RESEARCH PAPER

# Maternal Age at Childbirth and Perinatal and Under-five Mortality in a Prospective Birth Cohort from Delhi

*#Sikha Sinha, $Abha Rani Aggarwal, ‡Clive Osmond, ‡Caroline HD Fall, ^Santosh K Bhargava and *Harshpal Singh Sachdev

*From *Sitaram Bhartia Institute of Science and Research, New Delhi, India; #University School of Medicine and Para-medical Health Sciences, Guru Gobind Singh Indraprastha University, Delhi, India; $National Institute of Medical Statistics, Indian Council of Medical Research, New Delhi, India; ‡MRC Lifecourse Epidemiology Unit, University of Southampton, Southampton, UK; and ^Sunder Lal Jain Hospital, New Delhi, India.*

*Correspondence to: Prof HPS Sachdev, Senior Consultant Pediatrics and Clinical Epidemiology, Sitaram Bhartia Institute of Science and Research, B-16 Qutab Institutional Area, New Delhi 110 016, India. hpssachdev@gmail.com*

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**Objective:** To evaluate the relationship between maternal age at child birth, and perinatal and under-five mortality.

**Design:** Prospective birth cohort.

**Setting:** Urban community.

**Participants:** 9169 pregnancies in the New Delhi Birth Cohort resulted in 8181 live births. These children were followed for survival status and anthropometric measurements at birth (+3 days), 3,6,9 and 12 months (7 days), and every 6 months thereafter until 21 years age. Information on maternal age at child birth and socio-demographic profile was also obtained.

**Outcome measures:** Offspring mortality from 28 weeks gestation till 5 years age.

**Results:** Offspring mortality (stillbirths – 5 years; $n$=328) had a U-shaped association with maternal age ($P$<0.001). Compared to the reference group (20-24 years), younger (≤19 years) and older (≥ 35 years) maternal ages were associated with a higher risk of offspring mortality (HR: 1.68; 95% CI 1.16, 2.43 and HR 1.48; 95% CI 1.01, 2.16, respectively). In young mothers, the increased risk persisted after adjustment for socio-economic confounders (maternal education, household income and wealth; HR 1.51; 95% CI 1.03, 2.20) and further for additional behavioral (place of delivery) and biological mediators (gestation and birthweight) (HR 2.14; 95% CI 1.25,3.64). Similar associations were documented for post-perinatal deaths but for perinatal mortality the higher risk was not statistically significant ($P$ >0.05). In older mothers, the increased mortality risk was not statistically significant ($P$ >0.05) after adjustment for socio-economic confounders.

**Conclusion:** Young motherhood is associated with an increased risk of post-perinatal mortality and measures to prevent early childbearing should be strengthened.

**Key Words:** *Child mortality, Risk factors, Teenage pregnancy.*

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Reduction of under-five child mortality, the target of Millennium Development Goal 4 (MDG 4), has shown remarkable progress globally since 1990, with the highest average annual reduction rate of 4% during 2005-2013 [1]. Sub-Saharan Africa and South Asia continue to have the highest under-five mortality burden; India had 49 under-five deaths per 1000 live births in 2013 [2], and is lagging behind the committed target [3,4]. Perinatal mortality, which includes stillbirth, has received much less global attention despite being most common in low- and middle-income countries (LMIC) [5], and has declined at a slower rate than under-five mortality.

Current interventions for improving child health and survival focus primarily on medical aspects including immunization, and improving access to healthcare and illness management, eventhough social factors are also important. Optimal maternal age at child bearing is one such undervalued factor [6]. Early marriage and child-bearing are still quite prevalent in India, especially in rural areas; 18% and 47% are married before 15 years and 18 years, respectively [7]. If extremes of maternal age contribute substantially to stillbirths and child mortality, ensuring an optimal age at childbirth merits greater priority as an intervention for accelerating progress.

*Accompanying Editorial: Pages 868-69.*

Cross-sectional data suggest that children born to mothers <20 years of age are at increased risk for perinatal, neonatal and under-five child mortality [8-12]. However, this existing evidence has important methodological limitations. There is scant data from longitudinal cohorts in LMIC [13] exploring the association between maternal age at childbirth and mortality, particularly in relation to stillbirths. We, therefore, evaluated the relationship of maternal age with perinatal and under-five mortality in the New Delhi Birth Cohort (NDBC), using appropriate statistical techniques and adjustment for confounders and mediators.

## METHODS

The NDBC was drawn from a population of 119,799 living in a 12 $km^2$ area of south Delhi during 1969-72 [14,15]. 20,755 married women of reproductive age were recruited and followed regularly every other month to record menstrual dates. During recruitment, a social worker obtained information on maternal schooling and age, household structure including family income, number of family-members, ownership and type of residence, and sanitation and water supply facilities. Women who became pregnant were followed every two months initially and on alternate days from the 37$^{th}$ week of gestation to determine the pregnancy outcome. There were 9169 pregnancies, resulting in 8181 live births. Survival status and anthropometric measurements (length and weight) of these babies were recorded within 72 hrs of birth, at the ages of 3, 6, 9 and 12 months (±7 days) and every 6 months until 21 years by trained personnel.

*Statistical analysis*: From the available data, mortality could be categorized as perinatal (28 weeks gestation to 6 postnatal days), late neonatal (7-28 days), post-neonatal to infant (29 days-1 year), and thereafter at yearly intervals until 5 years. However, due to small numbers in each of these categories, we used the following categories in our analysis: (*i*) all deaths between 28 weeks of gestation and five years of age (including stillbirths), (*ii*) perinatal mortality (28 weeks of gestation-6 days), and (*iii*) post-perinatal mortality (7 days- 5 years age).

Data analysis was performed using SPSS version 20.0. Student's *t*-test and Chi square test were used to compare descriptive statistics between alive and dead cases. Associations of maternal age at birth with mortality were determined using Cox Proportional Hazard Model [16]. Maternal age was initially used in a continuous format and the quadratic term was used to assess the non-linear associations. Subsequently, it was divided into five groups (≤19, 20-24, 25-29, 30-34 and ≥35 years) with 20-24 years (maximum sample size) as the reference category.

The associations between maternal age and offspring mortality were evaluated in a stepwise manner. Crude analyses adjusted for the child's sex, followed by adjustment for confounders, and later for additional mediators. We included only those potential confounders and mediators, which were significantly ($P$<0.05) different between children who survived and those who died. Confounders included for adjustment were socio-economic factors (maternal education, per capita annual household income and household wealth). Household wealth scores were derived from the 1$^{st}$ principal component [17] for the combination of type of housing and ownership, sanitation, water supply and crowding (number of people/room); a higher score related to better wealth. The potential mediators available and considered for additional adjustment were behavioural (place of delivery and breastfeeding status), and biological (birth weight and gestation). As breastfeeding status was relevant only for the post-perinatal deaths, it was not included. The final primary analyses models were: (*i*) Model 1- adjusted for sex, (*ii*) Model 2- adjusted for sex and socio-economic confounders (maternal education, household income and household wealth); and (*iii*) Model 3- adjusted for sex, socio-economic confounders and mediators (place of delivery, gestation and birth weight). A sensitivity analysis was also performed on Model 3 with additional adjustments for breastfeeding status (only for post-perinatal deaths). Linear and quadratic associations between maternal age and socio-economic confounders and mediators were also analyzed.

## RESULTS

At the time of recruitment in 1969-1972, 60 percent of cohort families had an income above 50 rupees per month (national average, 28) and only 15 percent of parents were illiterate (national average, 66). Nevertheless, 43% of families lived in one room. Hindus were the majority religious group (84%) [15]. Information on maternal age at child birth was available for 5886 subjects (mean (SD) age 25.9 (5.3) years). All of them were married and 67% of them living in masonry buildings with good water supply and sanitation facilities. Only 31.5% of the mothers had received 10 or more years of education.

There were 328 deaths reported up to 5 years of age including stillbirths, with no significant sex differences (***Table* I**). Most deaths (84%) had occurred by 1 year of age, with neonatal to infant (41.1%), perinatal (29.0%) and late neonatal (13.7%) deaths being the major contributors. Demographic and birth characteristics among those censored (alive) and those who died are compared in ***Web Table* I.** Considering all deaths, children who had died were born smaller and at an earlier gestation than survivors. Their mothers had less education and poorer housing, water supply and sanitation facilities, and lower per capita annual household income and household wealth scores.

**TABLE I** SEX-WISE MORTALITY DISTRIBUTION

| *Mortality period* | *Male* | *Female* | *Total* |
|---|---|---|---|
| Perinatal (28 wk gestation-6 d) | 52 (33.3) | 43 (25.0) | 95 (29.0) |
| Late neonatal (7 d-28 d) | 21 (13.5) | 24 (13.9) | 45 (13.7) |
| Post-neonatal infant (29 d-1 y) | 64 (41.0) | 71 (41.3) | 135 (41.1) |
| 1-2 y | 10 (6.4) | 23 (13.4) | 33 (10.0) |
| 2-3 y | 5 (3.2) | 5 (2.9) | 10 (3.1) |
| 3-5 y | 4 (2.6) | 6 (3.5) | 10 (3.1) |
| Total | 156 | 172 | 328 |

*All values in No.(%). No statistically significant sex differences.*

However, there were no differences in mean maternal age at childbirth and birth order. An analysis restricted to post-perinatal and perinatal deaths, yielded similar findings. Predominant breastfeeding was nearly universal (98.9% at birth and 91.5% at 3 months) but practised more often in survivors. However, for perinatal deaths, the place of delivery and most of the socio-economic variables were not significantly different, except for household income and house-ownership.

All the socio-economic confounders (maternal education, household income and household wealth), and mediators (place of delivery, gestation and birthweight) had inverted U-shaped relationship with maternal age ($P\leq0.001$ for quadratic term) (***Web Table* II**). Both younger and older age of mothers was associated with lower education, household income, wealth, birthweight and gestation, and less likely to deliver in the healthcare services. Maternal age was unrelated to breastfeeding status.

Offspring mortality (stillbirths – 5 years) had a significant U-shaped relationship with maternal age ($P<0.001$), which persisted after adjustment for socio-economic status confounders ($P=0.003$) and mediators ($P=0.018$) (***Web Table* III**). There were similar associations, of borderline significance in the mediator-adjusted model ($P=0.07$), for post-perinatal deaths. However, for perinatal deaths there was no evidence of a significant ($P>0.05$) quadratic association.

*All deaths (stillbirths and mortality till five years of age)*: ***Table* II** depicts the risk of offspring mortality across the five maternal age groups. In comparison to mothers aged 20-24 years, younger (≤19 years) and older (≥35 years) maternal ages were associated with higher offspring mortality (stillbirth – 5 years) (HR:1.68; 95% CI 1.16, 2.43 and HR 1.48; 95% CI 1.01, 2.16, respectively). After adjustment for socio-economic confounders, this higher risk persisted for younger mothers (HR 1.51; 95% CI 1.03, 2.20) but not for older mothers (HR 0.99; 95% CI 0.66, 1.48). On further adjustment for mediators, offspring of both younger and older mothers had a higher risk of mortality (HR 2.14; 95% CI 1.25, 3.64 and HR 1.74; 95% CI 1.02, 2.97, respectively). In order to estimate the change in effect size of the association with additional confounder and mediator adjustments (which led to reductions in sample size), models 1 and 2 were run on the available sample for the fully adjusted model 3 (***Fig.* 1**). The hazard ratios for both younger and older mothers were sequentially attenuated from the crude to the fully adjusted models. The mothers available for fully adjusted model 3 (after reduction in sample size) were comparatively educated and had marginally higher household income and wealth score.

*Post-perinatal or perinatal deaths:* A similar pattern was found for post-perinatal mortality; the increased risk being statistically significant ($P<0.05$) for all three models in younger but not older mothers. The attenuation pattern was similar for perinatal deaths but the increased risk was not statistically significant. There were no instances for which the point estimate in one time interval was outside the 95% confidence for the other time interval, thereby suggesting that the effect sizes were similar or hazard was proportional in both perinatal and post-perinatal categories.

On sensitivity analyses (data not presented), the mortality risk for younger and older mothers remained similar after additional adjustments for birth-order (all three death categories) and breastfeeding (post-perinatal deaths).

## DISCUSSION

In this prospective cohort study, offspring of young (<20 years) mothers had an increased risk of mortality from the perinatal period up to age five years, primarily after the early neonatal period. An apparently similar dis-advantage in older (>35 years) mothers was principally a reflection of their adverse socio-economic profile.

Persistence of a higher overall mortality risk in children of young mothers, despite adjustments for confounders and mediators, suggests a causal relationship. Similar effects were evident for post-perinatal deaths but not for perinatal mortality. This could either reflect a true biological difference or insufficient statistical power for the perinatal mortality component, which showed broadly similar associations (29-95 deaths in various models). The confounder-adjusted association for post-perinatal mortality was further attenuated after the introduction of mediators and, except breastfeeding, the other three biological and

**TABLE II** ASSOCIATION BETWEEN DIFFERENT MATERNAL AGE-GROUPS AND OFFSPRING MORTALITY

| *Variables* | *Model 1 Hazard ratio (95% CI) (P value)* | *Model 2 Hazard ratio (95% CI) (P value)* | *Model 3 Hazard ratio (95% CI) (P value)* |
|---|---|---|---|
| *All deaths* | | | |
| Number of deaths/total sample (deaths + censored) | 328/5886 | 316/5478 | 156/4154 |
| *Maternal age (years)* | | | |
| -19 | 1.68 (1.16; 2.43) (0.006) | 1.51 (1.03; 2.20) (0.033) | 2.14 (1.25; 3.64) (0.005) |
| 20-24 | Reference | Reference | Reference |
| 25-29 | 1.00 (0.76; 1.31) (0.982) | 0.94 (0.71; 1.24) (0.655) | 1.34 (0.88; 2.05) (0.178) |
| 30-34 | 1.00 (0.71; 1.40) (0.990) | 0.77 (0.54; 1.09) (0.140) | 1.02 (0.59; 1.74) (0.956) |
| 35+ | 1.48 (1.01; 2.16) (0.043) | 0.99 (0.66; 1.48) (0.968) | 1.74 (1.02; 2.97) (0.042) |
| *Perinatal deaths* | | | |
| Number of deaths/total sample (deaths + censored) | 95/5886 | 91/5478 | 29/4154 |
| *Maternal age (years)* | | | |
| -19 | 1.51 (0.78; 2.92) (0.219) | 1.42 (0.72; 2.83) (0.312) | 1.22 (0.32; 4.63) (0.775) |
| 20-24 | Reference | Reference | Reference |
| 25-29 | 0.90 (0.54; 1.48) (0.667) | 0.84 (0.50; 1.40) (0.498) | 1.07 (0.40; 2.83) (0.891) |
| 30-34 | 0.91 (0.49; 1.69) (0.759) | 0.77 (0.40; 1.45) (0.410) | 0.85 (0.22; 3.31) (0.817) |
| 35+ | 0.93 (0.41; 2.09) (0.852) | 0.61 (0.25; 1.49) (0.280) | 1.73 (0.51; 5.90) (0.380) |
| *Post-perinatal deaths* | | | |
| Number of deaths/total sample (deaths + censored) | 233/5483 | 225/5080 | 127/3894 |
| *Maternal age (years)* | | | |
| -19 | 1.77 (1.13; 2.75) (0.012) | 1.57 (1.00; 2.46) (0.052) | 2.39 (1.33; 4.28) (0.003) |
| 20-24 | Reference | Reference | Reference |
| 25-29 | 1.05 (0.75; 1.46) (0.790) | 0.98 (0.70; 1.38) (0.911) | 1.38 (0.86; 2.22) (0.180) |
| 30-34 | 1.04 (0.70; 1.56) (0.845) | 0.76 (0.50; 1.16) (0.209) | 1.05 (0.59; 1.89) (0.862) |
| 35+ | 1.73 (1.13; 2.67) (0.013) | 1.14 (0.72; 1.79) (0.580) | 1.69 (0.93; 3.08) (0.087) |

*Model 1: adjusted for sex; Model 2: adjusted for sex, socio-economic confounders (maternal education, household income and wealth); and Model 3: adjusted for sex, socio-economic confounders and biological mediators (place of delivery, gestation and birth weight).*

behavioural factors (place of delivery, gestation and birth weight) were significantly related to young maternal age. The increased risk appears to be partly operating through lower birth weight and gestation [6], and less utilization of health care services (home delivery). These factors; however, are of limited relevance for the stillbirth component of perinatal mortality as the event is likely to determine the birth weight, gestation and access to health care rather than the converse. In contrast, the increased overall mortality risk in older mothers was not evident after socio-economic adjustments. Older maternal age may thus not biologically predispose the offspring to higher mortality, and older mothers are also likely to be more experienced in child care practices. In a recent meta-analysis of five birth cohorts from LMIC (of which NDBC was one) children of older mothers had a higher risk of preterm birth, but had better nutritional status and schooling after similar confounder adjustment [6]. Older mothers available for the fully adjusted model 3 had higher education and wealth score, which along with a lower sample size could explain the observed statistically significant associations.

Earlier cross-sectional data, including pooled analyses from 118 demographic and health surveys conducted between 1990 and 2008 in 55 low and middle income countries (LMIC), also documented a higher risk of perinatal, neonatal, infant and under-five mortality in young mothers [8-12,18-23]. It is suggested that this risk

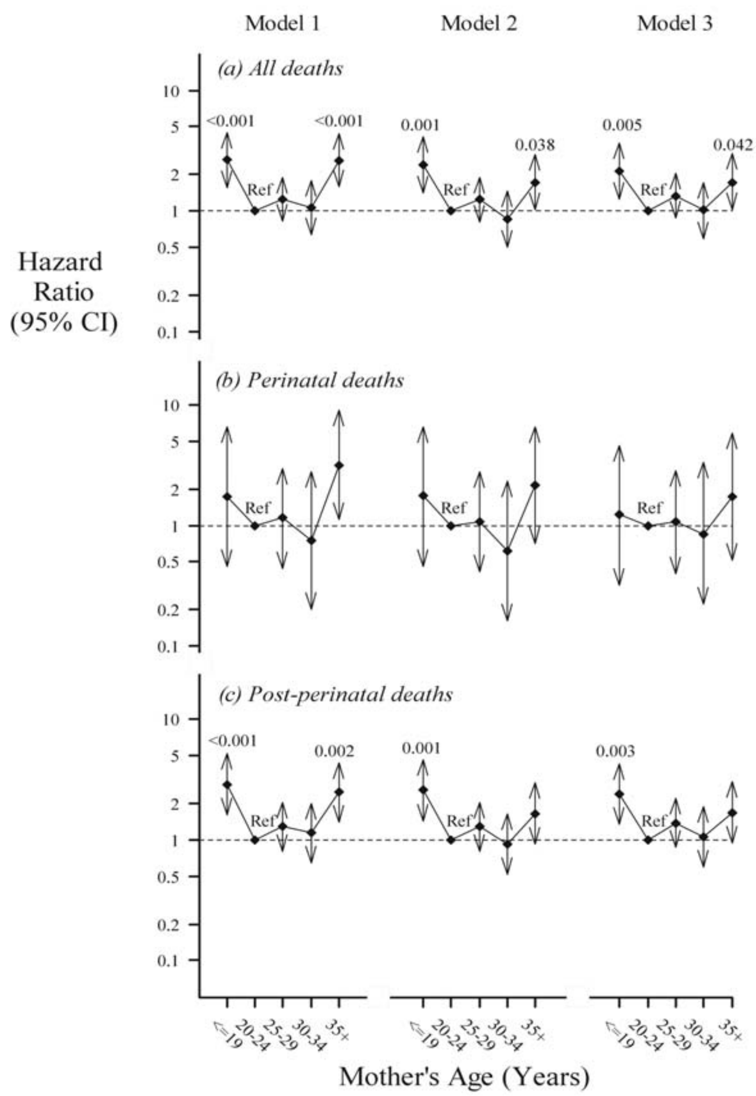


**FIG. 1** *Hazard ratio for mortality across different age groups of maternal age at childbirth (a) all deaths till five years including stillbirths (Number of deaths/total sample: 156/4154); (b) Perinatal deaths (Number of deaths/total sample: 29/4154); (c) Post-perinatal deaths (Number of deaths/total sample: 127/3894). (Model 1: adjusted for sex; Model 2: further adjusted for socio-economic confounders and Model 3: further adjusted for mediators (type of delivery, gestation and birth weight). The bars represent 95% confidence interval for the hazard ratio and figures at the top of the bars are P value for significant age groups. Ref: Reference age group.*

may operate through both biological and social mechanisms. Some studies also documented a higher risk in older mothers or J or U shaped association, particularly for unadjusted models [18,24]. However, this evidence has important limitations: (*a*) Cross-sectional design and variation in context and time period; (*b*) Sub-optimal confounder adjustments; (*c*) Non-linear relationships have been rarely explored; and (*d*) Prospective data collection, to minimize bias, is mostly restricted to developed countries. Three population-based cohorts in Brazil (1982, 1993 and 2004) observed an increased risk of post-neonatal infant mortality (confounder adjusted OR 1.6; 95% CI 1.2, 2.1) in children of young (<20 years) mothers but not for stillbirths, perinatal deaths or neonatal mortality [13]. Further adjustment for mediating variables (place of delivery, gestation and birth weight) led to the disappearance of the excess of post-neonatal mortality. It was concluded that social and environmental factors may be more important than biological immaturity for this increased mortality. However, in our data, the increased risk for post-perinatal deaths persisted even after

**WHAT IS ALREADY KNOWN?**

- Cross-sectional analyses, often with inadequate confounder adjustments, suggest that young motherhood is associated with perinatal, neonatal and under-five mortality

**WHAT THIS STUDY ADDS?**

- This prospective birth cohort data with confounder and mediator adjustments indicate that children of teenage mothers are at an increased risk of post-perinatal mortality, and measures to prevent young motherhood should be strengthened. An apparently similar disadvantage in older (>35 years) mothers is principally a reflection of their adverse socio-economic profile.

confounder and mediator adjustment, suggesting a causal relationship. These observed differences, among other factors, could relate to contextual variability, baseline mortality risk, social characteristics of young mothers, social and health care support systems and methodological differences (surveillance *versus* prospective cohort follow up, including or excluding mothers ≥30 years and restricting outcomes to infant or under-five mortality). We thus hypothesize that young maternal age predisposes the offspring to higher post-perinatal mortality, which only partly operates through socio-economic deprivation and biological-behavioural mediators (lower birthweight and gestation, and poorer access to healthcare); the additional precise biological mechanisms need further exploration.

Strengths of our study are a large sample size, prospective community-based recording of confounders, mediators and outcomes until five years age from a South Asian setting, and appropriate analyses. The following limitations also merit consideration: (*i*) the relevance of four decades old data for contemporary programmes could be questioned. However, the findings have important programmatic implications for several regions in the country that even now have similar fertility, mortality, poor socio-economic, water supply and sanitation and health access indicators. Further, there was no evidence of secular changes in associations in data spread over 2-3 decades. [13,18]; (*ii*) data are missing for some variables; however, most of this pertains to mediators rather than confounders and this is a familiar scenario in large prospective cohort studies from LMIC; (*iii*) there may be some residual unadjusted confounding; (*iv*) a separate category of early neonatal deaths was not available for analysis. In community settings in India, it is challenging to discern a live newborn from a stillbirth within the first day of delivery.

Offspring of teenage mothers in LMIC not only have poorer child survival, but are also disadvantaged at birth and during childhood, and have reduced human capital [6]. Measures to prevent young motherhood are currently underrated as public health interventions; these should receive greater prominence and investments in the proposed child health and survival agenda [25]. Teenage marriages and pregnancies are declining in India [26,27]. However, as per latest national estimates, 32% of all women and 40% of those illiterate are married before 18 years [26]; the intervention thus still retains importance, particularly in rural and tribal regions. Further, greater care and support is necessitated for their vulnerable children in public health programs. It would be unethical to conduct randomized controlled trials on this subject. However, operational and behavioural research to prevent young motherhood in different contexts is desirable. Pooled analyses from recent similar cohorts in LMIC could confirm the utility of this intervention with improvements in access to health care.

In conclusion, children of teenage mothers are at an increased risk of post-perinatal mortality and measures to prevent young motherhood should be strengthened.

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**WEB TABLE I** COMPARISON OF BIRTH AND DEMOGRAPHIC CHARACTERISTICS AMONG THOSE CENSORED AND THOSE WHO DIED

| *Variable* | *Stillbirth to under-five* | | | | | *Only perinatal* | | | | | *Only Post-perinatal* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Censored Alive (N= 5558)* | | *Deaths (N=328)* | | *P1* | *Censored Alive (N= 5791)* | | *Deaths (N=95)* | | *P2* | *Censored Alive (N= 5250)* | | *Deaths N=233)* | | *P3* |
| | *N* | *Mean (SD)/%* | *N* | *Mean (SD)/%* | | *N* | *Mean (SD)/%* | *N* | *Mean (SD)/%* | | *N* | *Mean (SD)/%* | *N* | *Mean (SD)/%* | |
| **Child** | | | | | | | | | | | | | | | |
| *Birth order* | | | | | | | | | | | | | | | |
| 1 | 5369 | 19.0 | 314 | 20.4 | 0.242 | 5591 | 18.9 | 92 | 27.2 | 0.216 | 5077 | 18.7 | 222 | 17.6 | 0.068 |
| 2 | | 26.2 | | 22.0 | | | 26.0 | | 26.1 | | | 26.2 | | 20.3 | |
| 3 | | 21.8 | | 20.4 | | | 21.7 | | 19.6 | | | 21.7 | | 20.7 | |
| 4+ | | 33.0 | | 37.3 | | | 33.4 | | 27.2 | | | 33.4 | | 41.4 | |
| Gestation (wks) | 4890 | 38.9 (2.7) | 239 | 37.9 (3.4) | <0.001 | 5063 | 38.9 (2.7) | 66 | 37.2 (4.0) | <0.001 | 4655 | 38.9 (2.7) | 173 | 38.2 (3.2) | <0.001 |
| Birth weight (g) | 4644 | 2806 (427) | 208 | 2398 (619) | <0.001 | 4814 | 2795 (437) | 38 | 1968 (661) | <0.001 | 4338 | 2810 (426) | 170 | 2494 (568) | <0.001 |
| Birth length (cm) | 4545 | 48.3 (2.2) | 165 | 46.8 (3.1) | <0.001 | 4692 | 48.3 (2.2) | 18 | 44.6 (4.2) | <0.001 | 4246 | 48.3 (2.2) | 147 | 47.1 (2.9) | <0.001 |
| Low Birth weight (<2500 g) | 4644 | 24.8 | 208 | 54.8 | <0.001 | 4814 | 25.7 | 38 | 71.1 | <0.001 | 4338 | 24.3 | 170 | 51.2 | <0.001 |
| Predominantly breastfed at birth | | | | | | | | | | | 3507 | 99.0 | 130 | 96.2 | 0.012 |
| Predominantly breastfed at 3 months | | | | | | | | | | | 3741 | 91.7 | 72 | 80.6 | 0.004 |
| **Mother** | | | | | | | | | | | | | | | |
| Married | 5555 | 100.0 | 326 | 100.0 | 1.000 | 5788 | 100.0 | 93 | 100.0 | 1.000 | 5247 | 100.0 | 233 | 100.0 | 1.000 |
| Age (years) | 5558 | 25.8 (5.2) | 328 | 26.1 (6.1) | 0.326 | 5791 | 25.9 (5.3) | 95 | 25.5 (5.8) | 0.473 | 5250 | 25.9 (5.2) | 233 | 26.4 (6.2) | 0.160 |
| *Education (formal years)* | | | | | | | | | | | | | | | |
| Illiterate (0) | 5548 | 35.2 | 327 | 52.0 | <0.001 | 5781 | 36.1 | 94 | 38.3 | 0.043 | 5241 | 34.7 | 233 | 57.5 | <0.001 |
| Primary (1-5) | | 15.9 | | 15.3 | | | 15.7 | | 22.3 | | | 15.9 | | 12.4 | |
| Middle (6-10) | | 15.8 | | 17.1 | | | 15.8 | | 20.2 | | | 16.0 | | 15.9 | |
| Matric (up to 10) | | 20.6 | | 12.2 | | | 20.3 | | 14.9 | | | 20.9 | | 11.2 | |
| College (10 to 14) | | 12.4 | | 3.4 | | | 12.1 | | 4.3 | | | 12.5 | | 3.0 | |
| *Place of delivery* | | | | | | | | | | | | | | | |
| Home | 5177 | 38.4 | 298 | 50.7 | <0.001 | 5389 | 38.9 | 86 | 44.2 | 0.319 | 4870 | 38.4 | 212 | 53.3 | <0.001 |
| Healthcare service | | 61.6 | | 49.3 | | | 61.1 | | 55.8 | | | 61.6 | | 46.7 | |
| *Family Demography* | | | | | | | | | | | | | | | |
| Household income | 5553 | 850.0 (2.1) | 325 | 622.5 (1.9) | <0.001 | 5784 | 838 (2.1) | 94 | 688 (1.9) | 0.010 | 5245 | 850 (2.1) | 231 | 598.0 (2.0) | <0.001 |

*Contd....*

*Web Table I continued*

**WEB TABLE I** COMPARISON OF BIRTH AND DEMOGRAPHIC CHARACTERISTICS AMONG THOSE CENSORED AND THOSE WHO DIED

| *Variable* | *Stillbirth to under-five* | | | | *P1* | *Only perinatal* | | | | *P2* | *Only Post-perinatal* | | | | *P3* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Censored Alive (N= 5558)* | | *Deaths (N=328)* | | | *Censored Alive (N= 5791)* | | *Deaths (N=95)* | | | *Censored Alive (N= 5250)* | | *Deaths N=233)* | | |
| | *N* | *Mean (SD) / %* | *N* | *Mean (SD) / %* | | *N* | *Mean (SD) / %* | *N* | *Mean (SD) / %* | | *N* | *Mean (SD) / %* | *N* | *Mean (SD) / %* | |
| (per capita in Rs.)* | | | | | | | | | | | | | | | |
| *Type of housing* | | | | | | | | | | | | | | | |
| Thatched hut | 5543 | 1.6 | 320 | 4.1 | <0.001 | 5771 | 1.8 | 92 | 0.0 | 0.114 | 5235 | 1.5 | 228 | 5.7 | <0.001 |
| Masonry building | | 66.3 | | 76.6 | | | 66.8 | | 71.7 | | | 65.8 | | 78.5 | |
| Block of flats | | 27.7 | | 18.4 | | | 27.2 | | 28.3 | | | 28.1 | | 14.5 | |
| Bungalow | | 4.4 | | 0.9 | | | 4.3 | | 0.0 | | | 4.5 | | 1.3 | |
| Owned house | 5542 | 40.8 | 319 | 38.2 | 0.380 | 5769 | 40.8 | 92 | 29.3 | 0.032 | 5234 | 41.8 | 227 | 41.9 | 1.000 |
| Crowding | 5182 | 3.6 (1.8) | 319 | 3.9 (2.0) | <0.001 | 5408 | 3.6 (1.8) | 93 | 3.5 (1.9) | 0.539 | 4874 | 3.6 (1.8) | 226 | 4.1 (2.1) | <0.001 |
| *Sanitation* | | | | | | | | | | | | | | | |
| Open field | 5188 | 22.2 | 321 | 37.4 | <0.001 | 5416 | 23.0 | 93 | 29.0 | 0.429 | 4880 | 21.6 | 228 | 40.8 | <0.001 |
| Scavenger cleaned | | 37.4 | | 38.0 | | | 37.5 | | 32.3 | | | 37.9 | | 40.4 | |
| Pit | | 2.1 | | 2.8 | | | 2.1 | | 3.2 | | | 1.9 | | 2.6 | |
| Flush | | 38.3 | | 21.8 | | | 37.4 | | 35.5 | | | 38.5 | | 16.2 | |
| *Water supply* | | | | | | | | | | | | | | | |
| Unprotected | 5547 | 17.9 | 320 | 25.6 | <0.001 | 5775 | 18.3 | 92 | 16.3 | 0.649 | 5239 | 17.4 | 228 | 29.4 | <0.001 |
| Both (Unprotected & Protected) | | 9.0 | | 15.9 | | | 9.4 | | 12.0 | | | 8.8 | | 17.5 | |
| Protected | | 73.1 | | 58.4 | | | 72.3 | | 71.7 | | | 73.8 | | 53.1 | |
| Household wealth score (Standardized 'Z') | 5173 | 0.03 (1.00) | 317 | -0.44 (0.95) | <0.001 | 5398 | 0.002 (1.0) | 92 | -0.09 (0.9) | 0.403 | 4865 | 0.04 (0.99) | 225 | -0.58 (0.92) | <0.001 |

** Geometric mean from log transformed values; P1 refers to P value for comparison between those censored (alive) and those with mortality from stillbirth until 5 years age, P2 refers to P value for comparison between those censored (alive) and those with perinatal deaths and P3 refers to P value for comparison between those censored (alive) and those with post- perinatal deaths*

**WEB TABLE II** ASSOCIATION OF MATERNAL AGE AS A CONTINUOUS VARIABLE WITH THE AVAILABLE CONFOUNDERS AND MEDIATORS (ADJUSTED FOR SEX)

| *Variables* | *N* | *Maternal age (per decade)* | | *Maternal age (per decade) (quadratic term)* | |
|---|---|---|---|---|---|
| | | *Coefficient (95% CI)* | *P value* | *Coefficient (95% CI)* | *P value* |
| Maternal education# | 5875 | 2.96 (2.45; 3.48) | <0.001 | -0.59 (-0.68; -0.50) | <0.001 |
| Household income (₹)* | 5878 | 0.36 (0.09; 0.62) | 0.008 | -0.12 (-0.16; -0.07) | <0.001 |
| Wealth$ | 5490 | 1.58 (1.20; 1.95) | <0.001 | -0.27 (-0.34; -0.21) | <0.001 |
| Place of delivery (Healthcare services in comparison to home) | 5475 | 7.95 (3.65; 17.31) | <0.001 | 0.67 (0.58; 0.77) | <0.001 |
| Gestation (weeks) | 5129 | 1.74 (0.67; 2.81) | 0.001 | -0.31 (-0.50; -0.12) | 0.001 |
| Birth weight (grams) | 4852 | 736 (561; 912) | <0.001 | -116 (-147; -85) | <0.001 |
| Feeding at birth (only for post perinatal cases) | 3637 | 0.77 (0.01; 49.78) | 0.903 | 1.10 (0.54; 2.24) | 0.795 |
| Birth order | 5683 | 4.51 (4.16; 4.86) | <0.001 | -0.61 (-0.68; -0.55) | <0.001 |

*#Maternal education categorized as 1- illiterate, 2- Primary, 3- Middle, 4- Matric and 5- College; * log transformed; $Household wealth was derived as 1st factor score generated from principal component analysis of type of housing, type of residence, sanitation, water supply and crowding (number of people/room).*

**WEB TABLE III** ASSOCIATION BETWEEN MATERNAL AGE AS A CONTINUOUS VARIABLE AND MORTALITY

| *Variables* | *Model 1Hazard ratio (95% CI) (P value)* | *Model 2Hazard ratio (95% CI) (P value)* | *Model 3Hazard ratio (95% CI) (P value)* |
|---|---|---|---|
| *Mortality: All deaths* | | | |
| Number of deaths/total sample (deaths + censored) | 328/5886 | 316/5478 | 156/4154 |
| Maternal age (per decade) | 0.10 (0.03; 0.35) (<0.001) | 0.12 (0.03; 0.46) (0.002) | 0.13 (0.02; 0.80) (0.028) |
| Maternal age (per decade) (quadratic term) | 1.52 (1.22; 1.90) (<0.001) | 1.42 (1.12; 1.79) (0.003) | 1.45 (1.07; 1.97) (0.018) |
| Sex (female in comparison to male) | 1.21 (0.97; 1.50) (0.090) | 1.19 (0.95; 1.48) (0.130) | 1.00 (0.73; 1.37) (0.986) |
| Maternal education# | | 0.90 (0.80; 1.01) (0.077) | 0.88 (0.75; 1.05) (0.150) |
| Household income (₹)* | | 0.70 (0.56; 0.86) (0.001) | 0.69 (0.51; 0.94) (0.019) |
| Wealth$ | | 0.72 (0.63; 0.81) (<0.001) | 0.74 (0.62; 0.88) (0.001) |
| Place of delivery (Healthcare services in comparison to home) | | | 1.27 (0.90; 1.78) (0.174) |
| Gestation (weeks) | | | 0.95 (0.90; 1.00) (0.062) |
| Birth weight (kg) | | | 0.17 (0.11; 0.24) (<0.001) |
| *Mortality: Perinatal deaths* | | | |
| Number of deaths/total sample (deaths + censored) | 95/5886 | 91/5478 | 29/4154 |
| Maternal age (per decade) | 0.10 (0.01; 1.23) (0.072) | 0.10 (0.01; 1.39) (0.086) | 0.21 (0.004; 10.59) (0.436) |
| Maternal age (per decade) (quadratic term) | 1.46 (0.95; 2.26) (0.086) | 1.43 (0.90; 2.72) (0.132) | 1.35 (0.70; 2.58) (0.369) |
| Sex (female in comparison to male) | 0.91 (0.61; 1.36) (0.643) | 0.97 (0.65; 1.47) (0.901) | 0.76 (0.36; 1.62) (0.476) |
| Maternal education# | | 0.94 (0.77; 1.15) (0.556) | 0.99 (0.68; 1.44) (0.944) |
| Household income (₹)* | | 0.68 (0.46; 1.00) (0.050) | 0.69 (0.34; 1.39) (0.296) |
| Wealth$ | | 1.07 (0.84; 1.34) (0.596) | 1.20 (0.79; 1.83) (0.391) |
| Place of delivery (Healthcare services in comparison to home) | | | 2.81 (1.03; 7.68) (0.045) |
| Gestation (weeks) | | | 0.99 (0.86; 1.13) (0.826) |
| Birth weight (kg) | | | 0.06 (0.02; 0.14) (<0.001) |
| *Mortality: post-perinatal deaths* | | | |
| Number of deaths/total sample (deaths + censored) | 233/5483 | 225/5080 | 127/3894 |
| Maternal age (per decade) | 0.10 (0.02; 0.45) (0.003) | 0.13 (0.03; 0.62) (0.011) | 0.16 (0.02; 1.30) (0.086) |
| Maternal age (per decade) (quadratic term) | 1.53 (1.18; 1.98) (0.001) | 1.41 (1.08; 1.84) (0.013) | 1.38 (0.97; 1.96) (0.071) |
| Sex (female in comparison to male) | 1.36 (1.05; 1.76) (0.021) | 1.28 (0.99; 1.67) (0.062) | 1.07 (0.75; 1.53) (0.703) |
| Maternal education# | | 0.88 (0.77; 1.02) (0.080) | 0.86 (0.71; 1.04) (0.115) |
| Household income (₹)* | | 0.70 (0.54; 0.90) (0.006) | 0.72 (0.51; 1.01) (0.059) |
| Wealth$ | | 0.61 (0.53; 0.71) (<0.001) | 0.66 (0.54; 0.80) (<0.001) |
| Place of delivery (Healthcare services in comparison to home) | | | 1.08 (0.75; 1.57) (0.685) |
| Gestation (weeks) | | | 0.95 (0.89; 1.01) (0.110) |
| Birth weight (kg) | | | 0.23 (0.15; 0.35) (<0.001) |

**log transformed; #Maternal education categorized as 1- illiterate, 2- Primary, 3- Middle, 4- Matric and 5- College; $Household wealth was derived as 1st factor score generated from principal component analysis of type of housing, type of residence, sanitation, water supply and crowding (number of people/room).*

*Model 1: adjusted for sex; Model 2: adjusted for sex, socio-economic confounders (maternal education, household income and wealth), Model 3: sex, socio-economic confounders and mediators (place of delivery, gestation and birth weight).*
*The sample sizes in models varied because of completeness of data for all variables.*