.

DISCUSSION

Our analyses show that in the post-neonatal period, females have a substantially higher risk of death as compared with males and this gender difference is seen across all socio-demographic and economic strata. Our analyses also show no gender disparity during the neonatal period, both from birth to 28 days and on the first day of life except for birth to 7 days, when the mortality rate in males is higher than in females. Our data confirm the previously observed female difference in child survival and also allow us to measure interactions between gender and socio-demographic variables.^{3,5}

Female infants are in a biologically advantageous position compared with male infants,¹⁹ so higher female mortality during the post-neonatal period is most likely not due to biological factors. Thus, the excess mortality in female infants is probably caused by societal factors or family building strategies, where females are considered a burden and males as a resource, which again is reflected in gender differentials in healthcare-seeking behaviour.

Our results show that, on average, female infant mortality was 35% higher than male mortality in the post-neonatal period. In 2013, Haryana had a population of 25.3 million, the annual crude birth rate was 21.3 per

1000 population, and female and male infant mortality rates were 42/1000 and 40/1000 live births, respectively.²⁰ According to these figures, roughly 7000 female infant deaths during the post-neonatal period could be averted each year if female infants were given the same level of care as male infants. Similar to the findings of other studies, our results show that the difference between male and female mortality persists despite the declining overall mortality rate.^{3,5,11} Such findings argue that socio-economic development or education alone does not address the mortality gender bias, despite having an impact on the overall mortality rate. Our analysis showed that caste significantly modified the association between gender and mortality from 29 to 180 days. In contrast to the findings of other studies, we did not find an increased risk of female infant mortality among Scheduled Castes and Tribes during the post-neonatal period. However, we did find an increased risk of female mortality among other castes at 29–180 days of life.⁵ This result is in line with our other finding that excess female infant mortality persists in higher socio-demographic strata.

Implications

An important implication of this study is that the influence of gender on health and development should be examined. Academics and policy-makers should investigate whether there are any gender-related trends in health inequalities and whether the apparent benefits of public health interventions are distributed equally

Table 4 Post-neonatal deaths (181–365 days) by socio-demographic variables

Variables		Male (n=12250)	Female (n=10867)	Adjusted OR (95% CI)*
Mother's education	No schooling	98 (0.8)	163 (1.5)	1.8 (1.4 to 2.4)
	Primary	27 (0.6)	41 (1.0)	1.7 (1.0 to 2.7)
	Secondary	47 (0.3)	61 (0.5)	1.5 (1.0 to 2.2)
Mother's occupation	Home	11 (1.1)	10 (1.0)	0.9 (0.4 to 2.1)
	Outside the home	161 (0.6)	254 (1.0)	1.8 (1.5 to 2.2)
Caste	Others	124 (0.5)	176 (0.9)	1.6 (1.3 to 2.1)
	Scheduled Tribe or Caste	48 (0.7)	88 (1.3)	1.9 (1.4 to 2.8)
Wealth quintile	Poorest	63 (1.1)	84 (1.6)	1.4 (1.0 to 2.0)
	Very poor	40 (0.7)	63 (1.2)	1.7 (1.2 to 2.6)
	Poor	26 (0.4)	54 (1.0)	2.3 (1.4 to 3.7)
	Less poor	20 (0.3)	39 (0.7)	2.2 (1.3 to 3.8)
	Least poor	23 (0.4)	25 (0.5)	1.3 (0.8 to 2.4)
Place of birth	Home	130 (0.8)	185 (1.2)	1.5 (1.2 to 1.9)
	Facility	42 (0.3)	80 (0.7)	2.3 (1.6 to 3.3)
Religion	Hindu	127 (0.5)	209 (0.9)	1.9 (1.5 to 2.3)
	Muslim	45 (1.0)	56 (1.3)	1.3 (0.9 to 2.0)
Distance from the PHC to the nearest point on the highway	<14 km	115 (0.5)	176 (0.9)	1.7 (1.4 to 2.2)
	≥14 km	57 (0.7)	89 (1.1)	1.7 (1.2 to 2.4)

All values are n (%) unless otherwise indicated.

*Adjustment for cluster design and intervention group.

PHC, primary health centre.

between males and females. Gender should also be taken into consideration when designing and implementing health programmes and measuring their effects. By examining health issues as regards gender, we can identify areas where gender-specific interventions are urgently required and would be of most benefit.

However, despite gender-oriented programmes and interventions, differences in mortality will persist as long as there are socio-cultural biases against girl children. Gender equity can only be achieved if parents themselves

stop discriminating between their children on the basis of gender.

Gender bias is a significant threat to the survival and health of girls in India.^{21 22} Our analysis shows that removal of this bias would be very beneficial: there would be a 6% reduction in the overall infant mortality rate if the post-neonatal mortality rate in infant girls could be reduced to the level in boys.

Large-scale programmes targeted at the female child should be established. The government has made

Table 5 Associations between gender and mortality by multiple logistic regression analysis*

Mortality time period	Adjusted OR†	95% CI	p Value
Neonatal deaths (birth–28 days)	0.96	0.9 to 1.04	0.32
Neonatal deaths on the first day of life	0.9	0.7 to 1.0	0.06
Neonatal deaths in the first week of life (birth–7 days)	0.8	0.66 to 0.97	0.02
Post-neonatal deaths (29–180 days) ‡	Interaction (see below)		
Gender and caste interaction	0.7	0.6 to 0.9	0.02
Among Schedule Tribes or Castes	1.2	1.0 to 1.5	0.14
Among others	1.6	1.4 to 1.9	<0.0001
Post-neonatal deaths (181–365 days)	1.7	1.4 to 2.0	<0.0001

*Using logistic regression adjusted for cluster design and intervention group and potential confounders (mother's education, mother's occupation, caste, wealth quintiles, place of birth, religion, distance from primary health centre to nearest point on the highway).

†Male as reference category.

‡Caste significantly modified the association between gender and mortality (p=0.02) from 29 to 180 days.

significant efforts to implement programmes in favour of the female child such as banning sex determination during pregnancy²³ and introducing conditional cash transfer schemes for the girl child.²² However, none of these measures seem to have had a significant impact.^{24,25} Transformation of society's attitude to girls is required instead.

STRENGTHS AND LIMITATIONS

The strengths of the study are the use of data from a well-conducted cluster randomised trial, the large sample size, low attrition rate and use of multiple socio-demographic and economic indicators. We chose to use caste, wealth index and mother's education and occupation as they cover different domains. Caste is a good measure of social status which may largely decide customs and social norms. The wealth index is based on material possession and focuses on economic aspects. Maternal education and occupation are measures of women's empowerment but not of socio-economic status.²⁶ Our analysis is less informative regarding the reasons for higher female mortality in the post-neonatal period, such as differences in seeking care, the incidence and prevalence of infectious disease, quality of sources of care, etc. We have not adjusted for potential confounding factors for which information was not available, such as birth weight, gestation, etc.

GENERALISABILITY

Although the study area is a typical north Indian rural setting and is similar to other states in north and north-west India (Uttar Pradesh, Haryana, Punjab, Rajasthan and Madhya Pradesh), where almost one third of the country's population live, it probably does not reflect the entire Indian subcontinent. The complex interplay of caste, household wealth and education could be different in other parts of the country.

CONCLUSION

Female infants have an increased risk of death in the post-neonatal period compared with males across all socio-demographic and economic strata. Specific interventions targeting gender issues are required to reduce the risk of female infant mortality. Gender should be taken into consideration when designing and implementing health programmes and when measuring the effects of health-related policies and interventions.

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Competing interests None declared.

Patient consent Not required as this a secondary data analysis from a cluster randomized trial.

Ethics approval Ethics approval for the primary study was obtained from ethics committees of the Society for Applied Studies (IRB00001359) and WHO (Geneva). Permissions were obtained from state and district authorities, community leaders, and women under surveillance. Informed consent was taken from women with a live birth before the first interview.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement Data used in the analyses for this study are available on request, subject to completion of a data sharing agreement. Please contact nita.bhandari@sas.org.in for further information.

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