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Article

Association between modern contraceptive use and child mortality in India: A calendar data analysis of the National Family Health Survey (2015-16)

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ABSTRACT:

Background: Influence of contraceptive use on increased gap between successive births and attributed reduced risk of child deaths is well documented in developing countries. However, there is scarcity of evidence on direct contribution of contraceptive use on child survival especially in Indian context.

Methods: Using information given in the reproductive calendar history of the National Family Health Survey of India conducted in 2015–16, this study examines the effect of modern contraceptive use on childhood mortality – infant mortality rate (IMR) and under-five mortality rate (U5MR). Bivariate analysis and cox proportional hazard model is applied in the study.

Results: Finding reveals that use of reversible contraceptives prior to birth resulted in low childhood mortality rates. IMR is 35 per 1000 live births among births with preceding use of modern reversible contraceptives as compared to 44 per 1000 live births among births with no use. Similarly, U5MR is 41 per 1000 live births as compared to 61 per 1000 live births among births with preceding use of contraceptive and no use respectively. The use of reversible modern contraceptives prior to birth is protective against child mortality even among births with preceding birth interval of less than 24 months.

Conclusions: This study provides evidence of dual benefit of contraceptive use. Such information is important for promoting evidence-based advocacy to expand use of family planning services. This will help the country to achieve Sustainable Development Goal 3.2 which calls for end of preventable deaths during childhood.

1. Introduction

Family planning is one of the most cost-effective and high-return health investments given that its benefits go beyond controlling births. Existing evidence show that the practice of family planning increases survival of both mothers and their children (Brhanie & Asires, 2016; Guttmacher Institute, 2002). Child mortality rates are found to be higher in countries where fewer women use modern contraceptive methods compared to countries where prevalence of modern contraceptive rate is very high (Guttmacher Institute, 2002).

Previous research showing the influence of family planning on child survival, often used length of preceding birth intervals as a byproduct of expanding contraceptive practices. It is widely believed that the use of contraceptives enable women in lengthening birth intervals and assist them with spacing between two successive births (Hailu & Gulte, 2016; Saha & Soest, 2013).

Several studies have found strong negative association between short birth intervals and neonatal mortality (Rutstein, 2005; Tsui & Creanga, 2009), infant mortality (Cleland, Conde-Agudelo, Peterson, Ross, & Tsui, 2012; Rutstein, 2005; Smith, Ashford, Gribble, & Clifton, 2009) and under-five mortality (Rutstein, 2005). In India too, few studies have examined effect of contraceptive use on child survival by evaluating the relationship between birth interval and child mortality. Studies based on national surveys have found that short preceding birth intervals are associated with an increased risk of mortality in childhood ages 0–5, especially in the early post-neonatal period (28 days- 1year) (Bhalotra & Soest, 2006; Pandey, Choe, Luther, Sahu, & Chand, 1998; Whitworth & Stephenson, 2002).

However, explaining the influence of contraceptive use on reduced childhood mortality through long preceding birth intervals could not be considered as adequate explanation given that preceding birth intervals are not only influenced by contraceptive use, rather by a variety of

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factors such as breastfeeding, sexual abstinence, mother's nutritional status, secondary sterility and survival status of the previous birth (Fall et al., 2003; Jain & Bongaarts, 1981; Kirk & Pillet, 1998; Orji, Shittu, Makinde, & Sule, 2004). Moreover, contraceptive use does not only help women to space between births but also prevents pregnancies considered to be at high risk i.e. pregnancies taking place too early or late in the mother's age, at high parity or any unwanted pregnancy when the mother is physically and economically not ready to have a child (Starbird, Norton, & Marcus, 2016). Those children whose mothers are at extreme maternal ages, high parities and short birth intervals are considered to have low chances of survival. Contraceptive use reduces mortality in children by preventing these unwanted and high-risk pregnancies (Starbird et al., 2016; WHO, 1995). Therefore, it is logical to establish a direct link between contraceptive use during interpregnancy period and risk of child mortality, instead of interpreting effect of birth intervals on child survival as proxy of contraceptive use influence.

To the best of our knowledge, so far only two studies have tried to explore the direct linkage between contraception and child survival (Finlay, 2012; Tsui & Creanga, 2009). Both of these studies were multi country analysis using survey data and found evidence that independent of birth interval, contraceptive use during interpregnancy interval has a direct positive effect on child mortality (Finlay, 2012; Tsui & Creanga, 2009). As mentioned earlier, the available research for India does not explicitly address the direct contribution of contraceptive method use on child mortality. Present study is an attempt to fill this research gap in establishing the role of modern contraceptive use in lengthening birth intervals and examining the effect of contraceptive use on child survival.

2. Material and methods

2.1. Data

Data for this cross-sectional analysis is drawn from the National Family Health Survey (NFHS) conducted in 2015–16, the fourth in the NFHS series, which provides information on population, health, and nutrition for India and each state and union territory. In the survey, total 723,875 eligible women aged 15–49 were identified for individual women's interviews, of which 699,686 interviews were completed, with a response rate of 97 percent. A detailed description of the study design and sample is available in the national report (IIPS & ICF, 2017) and elsewhere (Ram, 2014; Shekhar et al., 2014). In this present study, information from the calendar data along with women and birth history files is used to examine the relationship between contraceptive use, birth interval, and child mortality. The calendar of the NFHS collects a complete history of women's reproduction and contraceptive use for a period of between 5 and 7 years prior to the survey. It collects month-by-month history on four events: (a) births, pregnancies, and contraceptive use and non-use; (b) reason for contraception discontinuation; (c) marriage; and (d) ultrasonography during pregnancy.

Here the calendar data is decoded, and the episodes of contraceptive use are prepared using first column (vcal_1). vcal_1 gives information about births, pregnancies and contraceptive use. An episode of contraceptive use is defined as the time between last two births, where a woman may or may not use specific contraceptive methods. All women, who used any modern reversible contraceptives (Condom, pills, IUD, injectables and other modern reversible methods) within the episode are coded as '1', otherwise '0'. The analysis only includes cases where the women has had more than one birth within the calendar period of five years. This enabled us to track the use of modern reversible contraceptive between two consecutive births. Also, since the NFHS calendar data had information only for last 60 months, the analysis is limited to sample size of 77,914 births i.e. children born of birth order 2 and above within 5 years preceding the survey. However, it should be noted here that this sub sample is representative of the total sample of the survey.

2.2. Outcome variables

The outcomes of interest in this paper are high risk births, infant mortality and under-five mortality. Women with high risk births are defined as giving birth below 18 years or above 35 years of age, or women of high birth order (more than 3 children), or women with short preceding birth interval (less than 24 months) or if the child was unwanted. Infant mortality rate (IMR) is defined as probability of dying before reaching 1 year of age. Similarly, under-five mortality rate (U5MR) is defined as probability of dying before reaching 5 year of age. The outcomes are considered as dichotomous variable e.g.; for infant mortality, all children who died before completing age one is coded as 1 and rest of the children were coded as 0. Similarly, for under-five mortality, all children dying between ages 0–5 years are coded as 1 whereas rest are coded as 0.

2.3. Predictor variables

Two key predictor variables are considered in the analysis: use of modern reversible contraceptive (condom, pills, IUD and injectables) prior to birth and preceding birth intervals (less than 24 months, 24 months and above).Other confounders included in the analysis are mother's age at birth (less than 20 years, 20–25 years, 25–30 years, more than 30 years), mother's education (illiterate, 1–5 years of schooling, 5–10 years of schooling, 10+ years of schooling), household wealth quintiles (poorest, poorer, middle, richer, richest), religion (Hindu, Muslim, other), caste (others, Other Backward Caste, Scheduled Caste/Scheduled Tribes – SC/ST), place of residence (rural and urban), duration of breastfeeding (0–6 months, more than 6 months), previous child alive (no, yes), child was unwanted (no, yes) and sex of the child (male, female).

2.4. Statistical analysis

Bivariate and multivariate analyses are used in this study. Infant mortality rates and under-five mortality rates (with 95% confidence intervals) are estimated using life table technique. Correlates of highs risks births and short birth intervals are identified using binary logistic regression model because the outcome variable was dichotomous. Cox Proportional Hazard model is used to examine effect of contraceptive use and birth interval on child mortality after adjusting for the selected socio-demographic variables, and to estimate the survival function of children under the age of one year and five years. The survival time "t" is taken from the time of the birth to the event of interest, which in this case is death of child or the time of interview if the child is still alive. Proportional hazard models allows us to simultaneously test the effect of several variables on child survival (Klein & Moeschberger, 1997; Valsecchi, Silvestri, & Sasieni, 1996). The Proportional Hazards Model, which stems from the work of Cox (1972) (Cox, 1972) assumes that for an individual with a vector of covariates in x, the hazard rate (death rate) at time t is given by:

$$h_i\,(t_i, X_i) = h_0(t_i)\,\exp\,(\beta_i X_i)$$

National women weights are used for weighting and all the analysis is done in statistical software "STATA" (version 13).

3. Results

3.1. Sample characteristics of births

Almost half of the births are from women in the age group 20–25 years, 10% from women less than 20 years, and 13% from women more than 30 years (Table 1). About two-fifths (38%) of the births are from illiterate women, 16% births are from women with education up to primary level and the remaining 45% are from women has education up

Table 1
Distribution of selected sample of births by background characteristics, 2015–16, India.

Background characteristics	Number	Percentage
Mother's age at birth		
Less than 20 years	7974	10.2
20–25 years	38,013	48.8
25–30 years	21,979	28.2
More than 30 years	9948	12.8
Parity		
2	39,289	50.4
3	19,408	24.9
More than 3	19,217	24.7
Mother's education		
Illiterate	29,863	38.3
1–5 years of schooling	12,677	16.3
5–10 years of schooling	25,587	32.8
Above 10 years of schooling	9787	12.6
Place of residence		
Rural	62,689	80.5
Urban	15,225	19.5
Caste		
Others	14,739	18.92
OBC	31,005	39.79
SC/ST	32,170	41.29
Religion		
Hindu	55,227	70.9
Muslim	13,490	17.3
Others	9197	11.8
Housed wealth quintile		
Poorest	25,061	32.2
Poorer	20,250	26.0
Middle	15,082	19.4
Richer	10,929	14.0
Richest	6592	8.5
Use of modern reversible methods prior to birth		
No	70,287	90.2
Yes	7627	9.8
Preceding birth interval		
Less than 24 months	32,695	42.0
24 months and above	45,219	58.0
Total	77,914	100.0

All numbers are unweighted sample.

Table 2
Infant mortality and under-five mortality rates by contraceptive use and preceding birth interval, 2015–16, India.

	IMR	95% CI	U5MR	95% CI
Use of modern reversible methods prior to birth				
No	44.3	(42.7,45.9)	60.5	(52.2,70.0)
Yes	34.9	(30.8,39.4)	41.0	(34.6,48.6)
Preceding birth interval				
Less than 24 months	56.4	(53.9.59.0)	73.1	(64.7,82.5)
24 months and above	33.7	(32.0,35.4)	40.7	(38.2,43.3)
Total	43.4	(41.9,44.9)	59.3	(51.1, 68.7)

Note- Mortality rates are calculated using calendar data of women who had at least two births within five years prior to the survey (NFHS 4:2010–2015).

to secondary and above. Among the selected sample, 80% are from rural areas and 20% are from urban areas. Modern reversible contraceptive methods are used prior to only 10% of the births and 42% of the births have preceding birth interval of less than 24 months.

Both infant and under-five mortality rates are high among women who had not used modern reversible contraceptives prior to the birth Table 2. For instance, infant mortality rate is 44 per 1000 live births among those who are not using modern reversible methods, and 35 per 1000 live births among those who had used modern reversible methods. Similarly, under-five mortality rate is 61 per 1000 live births among those who had not used modern reversible method compared to 41 per 1000 live births among those who had used the methods prior to the birth. Infant mortality rate was 56 per 1000 live births when the preceding births interval was less than 24 months compared to 34 per 1000 live births when the birth interval was 24 months and above. A similar pattern is observed for under-five mortality rate as well – U5MR was 73 per 1000 live births vs. 41 per 1000 live births.

3.2. Effect of contraceptive use on high risk births, birth interval, child mortality

Logistic regression analysis, predicting correlates of high-risk births indicates that contraceptive use prior to birth is associated with the lower odds of high-risk births (Table 3). For instance, odds ratio of having a high-risk birth was 0.46 (CI: 0.44-0.49) when women used modern reversible contraceptives prior to the birth, compared to those who did not use the modern reversible method.

In Table 4 effect of contraceptive use on birth interval, infant and under-five mortality is presented. Women who used modern reversible contraceptives prior to the birth are more likely to have (OR 2.72; CI: 2.57-2.89) preceding birth interval of 24 months or above. Use of modern reversible contraceptives prior to birth has independent effect on under-five mortality, users has 0.72 lower hazard of mortality during 0–5 ages. Birth interval also independently effects child mortality in both the age groups 0–1 and 0–5 years.

The results of the interaction effect of birth interval and of use of modern reversible contraceptives prior to birth on child mortality is also shown in Table 4. Here the interaction of use of modern reversible contraceptives prior to birth and preceding birth intervals are categorized into four categories – no use of modern reversible methods and preceding birth interval of less than 24 months, used modern reversible methods and preceding birth interval of less than 24 months, no use of modern reversible methods and preceding birth interval of 24 months and above, and both use of modern reversible methods and preceding birth interval of 24 months and above.

Table 3
Results from logistic regression analysis examining the association between contraceptive and high-risk births, 2015–16, India.

	Odds Ratio of high-risk births	95% of CI
Used modern reversible method prior to birth		
No®		
Yes	0.46***	[0.44,0.49]
Previous child alive		
No®		
Yes	0.40***	[0.38,0.43]
Mother's age at birth		
Less than 20 years®		
20–25 years	0.60***	[0.57,0.63]
25–30 years	0.82***	[0.78,0.87]
More than 30 years	2.49***	[2.32,2.69]
Mother's education		
Illiterate®		
1–5 years of schooling	0.83***	[0.80,0.87]
5–10 years of schooling	0.68***	[0.65,0.71]
Above 10 years of schooling	0.58***	[0.55,0.61]
Place of residence		
Rural®		
Urban	1.00	[0.96,1.04]
Caste		
Others®		
OBC	1.00	[0.96,1.04]
SC/ST	1.03	[0.98,1.08]
Religion		
Hindu®		
Muslim	1.27***	[1.22,1.33]
Others	1.17***	[1.11,1.23]
Household wealth quintile		
Poorest®		
Poorer	1.00	[0.96,1.05]
Middle	0.99	[0.95,1.04]
Richer	0.97	[0.92,1.02]
Richest	0.79***	[0.73,0.84]

**p < 0.05, ***p < 0.01.

Table 4
Results from logistic regression and cox hazard model showing independent and interaction effect of contraceptive use on birth interval, infant mortality and under-five mortality, 2015–16, India.

	Odds ratio of preceding birth interval <24 months	Hazard ratio of Infant mortality	Hazard ratio of under-five mortality
Model1			
Used modern reversible method prior to birth			
No			
Yes	2.72*** (2.57,2.89)	0.75(0.52,1.08)	0.72*(0.52,0.99)
Model 2			
Birth interval			
Less than 24 months			
24 months and above		0.58*** (0.49,0.69)	0.59*** (0.51,0.69)
Model 3			
Interaction of birth interval and modern reversible method prior to birth			
No use of modern reversible method and preceding birth interval less than 24 months			
Used modern reversible method prior to birth		0.34** (0.18,0.65)	0.35*** (0.20,0.63)
Preceding birth interval≥24 months		0.56*** (0.47,0.66)	0.57*** (0.49,0.66)
Used modern reversible method prior to birth and preceding birth interval ≥ 24 months		0.63* (0.42,0.96)	0.61*(0.42,0.89)

*p < 0.10 **p < 0.05, ***p < 0.01. IMR is infant mortality and U5MR is under five mortality. All models are controlled for independent variables mentioned in the method section.

Use of modern reversible contraceptives prior to birth reduces the risk of infant as well as under-five mortality – (hazard ratio was 0.34 for infant mortality 0.35 for U5MR) compared to those who did not use reversible contraceptives nor had large birth intervals. Risk of infant and under-five mortality is less among those women who only had preceding birth intervals of 24 months and above – (hazard ratio of infant mortality is 0.56, and for U5MR is 0.57). Among those births where women had used reversible contraceptives and had the preceding birth intervals of 24 months and above the hazard ratio was 0.64 for infant mortality and 0.61 for U5MR. Hazard ratio of childhood mortality was significantly high among girl child, higher parity births, and among children belonged to SC/ST. The hazard ratio was low with survival status of previous child and mother's high level of education.

4. Discussion

Using calendar data of the National Family Health Survey 2015–16, conducted in India, this paper examined effect of modern contraceptive use on birth interval and childhood mortality. The present analysis, in consistence with earlier findings revealed that women who use reversible modern contraceptives prior to birth have longer birth intervals compared to non-users (Hailu & Gulte, 2016; Yeakey et al., 2009; Yoder, Lugalla, & Sambaiga, 2013). And these long birth intervals are protective against child mortality (Bhalotra & Soest, 2006; Pandey, Choe, Luther, Sahu, & Chand, 1998; Whitworth & Stephenson, 2002).

For long, this association has been seen as the evidence for the contribution of family planning in reducing child mortality. However, present study reveals that even in the absence of long birth intervals, contraceptive use reduces the risk of infant and child mortality. Strengthening birth intervals is only one of the pathways through which contraceptives use increases child survival. Women's use of modern contraceptive methods indicates that these women have better access to healthcare. And hence they have better knowledge and access to maternal and child health programs. Moreover, usage of contraceptives prevents unwanted pregnancies, some of which may have resulted in child death.

The WHO recommends an interval of at least 24 months between two births (WHO, 2005), however in India, many births take place with preceding birth interval shorter than the intervals recommended. Women giving births in these short birth intervals need extra care and precaution. Usage of contraceptives among women can be considered as a proxy for their contact with health workers or their access to health facilities. They are equipped with better knowledge and hence are able to avoid many risks related to short birth interval pregnancies.

While the study findings offer important insights into the effect of contraceptive use on infant and child mortality, the results may be interpreted cautiously considering certain limitations. Calendar data provided in NFHS, may have recall bias as women are asked to recall contraceptive history on a month-by-month basis for up to 80 months prior to the interview. This sample is limited to births within 5 years prior to survey, hence not all the children will have exposure of the full 5 years for estimating under-five mortality. However, comparison of these estimates with NFHS 4 shows very little difference e.g. in NFHS 4 infant mortality is 40.7 whereas in this sample it is 43.4. Moreover, it only includes inter-birth intervals from women with 2 or more births hence it can be seen as a conservative test of influence of family planning on child mortality. Moreover, the cross-sectional type of data inhibits from establishing any causal inferences between the variables in this study.

5. Conclusions

Overall, this analysis provides important insights into the benefits of contraceptive use. Contraceptive use increases birth intervals which increases child survival, but even in the absence of longer birth intervals, it reduces risk of infant and child mortality. Present findings emphasize the fact that contraception is not only centered around avoiding births, but access to reliable birth control methods will allow women to time the birth of the next child, which will help women's own health as well as their children's health. Women using contraception are more aware and better informed of maternal and child health care services and hence can take better care of their offspring. According to the NFHS 2015-16 findings, use of reversible methods has shown a slight increase from 10% in 2005-06 to 11% in 2015-16 especially in rural areas where it has increased from 7% in 2005-06 to 10% in 2015–16. States like Uttar Pradesh, Bihar, Chhattisgarh and Jharkhand have low mCPR and high child mortality rates (IIPS & ICF, 2017). Considering the high child mortality in India, it can be recommended that, increasing use of reversible contraceptives can be a cost-effective strategy to achieve the Sustainable Development Goals –3.2– related to child mortality.

Ethics statement

The study is based on the National Family Health Survey (NFHS) 2015-16 dataset which is available in the public domain with no identifiable information on the survey participants; therefore, no ethics statement is required for this work. The data can be downloaded from www.DHSprogram.com on proper request.

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Declaration of competing interest

None.

CRediT authorship contribution statement

Ankita Shukla: Software, Formal analysis, Writing - original draft, Writing - review & editing, Conceptualization, Methodology. **Abhishek Kumar:** Conceptualization, Methodology, Resources, Supervision, Writing - review & editing. **Arupendra Mozumdar:** Resources, Supervision, Writing - review & editing. **Kumudha Aruldas:** Resources, Supervision, Writing - review & editing. **Rajib Acharya:** Resources, Supervision, Writing - review & editing. **F. Ram:** Resources, Supervision, Writing - review & editing. **Niranjan Saggurti:** Resources, Supervision, Writing - review & editing.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2020.100588.

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