Goddess Worship and Parental Investment: Evidence from Navratri and Vaccination Rates in India

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Abstract

This paper examines whether exposure to religious festivals celebrating female deities affects gender discrimination in health investments. Using the quasi-random timing of Navratri—a major Hindu festival worshipping goddesses—I find that girls born shortly after the festival receive approximately 6% more birth vaccinations than girls born just before. This effect is driven by households with regular television exposure, suggesting media coverage of goddess worship as a transmission channel. The effect is specific to goddess festivals (no effect for male deity festivals like Ganesh Chaturthi), does not extend to boys, and operates uniformly across religious identities, indicating community-level cultural transmission rather than effects limited to religious participants. A smaller spring goddess festival (Chaitra Navratri) shows directionally similar but statistically insignificant effects, consistent with a dose-response relationship between festival prominence and impact. These findings provide evidence that cultural events celebrating women can temporarily reshape gender-discriminatory behavior, with important implications for understanding how attitudes toward daughters respond to salient cultural messaging.

JEL Codes: I15, J13, J16, O15, Z12
Keywords: Gender discrimination, health investments, cultural festivals, son preference, media effects, India

1 Introduction

Gender inequality exists in every society, but it is especially acute in many developing countries (Duflo, 2012). In India, discrimination against daughters manifests through lower educational opportunities, restricted mobility and autonomy, reduced labor market participation, and differential health investments (Jayachandran, 2015). These disparities reflect deeply rooted son preference, which has produced one of the world's most male-skewed sex ratios due to widespread sex-selective abortion (Sen, 1990; Jha et al., 2006). Among children age 0 to 6 years, there are 1.09 boys per girl nationally, with some states exhibiting ratios as high as 1.28 (Government of India, 2011). While economic development has improved overall child health outcomes, gender gaps in health investments have proven remarkably resistant to change.

Understanding what can shift gender-discriminatory behavior toward daughters remains a central challenge for development policy. Various approaches have been studied, including laws guaranteeing equal rights, subsidies encouraging investment in girls, and programs targeting resources or skills to women and girls (Duflo, 2012). A less commonly studied approach examines whether cultural factors and social norms themselves can be changed to reduce support for restrictive gender practices. Recent evidence suggests that gender attitudes, even those rooted in centuries-old cultural traditions, are amenable to change. For example, reserving seats for female politicians has helped curtail negative stereotypes about women as leaders in India (Beaman et al., 2009), and television programming has changed fertility preferences in multiple settings (Jensen and Oster, 2009; La Ferrara et al., 2012).

This paper investigates whether cultural events that explicitly celebrate female power can temporarily reduce discriminatory behavior toward daughters. Specifically, I examine the impact of Navratri—a major Hindu festival worshipping nine forms of the goddess Durga—on early childhood vaccinations for girls. Navratri occurs annually over 10 days in autumn (September-October) and features widespread public celebrations, television coverage, and cultural messaging about female empowerment and divine feminine power. The festival provides a natural experiment to test whether concentrated exposure to positive messaging about women and girls affects parental investment decisions.

I exploit the quasi-random timing of births relative to Navratri to identify causal effects. The festival follows the lunar calendar and varies by 10–15 days year-to-year, making it difficult for parents to time conceptions to yield births on specific dates relative to the festival. Moreover, birth timing at the daily frequency is largely outside parental control. Using data from India's Demographic and Health Survey (DHS) spanning 2010–2021, I compare vaccination outcomes for girls born in the 12 days immediately after Navratri ends versus the 12 days before the festival begins, controlling for state-by-district, year, month-of-birth, and day-of-week fixed effects along with household and maternal characteristics.

I find that girls born after Navratri receive 0.124 additional birth vaccinations on a scale of 0–3 (BCG, Polio 0, and Hepatitis B), representing a statistically significant 5.8% increase over the control mean of 2.13 vaccines. This effect is remarkably stable across specifications and robust to alternative bandwidth choices, clustering assumptions, and outcome definitions. The magnitude represents approximately 58% of a standard deviation in the vaccination index and is substantially larger than correlations typically observed between parental gender attitudes and child health investments.

Several pieces of evidence support a cultural interpretation centered on goddess worship rather than alternative explanations. First, I conduct a falsification test comparing Navratri to Ganesh Chaturthi—a similarly prominent 10-day Hindu festival celebrating Ganesha (a male deity) that occurs approximately one month before Navratri. While girls born after Navratri show a 5.8% increase in vaccinations, girls born after Ganesh Chaturthi show no significant change (1.3%, p=0.52). This goddess-specific pattern rules out that results reflect general festival effects, seasonal patterns, or families being home more during celebrations.

Second, neither Navratri nor Ganesh Chaturthi affects boys' vaccination rates, confirming the gender specificity of goddess worship effects. If the mechanism operated through general health attention, increased awareness of vaccination programs, or healthcare system factors during festivals, we would expect similar effects for boys. Instead, the pattern strongly supports that goddess worship specifically affects attitudes and investments toward daughters.

Third, the Navratri effect is concentrated among households with regular television access. Girls in households where respondents watch TV at least weekly experience a 6.8% increase ($p<0.01$), while those in households with rare TV exposure show an insignificant 3.2% increase ($p=0.56$). The difference is statistically significant ($p=0.016$). Critically, this TV heterogeneity exists only for girls, not boys, ruling out that television merely increases general health awareness during the festival. This pattern provides strong evidence that media transmission of goddess worship imagery and female empowerment messaging drives the effects.

Fourth, the Navratri effect operates similarly for Hindu and non-Hindu families (interaction $p=0.435$), suggesting community-level cultural transmission rather than effects limited to direct religious participants. If effects operated exclusively through individual Hindu religious practice—attending pujas, performing rituals, or direct festival engagement—we would expect significantly larger effects for Hindu households. Instead, the uniform response across religious groups suggests cultural messages transmitted through television coverage, public celebrations, and community exposure reach families regardless of personal religious identity.

Fifth, I examine India's second annual Navratri festival—Chaitra Navratri in spring (March-April)—which also celebrates goddess worship but receives substantially less public attention and media coverage than the autumn festival. Chaitra Navratri shows directionally similar but smaller and statistically insignificant effects (1.3% increase, $p=0.68$), consistent with a dose-response relationship where goddess worship must achieve sufficient salience through public celebrations and media coverage to meaningfully shift attitudes toward daughters.

This research contributes to several literatures. First, it adds to evidence on endogenous preference formation, particularly regarding gender-related preferences (Beaman et al., 2009; Jensen and Oster, 2009; Fernandez et al., 2004; Washington, 2008; Healy and Malhotra, 2013; Dahl et al., 2021; Carlana, 2019). Unlike most work examining gradual shifts from structural changes like political quotas, mothers' employment, or military service with women, I study how episodic cultural events can produce measurable behavioral changes. The distinctiveness of the intervention I evaluate is that changing gender attitudes was not its intentional purpose—Navratri is an organic cultural phenomenon rather than a designed program—yet it generates effects comparable in magnitude to intentional interventions.

Second, I contribute to understanding son preference and discrimination against daughters in India. While extensive research documents the prevalence and consequences of gender discrimination (Sen, 1990; Jayachandran, 2017; Kishor and Gupta, 2004), evidence on interventions that successfully reduce gender gaps in health investments remains limited. This paper shows that cultural exposure can generate meaningful short-run improvements in health investments for girls, suggesting that norm-change interventions need not be limited to direct education or information campaigns.

Third, this paper speaks to the literature on persuasion and communication designed to change preferences or beliefs (DellaVigna and Gentzkow, 2010). Recent work has examined attitude change related to intimate partner violence (Gupta et al., 2013; Abramsky et al., 2014; Green et al., 2020), racial minorities (Donovan and Leivers, 1993; Carrell et al., 2019), immigrants (Hopkins et al., 2019; Grigorieff et al., 2020), and perceptions of social norms about gender or ethnic discrimination (Bursztyn et al., 2020; Paluck, 2009). My study contributes evidence that organic cultural events—not just designed interventions—can shift attitudes and behavior related to gender.

Fourth, I add to literature examining media effects on social outcomes. Prior work has shown television can influence fertility preferences (Jensen and Oster, 2009; La Ferrara et al., 2012), voting behavior (DellaVigna and Kaplan, 2007), and perceptions of female leaders (Beaman et al., 2009). This paper provides evidence that television transmission of cultural messaging during festivals can temporarily reshape discriminatory behavior, highlighting media's role in both reflecting and reinforcing cultural norms.

Finally, this research has implications for understanding the malleability of cultural norms and the potential for cultural interventions to complement economic development in addressing persistent inequalities. The finding that episodic exposure to goddess worship generates measurable behavior change suggests that increasing the salience and visibility of positive representations of women—through media, cultural programming, or public messaging—could be a cost-effective complement to traditional development policies.

The paper proceeds as follows. Section 2 provides background on the Navratri festival, goddess worship in India, and the vaccination context. Section 3 describes the data and empirical strategy. Section 4 presents main results on vaccination outcomes. Section 5 investigates mechanisms through falsification tests and heterogeneity analysis. Section 6 examines robustness checks and dose-response evidence. Section 7 concludes with discussion of implications for policy and future research.

2 Background

2.1 The Navratri Festival

Navratri (meaning "nine nights" in Sanskrit) is one of India's most important Hindu festivals, celebrated twice annually. The more prominent Sharad Navratri occurs in autumn (September–October), while Chaitra Navratri takes place in spring (March–April). This study focuses primarily on Sharad Navratri, which receives extensive public celebration and media coverage throughout India.

The festival spans 10 days and worships the goddess Durga and her nine manifestations, representing different aspects of feminine divine power (*shakti*). The festival commemorates Durga's mythological victory over the demon Mahishasura, symbolizing the triumph of good over evil and the supreme power of the feminine divine. Celebrations feature elaborate public displays across India, with communities erecting large pandals housing ornate goddess idols. Daily rituals include devotional ceremonies, singing, and traditional dances, culminating on the tenth day with processions carrying goddess idols for immersion in rivers.

According to the 2011 Census, approximately 80% of India's population identifies as Hindu, giving the festival near-universal cultural salience even among non-Hindu communities. The scale of celebration is substantial, with major intersections and neighborhoods featuring multiple pandals and cultural programs throughout the festival period.

2.2 Media Coverage and Cultural Messaging

Television plays a central role in Navratri observance. National broadcasters and regional channels air special programming throughout the festival period, including live coverage of temple ceremonies, devotional programs featuring goddess worship, mythological serials depicting Durga's stories, and cultural shows highlighting female empowerment themes. This intensive media coverage makes Navratri imagery and messaging ubiquitous even for households not directly participating in public celebrations.

Television ownership in India expanded rapidly during the study period. In the DHS data used for this study, approximately 63% of households with births near Navratri report that the respondent watches television at least once per week.

The cultural messaging during Navratri centers explicitly on themes of female power, strength, and divine feminine energy. Hindu philosophy conceptualizes *shakti* (feminine energy) as the dynamic force animating the universe, and during Navratri this principle receives concrete representation through goddess worship. Durga is portrayed as the supreme power who intervenes when male gods cannot defeat demons, emphasizing female superiority in strength and effectiveness. The central mythology depicts Durga independently defeating Mahishasura after a nine-day battle, with Durga acting as the primary agent rather than a supporting character.

An important ritual during the festival is *Kanya Puja*, performed on the eighth or ninth day, in which families worship young girls (typically ages 2–10) as living embodiments of the goddess. Families invite girls to their homes, wash their feet, offer them special foods, and give them gifts and money. This ritual explicitly equates daughters with divine power, potentially increasing the salience and value parents place on their own daughters.

Television coverage frequently draws explicit connections between goddess worship and contemporary women's empowerment. News programs feature segments on women's achievements, special programs discuss girls' education and women's rights in religious contexts, and cultural programming emphasizes themes of female strength and capability. The intensity and concentration of this messaging during Navratri may temporarily increase parents' valuation of daughters. Prior research demonstrates that salience matters for decision-making, and exposure to positive representations can reduce implicit bias and discrimination (Beaman et al., 2009).

2.3 Comparison Festivals

To test whether effects are specific to goddess worship, I compare Navratri to Ganesh Chaturthi, a major Hindu festival celebrating Ganesha (a male deity) with similar structure and prominence. Ganesh Chaturthi typically occurs in late August or early September, approximately one month before Sharad Navratri. Both festivals last 10 days with public celebrations and concluding immersion processions, feature large-scale public pandals and extensive media coverage, and rank among the most important Hindu festivals. The critical difference is gender: Ganesha is male and his mythology emphasizes wisdom, prosperity, and obstacle removal rather than themes of power, strength, and cosmic feminine energy.

India's second annual Navratri occurs in March–April but differs substantially in prominence and visibility from the autumn festival. Chaitra Navratri is observed more widely in northern India but less prominent in other regions, features more limited public celebrations that are more household-based, and receives substantially less television programming compared to Sharad Navratri. Examining Chaitra Navratri provides a dose-response test:

if goddess worship affects daughter investments, effects should be proportional to festival intensity and media saturation.

2.4 Vaccination Context and Gender Discrimination

This study examines three birth vaccinations recommended within 24 hours of delivery under India's Universal Immunization Programme: BCG (protecting against tuberculosis), Polio 0 (first oral polio dose), and Hepatitis B (birth dose). These vaccines are administered free of charge at all government health facilities and by accredited social health activists who visit homes after delivery. Despite free availability and government efforts, substantial gaps exist in birth vaccination coverage, with particularly large gender disparities in several states.

Differential vaccination by child gender provides a revealed-preference measure of son preference. Unlike stated preferences or attitudinal surveys, vaccination decisions involve real health consequences and resource allocation. Parents must take active steps—ensuring facility delivery or requesting health worker visits—for children to receive birth vaccinations. Lower vaccination rates for daughters thus directly reflect weaker parental investment in girls' health.

The focus on birth vaccinations offers several advantages for this study. First, timing is precise: birth vaccinations should occur within 24 hours, meaning decisions happen immediately adjacent to festival exposure. Second, parents retain significant discretion over vaccine acceptance. Third, measurement is objective: vaccination records come from health cards, avoiding recall bias in self-reports. The study uses card-verified vaccination data rather than maternal reports, substantially improving data quality by eliminating recall errors and social desirability bias.

Substantial evidence documents gender discrimination in health investments in India. Girls experience higher mortality than boys throughout childhood despite biological advantages that should yield lower female mortality. This excess female mortality reflects differential care during illness, delayed healthcare seeking, and lower nutritional investments

(Oster, 2009). Son preference has deep cultural and economic roots, as sons provide old-age support, continue family lineages, perform essential funeral rites, and generate income without requiring costly dowry payments at marriage (Das Gupta, 1987).

However, gender attitudes and cultural norms also matter independently of economic factors. Studies show son preference persists even among wealthy, educated families with adequate old-age security (Arnold et al., 1998). Cultural beliefs about appropriate gender roles shape behavior beyond purely economic calculations. This observation motivates examining whether cultural interventions—even temporary ones like festival exposure—can reduce discriminatory behavior by shifting attitudes and increasing daughters' salience and perceived value.

3 Data and Empirical Strategy

3.1 Data Sources

I use data from India's Demographic and Health Survey (DHS) spanning 2010–2021. The DHS collects detailed health and demographic information for nationally representative samples of households across India. The survey provides several features crucial for this analysis. First, it includes card-verified vaccination records, where enumerators directly observe and record information from children's health cards, avoiding recall bias. Second, the DHS records complete birth dates (day, month, year), enabling precise calculation of each child's birth timing relative to Navratri. Third, the survey collects extensive household and maternal characteristics, including television ownership and viewing frequency, religious affiliation, caste, wealth indicators, and maternal education and health measures.

3.2 Sample Construction

I construct the analytical sample by identifying all girls born within 12 days before Navratri begins or within 12 days after the 10-day festival ends, across all Navratri celebrations from

2010–2021. This creates a 24-day comparison window around each festival, with 12 days in the pre-period serving as the control group and 12 days in the post-period serving as the treatment group. Births occurring during the 10-day festival itself are excluded to create a clean comparison between pre- and post-festival exposure.

Navratri follows the lunar calendar, with the festival date varying by 10–15 days across years. For each year, I obtain the exact start date of Sharad Navratri and calculate each child's birth timing relative to that year's festival. The variation in festival timing across years prevents any single calendar period from being systematically classified as treatment or control.

The final sample includes 4,661 girls born within the 24-day window across 624 state-district clusters throughout India. This sample spans all Indian states, representing diverse cultural, economic, and geographic contexts. Approximately 51% of sample births occur in the post-Navratri period, with 49% in the pre-period, consistent with the quasi-random timing assumption.

3.3 Outcome Variables

The primary outcome is a count of card-verified birth vaccinations, ranging from 0 to 3. The three birth vaccinations are BCG (protecting against tuberculosis), Polio 0 (birth dose of oral polio vaccine), and Hepatitis B (birth dose). These vaccines should be administered within 24 hours of delivery according to India's immunization schedule. I restrict the analysis to card-verified vaccinations to ensure measurement accuracy and avoid recall bias. Children without vaccination cards (approximately 8–9% of the sample) are excluded from the primary analysis.

3.4 Identification Strategy

The identification strategy exploits the quasi-random timing of births relative to Navratri. The key assumption is that parents cannot precisely time births to occur on specific days relative to the festival. This assumption is plausible for several reasons. First, Navratri follows the lunar calendar and varies by 10–15 days year-to-year, making it difficult for parents to plan conceptions to yield births on particular dates relative to the festival. Second, human gestation length varies naturally, making precise timing of birth dates largely outside parental control (Jukic et al., 2013). Third, the majority of births now occur in health facilities (88.6% institutional delivery rate), where delivery timing is determined by medical factors rather than parental choice.

The quasi-experimental design resembles a regression discontinuity in time, comparing outcomes for girls born just after festival exposure versus just before. The treatment is intensive exposure to goddess worship and female empowerment messaging through the 10-day Navratri festival. Girls born after the festival end were in utero during Navratri, meaning their parents experienced festival exposure shortly before delivery and the vaccination decision.

3.5 Empirical Specification

The main specification estimates the following regression:

$$Y_{ijdt} = \beta_0 + \beta_1 \text{BornAfterNavratri}_{ijdt} + X'_{ijdt}\beta_2 + \gamma_{sd} + \delta_t + \theta_m + \lambda_w + \epsilon_{ijdt}$$

where Y_{ijdt} is the count of card-verified birth vaccinations (0–3) for girl i in household j, district d, and year t. The variable BornAfterNavratri is an indicator equal to 1 if the girl was born in the 12 days after Navratri ended, and 0 if born in the 12 days before the festival began. The coefficient β_1 captures the causal effect of Navratri exposure on daughter vaccination.

The vector X_{ijdt} includes household and maternal controls: wealth quintiles, urban residence, maternal education (years), maternal height, maternal BMI, maternal age at birth, and birth order. The specification includes state-by-district fixed effects (γ_{sd}), year fixed effects (δ_t), month-of-birth fixed effects (θ_m), and day-of-week fixed effects (λ_w). Standard errors are clustered at the state-district level.

3.6 Validation of Research Design

3.6.1 Balance of Predetermined Characteristics

A key test of the quasi-random assignment assumption is whether predetermined characteristics are balanced across the treatment threshold. If birth timing were truly quasi-random, we should observe no systematic differences in characteristics determined before or independently of Navratri exposure.

Table 1 presents balance tests for predetermined characteristics across five domains: birth characteristics (card possession rate, birth order), maternal characteristics (age, age at birth, education, height), household socioeconomic status (wealth quintiles, urban residence), caste, and religion. The table compares means for girls born before versus after Navratri, with difference estimates from regressions controlling for state-district, year, month-of-birth, and day-of-week fixed effects.

None of the 24 characteristics shows a statistically significant difference across the threshold. The magnitudes of differences are small relative to means and standard errors, with no discernible pattern. The joint F-test of whether all covariates jointly predict treatment status yields a p-value of 0.987, providing strong support for the null hypothesis of balance. This result indicates we cannot reject that predetermined characteristics are orthogonal to birth timing relative to Navratri, consistent with the quasi-random assignment assumption.

3.6.2 Continuity of Birth Density

If parents manipulate birth timing around Navratri, we would expect discontinuities in the density of births at the festival threshold. Appendix Figure A1 plots the daily distribution of female births in the 12 days before and 12 days after Navratri begins, pooled across all Navratri cycles from 2010–2021. The relatively uniform distribution across days suggests

Table 1: Balance of Pre-Determined Characteristics

	Before Navratri Mean (SE)	After Navratri Mean (SE)	Difference (2)−(1)
Panel A: Birth Characteristics			
Card possession rate	0.911 (0.007)	0.919 (0.007)	−0.008
Birth order	2.172 (0.034)	2.140 (0.034)	0.032
Panel B: Maternal Characteristics			
Mother's age (years)	27.031 (0.118)	26.984 (0.120)	0.047
Mother's age at birth (years)	25.221 (0.115)	25.237 (0.116)	−0.016
Mother's education (years)	6.792 (0.144)	6.645 (0.135)	0.147
Mother's height (mm)	1519.9 (1.527)	1517.9 (1.623)	2.024
Panel C: Household Socioeconomic Status			
Wealth: Poorer	0.223 (0.010)	0.228 (0.010)	−0.005
Wealth: Middle	0.209 (0.009)	0.204 (0.009)	0.005
Wealth: Richer	0.188 (0.009)	0.180 (0.009)	0.008
Urban residence	0.272 (0.013)	0.250 (0.012)	0.022
Panel D: Caste			
Scheduled Caste	0.199 (0.010)	0.203 (0.010)	−0.004
Scheduled Tribe	0.192 (0.016)	0.190 (0.016)	0.001
Other Backward Caste	0.380 (0.015)	0.368 (0.014)	0.012
No caste/other	0.180 (0.011)	0.180 (0.010)	0.001
Panel E: Religion			
Hindu	0.692 (0.017)	0.698 (0.017)	−0.006
Muslim	0.159 (0.013)	0.155 (0.011)	0.004
Christian	0.104 (0.015)	0.091 (0.014)	0.013
Sikh	0.025 (0.005)	0.033 (0.007)	−0.008
Observations	2,302	2,373	4,675
Number of clusters	610	606	638
Joint F-test: p-value			0.987

Notes: Sample includes girls born within 12 days of Navratri date, 2010–2021 DHS. "Before Navratri" includes births occurring before the start of Navratri; "After Navratri" includes births occurring after the festival ends. The difference column reports coefficients from regressions of each row variable on the post-Navratri indicator, controlling for state×district, year, month-of-birth, and day-of-week fixed effects. Standard errors (in parentheses) are clustered at the state×district level. The F-test of joint significance tests whether all covariates jointly predict treatment status.

no evidence of systematic manipulation of birth timing around the festival. A formal test for discontinuity in birth density at the Navratri cutoff yields a test statistic of -0.13 ($p = 0.89$), providing no evidence of sorting around the threshold (McCrary, 2008).

4 Results

4.1 Main Effects on Birth Vaccinations

Table 2 presents the main results. Column 1 includes only fixed effects, while columns 2–4 progressively add household controls, maternal controls, and birth controls. Girls born after Navratri receive 0.124 additional vaccines (standard error: 0.049) in the preferred specification (column 4), a statistically significant 5.8% increase over the control mean of 2.13 vaccines. The effect is remarkably stable across specifications, ranging from 0.130 to 0.124, suggesting that the result is not driven by observable differences in household or maternal characteristics. The R-squared increases modestly from 0.353 to 0.375 as controls are added, indicating that much of the variation in vaccination outcomes is explained by geographic and temporal fixed effects rather than individual-level covariates.

The effect size can be contextualized in several ways. First, the 0.124 increase represents approximately 58% of a standard deviation in the vaccination index. Second, examining individual vaccines shows consistent effects across all three birth vaccinations (Appendix Table A1): BCG increases by 0.040 (4.8%, $p<0.05$), Polio 0 by 0.040 (5.6%, $p<0.05$), and Hepatitis B by 0.044 (7.4%, $p<0.05$). The sum of individual effects equals the total count effect, confirming internal consistency and indicating that improvements occur broadly rather than through substitution across vaccine types. Third, converting to binary outcomes (Appendix Table A2), the treatment increases the likelihood of receiving any vaccine by 4.8 percentage points and all three vaccines by 7.1 percentage points.

Figure 1 presents event study estimates using 4-day bins relative to Navratri start and end dates. The omitted category is days -4 to -1 (immediately before the festival begins).

Table 2: Effect of Navratri Timing on Birth Vaccinations for Girls

	Vaccination Index			
	(1)	(2)	(3)	(4)
Born after Navratri	0.130**	0.125**	0.124**	0.124**
	(0.051)	(0.050)	(0.049)	(0.049)
Observations	4,661	4,661	4,661	4,661
R^2	0.353	0.365	0.373	0.375
Control mean	2.13	2.13	2.13	2.13
Effect (% of mean)	6.1	5.8	5.8	5.8
Household controls		✓	✓	✓
Maternal controls			✓	✓
Birth controls				✓
State × District FE	✓	✓	✓	✓
Year, Month, DOW FE	✓	✓	✓	✓

Notes: Sample: girls born ±12 days around Navratri, 2010–2021 DHS. Dependent variable: count of card-verified birth vaccinations (0–3). Household controls: wealth, urban. Maternal controls: education, height, BMI, age. Birth controls: birth order. Standard errors clustered at state×district level in parentheses. ** $p < 0.05$, * $p < 0.10$.

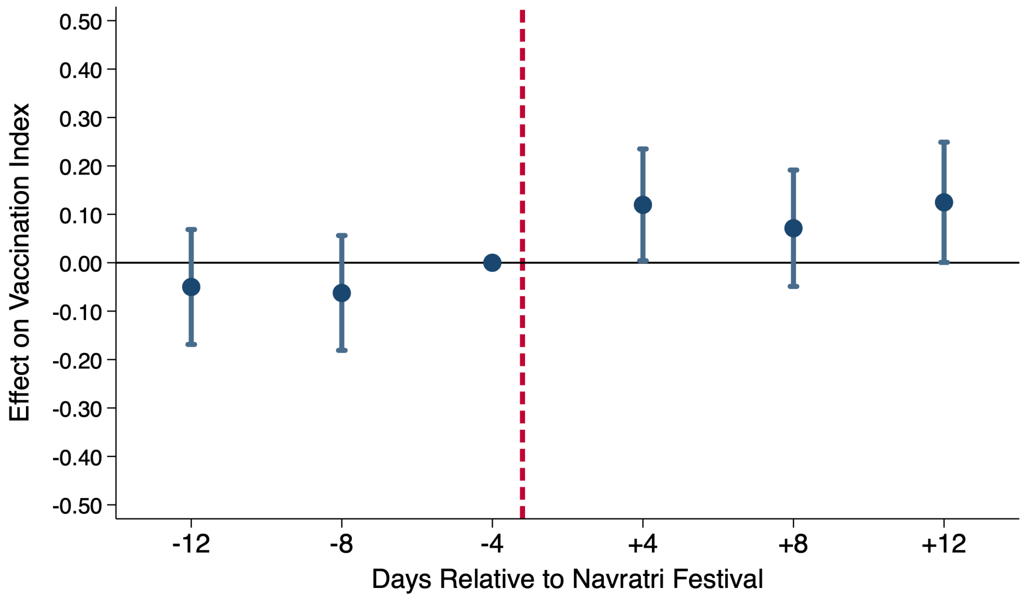
Coefficients are centered near zero in the pre-period (days -12 to -5) and jump sharply positive after Navratri ends (days +1 to +12), with all post-period estimates significantly above pre-period levels. This pattern provides visual confirmation of a discrete shift in vaccination behavior following festival exposure. The absence of pre-trends—coefficients in earlier pre-period bins show no systematic pattern—supports the identifying assumption that treatment and control groups would have followed parallel trends absent the festival.

5 Mechanisms

5.1 Falsification Test: Goddess Festival versus Male Deity Festival

If results reflect goddess-specific cultural messaging rather than general festival effects, seasonal patterns, or families being home more during celebrations, effects should be specific to Navratri versus festivals celebrating male deities. Table 3 tests this prediction using Ganesh

Figure 1: Girl's Birth Vaccinations Before and After Navratri



Notes: Figure plots coefficients from regression of vaccine count on 4-day bins relative to Navratri. Days -4 to -1 omitted as reference. 95% confidence intervals shown. Sample: 4,661 girls, ±12 days around Navratri, 2010–2021 DHS. Specification includes all controls and fixed effects from Table 2, Column 4.

Chaturthi—a similarly prominent 10-day Hindu festival occurring approximately one month before Navratri that celebrates Ganesha, a male god. Both festivals last 10 days, feature large-scale public celebrations and concluding immersion processions, receive extensive media coverage, and rank among the most important Hindu festivals.

The contrast is striking. While girls born after Navratri show a 5.8% increase in vaccinations (column 1: 0.124, $p<0.05$), girls born after Ganesh Chaturthi show virtually no change (column 2: 0.029, $p=0.52$). The Ganesh Chaturthi coefficient is less than one-fourth the magnitude of the Navratri effect and statistically indistinguishable from zero. Neither festival affects boys' vaccination rates (columns 3–4), confirming the gender specificity of cultural effects. For boys, the Navratri coefficient is essentially zero (-0.000) and the Ganesh Chaturthi coefficient is similarly small (0.028). This goddess-specific, gender-specific pattern provides compelling evidence that Navratri's cultural content about female divinity—rather than generic festival effects like healthcare system factors, seasonal variations, or general attention to children during celebrations—drives the results.

Table 3: Falsification Test: Navratri versus Ganesh Chaturthi

	Girls		Boys	
	Navratri (1)	Ganesh (2)	Navratri (3)	Ganesh (4)
Born after festival	0.124**	0.029	−0.000	0.028
	(0.049)	(0.045)	(0.046)	(0.048)
Observations	4,661	4,549	4,830	4,863
R^2	0.375	0.379	0.355	0.375
Control mean	2.13	2.18	2.15	2.15
Effect (% of mean)	5.8	1.3	−0.0	1.3
All controls & FE	✓	✓	✓	✓

Notes: Sample: births ±12 days around each festival. Navratri celebrates goddess Durga; Ganesh Chaturthi celebrates male deity Ganesha. Both are major 10-day Hindu festivals with similar scale. All specifications include controls and fixed effects from Table 2. Standard errors clustered at state×district level in parentheses. ** $p < 0.05$, * $p < 0.10$.

5.2 Television as Transmission Channel

Table 4 tests whether effects operate through media transmission of cultural messaging by splitting the sample by television viewing frequency. Column 1 restricts to households where the respondent watches television rarely or never (less than once per week), while column 2 restricts to households where the respondent watches television regularly (at least once per week). Effects are concentrated among regular TV watchers: a 6.8% increase (0.157, p<0.01) versus an insignificant 3.2% increase (0.058, p=0.56) for rare watchers. The difference between groups is statistically significant (p=0.016, calculated from a pooled regression including a TV × Treatment interaction term). This heterogeneity pattern strongly supports media transmission as a key mechanism. Households watching Navratri television coverage—featuring goddess imagery, devotional programming, mythological serials depicting Durga's victories, and female empowerment messaging—show substantially stronger responses.

Table 4: Heterogeneity by Television Exposure

	TV Watching Frequency	
	Rare/No TV	Regular TV
	(1)	(2)
Born after Navratri	0.058	0.157***
	(0.099)	(0.058)
Observations	1,563	2,932
R^2	0.425	0.415
Control mean	1.84	2.30
Effect (% of mean)	3.2	6.8
Regular − Rare TV (p-value)	0.016	
All controls & FE	✓	✓

Notes: Sample: girls ±12 days around Navratri. Column 1: respondent watches TV less than weekly. Column 2: at least weekly. P-value from pooled regression with TV × Treatment interaction. All specifications include controls and fixed effects from Table 2. Standard errors clustered at state×district level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

However, an alternative explanation for the TV heterogeneity could be that television viewing during Navratri increases general health awareness or attention to vaccination messages, rather than specifically transmitting goddess worship content that affects attitudes toward daughters. Table 5 distinguishes between these interpretations by testing whether TV heterogeneity is gender-specific (supporting the goddess-specific cultural mechanism) or applies to both genders (supporting a general health attention mechanism).

Columns 1–2 reproduce the TV heterogeneity results for girls from Table 4: regular TV watchers show strong, significant effects (0.157, p<0.01) while rare watchers show small, insignificant effects (0.058, p=0.56), with the interaction highly significant (p=0.016). Columns 3–4 test the identical specification for boys. Boys show no effects in either group: rare TV watchers (-0.038, p=0.70) and regular TV watchers (0.011, p=0.84) both have coefficients statistically indistinguishable from zero. Critically, the TV interaction for boys is entirely insignificant (p=0.421), indicating no differential response by TV exposure. This gender-specific pattern—strong TV heterogeneity for girls (p=0.016) but none for boys (p=0.421)—provides compelling evidence against alternative explanations based on general health attention, vaccination awareness campaigns, or families being home more during festivals.

Table 5: TV Heterogeneity by Gender

	Girls		Boys	
	Rare TV (1)	Regular TV (2)	Rare TV (3)	Regular TV (4)
Born after Navratri	0.058	0.157***	−0.038	0.011
	(0.099)	(0.058)	(0.097)	(0.054)
Observations	1,563	2,932	1,546	3,115
R^2	0.425	0.415	0.429	0.378
Control mean	1.84	2.30	1.87	2.30
Effect (% of mean)	3.2	6.8	−2.1	0.5
Interaction p-value	0.016		0.421	
All controls & FE	✓	✓	✓	✓

Notes: Sample: births ±12 days around Navratri. Rare TV: watches less than weekly. Regular TV: at least weekly. P-values from pooled regressions with TV × Treatment interaction, estimated separately by gender. All specifications include controls and fixed effects from Table 2. Standard errors clustered at state×district level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

5.3 Religious Heterogeneity

Table 6 tests whether treatment effects differ by religious identity. If Navratri's effects operated exclusively through individual Hindu religious participation—attending pujas, performing rituals, or direct festival engagement—we would expect significantly larger effects for Hindu households compared to non-Hindu households. The specification includes the treatment indicator (Born after Navratri), a Hindu indicator variable, and their interaction. The base coefficient (Born after Navratri, 0.158, p<0.05) captures the effect for non-Hindu households (the reference group). The interaction term (Navratri × Hindu, -0.049, p=0.435) tests whether Hindu households show different responses. The interaction is small, negative, and statistically insignificant, indicating we cannot reject that Hindu and non-Hindu families respond similarly to Navratri. This pattern supports community-level cultural transmission rather than effects limited to Hindu religious practitioners. Cultural messages transmitted through television coverage, public celebrations, and community exposure appear to reach families regardless of personal religious identity.

Table 6: Heterogeneity by Religion

	Vaccination Index (1)
Born after Navratri	0.158**
	(0.063)
Hindu (=1)	0.126**
	(0.057)
Navratri × Hindu	−0.049
	(0.062)
Observations	4,661
Interaction p-value	0.435
Implied Hindu effect	0.110
Implied non-Hindu effect	0.158
All controls & FE	✓

Notes: Sample: girls ±12 days around Navratri. Regression includes treatment indicator, Hindu indicator, and their interaction. Base coefficient captures effect for non-Hindu households. Implied Hindu effect = 0.158 - 0.049. All specifications include controls and fixed effects from Table 2. Standard errors clustered at state×district level in parentheses. ** $p < 0.05$, * $p < 0.10$.

6 Robustness Checks and Dose-Response Evidence

This section examines the robustness of the main findings to alternative specifications and measurement approaches, and tests whether effects exhibit a dose-response relationship with festival prominence by examining India's spring Navratri festival.

6.1 Alternative Outcome Specifications

The main results measure vaccination using a count index (0-3). Appendix Table A1 decomposes this effect by individual vaccine type to confirm that improvements occur broadly rather than through substitution. All three birth vaccinations show consistent positive effects: BCG increases by 0.040 (4.8%, $p<0.05$), Polio 0 by 0.040 (5.6%, $p<0.05$), and Hepatitis B by 0.044 (7.4%, $p<0.05$). The sum of individual effects equals the total count effect, confirming internal consistency and indicating that improvements occur broadly rather than through substitution across vaccine types.

Appendix Table A2 tests robustness to alternative outcome definitions. Converting to binary measures, the treatment increases the likelihood of receiving any vaccine by 4.8 percentage points ($p<0.05$) and receiving all three vaccines by 7.1 percentage points ($p<0.10$). Using the average of standardized vaccine indicators yields virtually identical results (0.041, 5.8% increase). The consistency across functional forms confirms that results are not driven by the specific outcome definition.

6.2 Alternative Bandwidth and Clustering Specifications

Appendix Table A3 examines sensitivity to bandwidth choice by varying the comparison window from ± 10 to ± 20 days around Navratri. The treatment effect remains positive and statistically significant across all bandwidths, ranging from 0.105 (± 10 days) to 0.139 (± 16 days). The stability of estimates across bandwidths—and the absence of systematic patterns as bandwidth varies—provides strong support for the identification strategy. The slight increase in precision with wider bandwidths reflects the efficiency gains from larger samples, while narrower bandwidths ensure closer comparability of treatment and control groups. The preferred ± 12-day specification balances these considerations.

Appendix Table A4 demonstrates robustness to alternative standard error clustering. The baseline specification clusters at the state$\times$district level (624 clusters). Alternative approaches include clustering at the state level (36 clusters), at the DHS primary sampling unit (PSU) level, and two-way clustering by state$\times$district and year or by state$\times$district and day-of-week. The point estimate remains identical (0.124) across all specifications, and statistical significance is maintained in every case, with standard errors ranging from 0.043

to 0.053. This robustness to clustering specifications indicates that the main results are not driven by particular assumptions about error correlation structure.

6.3 Dose-Response: Chaitra Navratri

A key prediction of the cultural mechanism is that effects should be proportional to festival prominence and media saturation. India's second annual Navratri—Chaitra Navratri in spring (March-April)—provides a natural test of this dose-response relationship. Chaitra Navratri also celebrates the nine goddess forms over nine days but differs substantially from Sharad Navratri in visibility and cultural salience. The spring festival is observed more widely in northern India but less prominent in other regions, features more limited public celebrations that are more household-based rather than community-wide, and receives substantially less television programming and media coverage compared to the autumn festival.

Table 7 presents results for Chaitra Navratri using the identical empirical strategy applied to Sharad Navratri. The coefficient in the preferred specification (column 4) is 0.026 ($p=0.68$), representing a 1.3% increase that is not statistically significant. This point estimate is substantially smaller than the main Sharad Navratri effect (0.124, $p<0.05$; Table 2). The positive sign across all specifications suggests goddess worship themes may produce modest effects during Chaitra Navratri, but the festival lacks sufficient visibility to generate statistically detectable impacts on parental vaccination decisions.

This dose-response pattern—significant effects for India's most prominent goddess festival (Sharad Navratri, 5.8% increase) but small, insignificant effects for the quieter spring observance (Chaitra Navratri, 1.3% increase)—strongly supports the cultural mechanism interpretation. The findings suggest that goddess worship must achieve sufficient salience through public celebrations and media coverage to meaningfully shift parental attitudes toward daughters. This is consistent with the television heterogeneity results showing concentrated effects among regular TV watchers: cultural messaging affects behavior when it reaches sufficient intensity and penetration to temporarily reshape the salience parents place on daughters' value.

Table 7: Chaitra Navratri (Spring Festival)

	Vaccination Index			
	(1)	(2)	(3)	(4)
Born after Chaitra Navratri	0.066	0.044	0.029	0.026
	(0.062)	(0.062)	(0.062)	(0.062)
Observations	4,254	4,254	4,254	4,254
R^2	0.374	0.397	0.404	0.407
Control mean	1.98	1.98	1.98	1.98
Effect (% of mean)	3.3	2.2	1.5	1.3
Household controls		✓	✓	✓
Maternal controls			✓	✓
Birth controls				✓
State×District FE	✓	✓	✓	✓
Year, Month, DOW FE	✓	✓	✓	✓

Notes: Sample: girls ±12 days around Chaitra Navratri (spring festival, March/April). Chaitra Navratri celebrates the same goddess forms but features less public visibility and media coverage than autumn Sharad Navratri. All specifications follow Table 2 structure. Standard errors clustered at state×district level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

7 Conclusion

This paper examines whether cultural festivals celebrating female deities can reduce gender discrimination in health investments. Using the quasi-random timing of Navratri—a major Hindu festival worshipping goddesses—I find that girls born shortly after the festival receive approximately 6% more birth vaccinations than girls born just before. This effect is driven by households with regular television exposure, specific to goddess festivals rather than male deity festivals, does not extend to boys, and operates uniformly across religious identities. A smaller spring goddess festival shows directionally similar but insignificant effects, consistent with a dose-response relationship between festival prominence and impact.

The mechanisms evidence points to media transmission as a key channel. Television coverage during Navratri saturates households with imagery of powerful female deities and explicit connections between goddess worship and women's empowerment. The concentration of effects among TV-watching households, combined with the gender specificity and religious uniformity, suggests that cultural messages transmitted through media can temporarily reshape gender-discriminatory behavior independent of direct religious participation.

These findings contribute to several literatures. First, they add to evidence on endogenous preference formation, showing that gender attitudes respond to episodic cultural exposure even when attitude change is not the intervention's intentional purpose. Second, they demonstrate that organic cultural phenomena can generate effects comparable to designed interventions, suggesting potential for policies that strategically leverage cultural moments to amplify program impacts. Third, they highlight media's role in transmitting cultural messages that shift behavior, connecting to broader evidence on media effects in development settings.

The results have important limitations. The study examines only short-run effects on a single health outcome; whether improvements persist or extend to other daughter investments remains unknown. The magnitudes, while statistically significant, are modest—a 6% increase represents progress but does not eliminate gender gaps. Generalizability to contexts with different religious traditions or cultural frameworks is uncertain. Finally, while the falsification tests and heterogeneity patterns strongly support a cultural mechanism, other unobserved factors correlated with Navratri timing could potentially contribute.

Despite these limitations, the findings suggest that cultural interventions—increasing visibility of positive representations of women through media and cultural programming—could complement traditional development policies in reducing gender discrimination. Future research could examine longer-run outcomes, test whether other cultural traditions celebrating women generate similar effects across different contexts, and explore whether interventions can strategically coordinate with cultural moments to enhance impacts. Understanding how cultural salience and media transmission interact with economic incentives may offer promising avenues for addressing persistent gender inequalities.

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A Appendix

A.1 Theoretical Framework

This section presents a simple model of parental investment decisions to motivate the empirical analysis. Consider a household with a daughter born near Navratri. Parents allocate resources between investment in the daughter's health (h) and other consumption (c). Parents maximize utility:

$$U = u(c) + \theta \cdot v(h) \tag{1}$$

where $u(\cdot)$ and $v(\cdot)$ are standard concave utility functions, and θ represents the weight parents place on their daughter's health outcome. The parameter θ captures both economic incentives (daughters' expected contributions to household welfare) and cultural attitudes toward daughters.

Parents face a budget constraint:

$$c + p \cdot h = Y \tag{2}$$

where p is the cost of health investment, and Y is household income. For simplicity, assume vaccinations are free ($p = 0$), but parents incur time and effort costs proportional to h.

The first-order condition for optimal health investment is:

$$\theta \cdot v'(h^*) = u'(c^*) \tag{3}$$

This yields the optimal investment level $h^*(\theta)$, where $\frac{\partial h^*}{\partial \theta} > 0$ by the implicit function theorem.

Cultural Exposure and Salience. I model Navratri exposure as temporarily increasing θ. Specifically, let:

$$\theta = \theta_0 + \delta \cdot \mathbb{1}[\text{Post-Navratri}] \cdot \mathbb{1}[\text{TV exposure}] \tag{4}$$

where θ_0 is the baseline weight on daughter's health, $\delta > 0$ captures the increase in salience from cultural exposure to goddess worship, and the effect is mediated by television access.

Predictions. This framework generates the following testable predictions:

Prediction 1 (Main Effect): Girls born after Navratri receive higher health investments: $h^*(\theta_0 + \delta) > h^*(\theta_0)$.

Prediction 2 (TV Heterogeneity): The Navratri effect is larger for households with TV access, since δ is increasing in media exposure.

Prediction 3 (Gender Specificity): Navratri does not affect boys' outcomes, since goddess worship specifically increases the weight on daughters ($\theta^{\text{daughters}}$ increases, θ^{sons} unchanged).

Prediction 4 (Goddess Specificity): Male deity festivals do not affect daughters, since they do not increase θ for girls.

Prediction 5 (Dose-Response): The effect is proportional to festival prominence, as larger festivals generate higher δ through greater media saturation and cultural salience.

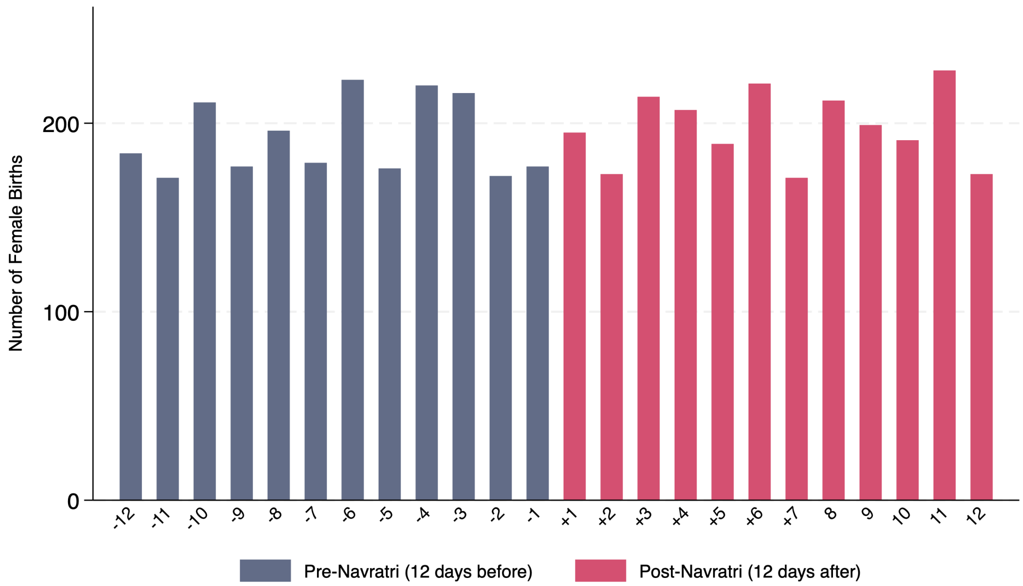
Alternative Mechanisms. The model assumes cultural exposure affects attitudes (θ). Alternative mechanisms could operate through:

- Information: Navratri increases awareness of vaccination benefits (would affect both genders)
- Supply-side: Healthcare systems function better during festivals (would affect both genders and both festivals)
- Income: Festival periods increase household resources (would affect both genders)

The empirical tests in Section 5 distinguish between these mechanisms. The gender specificity and goddess-festival specificity of effects rule out information, supply-side, and income channels, supporting the cultural attitude mechanism embedded in the model.

A.2 Additional Figures

Figure A1: Distribution of Female Births Around Navratri



Notes: Figure shows the daily distribution of female births in the 12 days before and 12 days after Navratri begins, pooled across all Navratri cycles from 2010–2021 in the DHS data. Navy bars represent births occurring before Navratri starts; red bars represent births occurring after Navratri begins. The relatively uniform distribution across days suggests no evidence of systematic manipulation of birth timing around the festival. Total sample: 4,675 girls across 624 state-district clusters. A formal test for discontinuity in birth density at the Navratri cutoff yields a test statistic of -0.13 (p = 0.89), providing no evidence of sorting around the threshold.

A.3 Robustness Tables

Table A1: Effects on Individual Birth Vaccinations

	Card-Verified Vaccines			
	BCG (1)	Polio 0 (2)	Hep B (3)	Total (4)
Born after Navratri	0.040**	0.040**	0.044**	0.124**
	(0.017)	(0.020)	(0.021)	(0.049)
Observations	4,661	4,661	4,661	4,661
R^2	0.302	0.341	0.360	0.375
Control mean	0.83	0.72	0.59	2.13
Effect (% of mean)	4.8	5.6	7.4	5.8
All controls & FE	✓	✓	✓	✓

Notes: Table decomposes main treatment effect by individual vaccine type. Sample restricted to births within ±12 days around Navratri, girls only. Columns 1–3 present effects on binary indicators for whether each specific vaccine is card-verified: BCG (bacille Calmette-Guérin), Polio 0 (birth dose), and Hepatitis B (birth dose). Column 4 replicates main result using the count of all three vaccines (0–3). All specifications include household controls (wealth, urban), maternal controls (education, height, BMI, age), birth controls (birth order), and state×district, year, month-of-birth, and day-of-week fixed effects. Standard errors clustered at state×district level in parentheses. ** $p < 0.05$, * $p < 0.10$.

Table A2: Robustness to Alternative Outcome Definitions

	Alternative Outcome Definitions			
	Count (1)	Any (2)	All 3 (3)	Average (4)
Born after Navratri	0.124**	0.040**	0.041*	0.041**
	(0.049)	(0.017)	(0.022)	(0.016)
Observations	4,661	4,661	4,661	4,661
R^2	0.375	0.306	0.364	0.375
Control mean	2.13	0.83	0.58	0.71
Effect (%)	5.8	4.8	7.1	5.8

Notes: Table tests robustness to alternative outcome definitions. Sample: births ±12 days around Navratri, girls only. Column 1: baseline count of card-verified vaccines (0–3). Column 2: binary indicator for any card-verified vaccine. Column 3: binary for all three vaccines. Column 4: average of all three vaccines. The consistency of positive, significant effects across all outcome definitions confirms that results are not driven by the specific functional form of the outcome variable. All specifications include household controls (wealth, urban), maternal controls (education, height, BMI, age), birth controls (birth order), and state×district, year, month-of-birth, and day-of-week fixed effects. Standard errors clustered at state×district level in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.10.

Table A3: Robustness to Alternative Bandwidth Specifications

	Vaccination Index					
	±10d (1)	±12d (2)	±14d (3)	±16d (4)	±18d (5)	±20d (6)
Born after Navratri	0.105**	0.124**	0.137***	0.139***	0.134***	0.109***
	(0.052)	(0.049)	(0.048)	(0.045)	(0.043)	(0.041)
Observations	3,889	4,661	5,448	6,227	6,964	7,710
R^2	0.406	0.375	0.356	0.344	0.337	0.333
Control mean	2.14	2.13	2.13	2.13	2.14	2.14
Effect (% of mean)	4.9	5.8	6.5	6.5	6.2	5.1
All controls & FE	✓	✓	✓	✓	✓	✓

Notes: Each column presents results from a separate regression comparing births in symmetric windows around Navratri. For bandwidth ±k, the control group includes births k days before Navratri starts (days −k to −1), and the treatment group includes births k days after Navratri ends (days 10 to 10+k−1, where days 0–9 constitute the festival period). Dependent variable is count of card-verified birth vaccinations (BCG, Polio 0, Hepatitis B), ranging 0–3. The stability of coefficients across bandwidths demonstrates robustness. All specifications include household controls (wealth, urban), maternal controls (education, height, BMI, age), birth controls (birth order), and state×district, year, month-of-birth, and day-of-week fixed effects. Standard errors clustered at state×district level in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.10.

Table A4: Robustness to Alternative Clustering Specifications

	Standard Error Clustering Method				
	St×Dist (1)	State (2)	PSU (3)	2-way (1) (4)	2-way (2) (5)
Born after Navratri	0.124**	0.124***	0.124**	0.124**	0.124*
	(0.049)	(0.043)	(0.050)	(0.049)	(0.053)
Observations	4,661	4,661	4,661	4,661	4,661
R^2	0.375	0.375	0.375	0.375	0.375

Notes: Table demonstrates robustness to alternative standard error clustering specifications. Sample: births within ±12 days around Navratri, girls only. Dependent variable is count of card-verified birth vaccinations (0–3). All columns estimate identical regression specification; only the clustering of standard errors varies. Column 1 presents baseline specification clustering at state×district level (624 clusters). Column 2 uses clustering at state level (36 clusters). Column 3 clusters at DHS primary sampling unit (PSU) level. Columns 4–5 implement two-way clustering: Column 4 clusters by state×district and year; Column 5 clusters by state×district and day-of-week. The coefficient remains identical across specifications (0.124), and statistical significance is maintained in all cases. All specifications include household controls (wealth, urban), maternal controls (education, height, BMI, age), birth controls (birth order), and state×district, year, month-of-birth, and day-of-week fixed effects. Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.