Long-term Effects of Reduced Red Meat Availability during Pregnancy: the case of Cattle Slaughter Bans in India

Aparajita Dasgupta  
Department of Economics, Ashoka University

Email: aparajita.dasgupta@ashoka.edu.in  
Farhan Majid  
L.E. and Virginia Simmons Fellow in Health and Technology Policy  
Baker Institute for Public Policy  
Rice University  
Houston, TX 77005  
Email: farhan.majid@rice.edu

Wafa Hakim Orman  
Department of Economics, Accounting, & Finance  
University of Alabama in Huntsville  
Huntsville, AL 35899  
Email: wafa.orman@uah.edu

**Abstract:**

This paper evaluates the health impact of cattle slaughter ban laws in India. Using a triple difference in difference strategy which exploits variation across religious and caste groups which do and do not consume beef, time (cohort) variation in the passage of laws over more than 40 years from the 1950s to the 1990s, in different states of India, we find that overall, women exposed to cattle slaughter bans in their year of birth have lower levels of hemoglobin (Hb) and are more likely to be anemic in their prime reproductive ages between 15 and 35, particularly those of low SES. The more restrictive the ban—for example, a ban on beef sale in addition to a ban on cattle slaughter—the larger is the estimated effect. We use data from a nationally representative survey—India’s DHS 2005-2006—for this purpose. These impacts are evident in our triple difference-in-difference models and are robust to the inclusion of linear state specific time trends and an array of SES variables. We conclude that cattle slaughter ban laws can have long-term harmful effects for women of reproductive age among minorities which historically consume beef (scheduled caste Hindus, Christian and Muslims in particular).We also briefly discuss some policy implications of our results. To the best of our knowledge, this is the first paper to document the long-term detrimental effects of cattle slaughter ban laws on Hb and anemia during adulthood.

1. **Introduction**

A large and growing literature has been studying the role of first 1000 days of life, and particularly the fetal period, in shaping life cycle health and skill formation (Almond and Currie, 2011; Cunha and Heckman, 2007). Restricted maternal nutrition during the period even before birth can lead to adaptive physiological responses that are beneficial for short term survival but scar the growth and development of vital organs leading to persistent long-term damage (Gluckman and Hanson, 2005).

Most papers exploit rare and extreme shocks and have paid scarce attention to importance of dietary choices during pregnancy. Exceptions include some recent work on effects of fasting during pregnancy, though the role of specific food choices is not well understood (Almond and Mazumder, 2011; Majid, 2015). In this paper we exploit an ongoing natural experiment from the rollout of legislation banning cattle slaughter across states in India to study the long-term effect of disruptions in red meat intake during pregnancy on the next generation of girls and women, particularly those from low SES background, who are more likely to be anemic to begin with.

Red meat is one of the best sources of dietary iron. The iron in red meat is part of a molecule called heme, and the human body absorbs heme iron more readily than other forms of this mineral, say in plant based diets. As a result, anemia (especially severe anemia) is more common among populations with a diet low in animal proteins, and high in rice or in whole wheat, which are known to be high in phytates, thereby reducing the absorption of iron and causing mineral deficiency (Zijp et al., 2000). Among pregnant women, severe anemia has been shown to result in low birth weight and child mortality (Stoltzfus, 2001).

India has among the world’s highest incidence rates of iron-deficiency anemia—over 50% of Indian women suffer from at least mild to moderate anemia. It is estimated that anemia directly causes 20% of maternal deaths in India and indirectly accounts for another 20%. (Rammohan et al, 2011; Ministry of Health and Family Welfare, 2013). Anand et al. (2014) discuss the extremely high incidence of iron-deficiency anemia in India even relative to Sub-Saharan African nations—barely 50% of cases of anemia in sub-Saharan Africa are attributable to iron deficiency, while over 70% of anemia cases among premenopausal women in India are. Anemia incidence in India is also significantly higher than in neighboring Pakistan and Bangladesh. Rammohan et al. (2011), who also use data from 2005-06 DHS surveys in India, find that anemia incidence is 11% lower among those who eat meat daily, and conclude that the high prevalence of vegetarianism (about a third of the population follows a strict vegetarian diet) combined with the lack of iron in popular Indian vegetarian foods contributes to the problem.[[1]](#footnote-1)

We expect cattle slaughter bans to reduce the intake of beef, either directly or indirectly by reducing the supply and increasing relative prices for red meat.[[2]](#footnote-2)The reduced consumption of iron-rich animal proteins is likely to be particularly harmful for pregnant women, who have a significantly greater need for iron (27 mg/day versus 18 mg/day otherwise). Anemic mothers may be more likely to give birth to anemic children. In the absence of compensatory investments, through the process of dynamic complementarity and self-productivity, we expect that the initial loss in anemia during fetal stage may be compounded to have large effects during adulthood (Cunha and Heckman 2007). For example, Shi et al (2013) find that fetal exposure to the Chinese famine from 1959-1961 was associated a 37% increase in the likelihood of anemia in adulthood. We hypothesize that for the treated individuals- especially those traditionally known for consuming beef—Muslims, Christians, and members of scheduled castes—cattle slaughter ban variation across space and time should generate corresponding variation in early life, and hence late life health. Those who do not traditionally consume beef—upper caste Hindus, Jains and Sikhs—serve as placebos, since we should not expect any effect of cattle slaughter bans for these groups.

Our study has considerable data requirements. It necessitates information on cattle slaughter bans experienced by women several decades earlier, as well as detailed current information on adult outcomes on a blood sample based bio marker—hemoglobin—at a population level. We use information in the 2005-06 Demographic and Health Surveys (DHS) on an individual’s year and state of birth, and link each individual in that survey to state- specific cattle slaughter bans for their birth year. For cattle slaughter ban data, we construct our own policy panel dataset of state year observations from 1950-2005 using data from the 2002 Report of the National Commission on Cattle, prepared for the Indian Ministry of Agriculture (Lodha, 2002) and the text of state legislation. We focus on cow slaughter bans, as well as additional legal restrictions imposed in some states, such as bans on the sale of beef, bans on the export of cows for slaughter, and bans on the slaughter of bulls/bullocks or water buffalo. This allows to measure the effect of the strictness of a ban at the margin, since we expect that more restrictive legislation will lead to greater reductions in the supply of beef than only a ban on cow slaughter.

**Since the consumption of red meat is a mitigating factor in the development of iron deficiency anemia, we hypothesize that in states with bans on cattle slaughter, which effectively restrict the supply of red meat for communities that would otherwise consume it, rates of anemia would be higher.** We use data from the nationally representative DHS survey (2005-06) and find that overall, girls exposed to cattle slaughter bans in their year of birth have lower levels of hemoglobin (Hb) and are more likely to be anemic in their prime reproductive ages between 15 and 35, particularly for women who have not completed primary schooling or who come from poorer families.

**This paper makes some important contributions. To the best of our knowledge, it is the first paper to study the impact of cattle slaughter bans on health outcomes. Its focus on long-term effects allows us to look at effects of changes in consumption of beef and hence the implied intake of iron on anemia levels 15 to 35 years after birth. Recent work has explored he effects of fasting during pregnancy on later life health (Almond and Mazumder 2011; van Ewijk 2011; Majid 2015). This work complements such work and explores the impact of a specific food item- beef- on later life health. We find evidence of significant adverse effects of cattle slaughter bans, especially among low SES groups who would otherwise have consumed beef. This work also informs the literature on the impact of religious institutions and norms on health and human capital formation (Iyer 2016).**

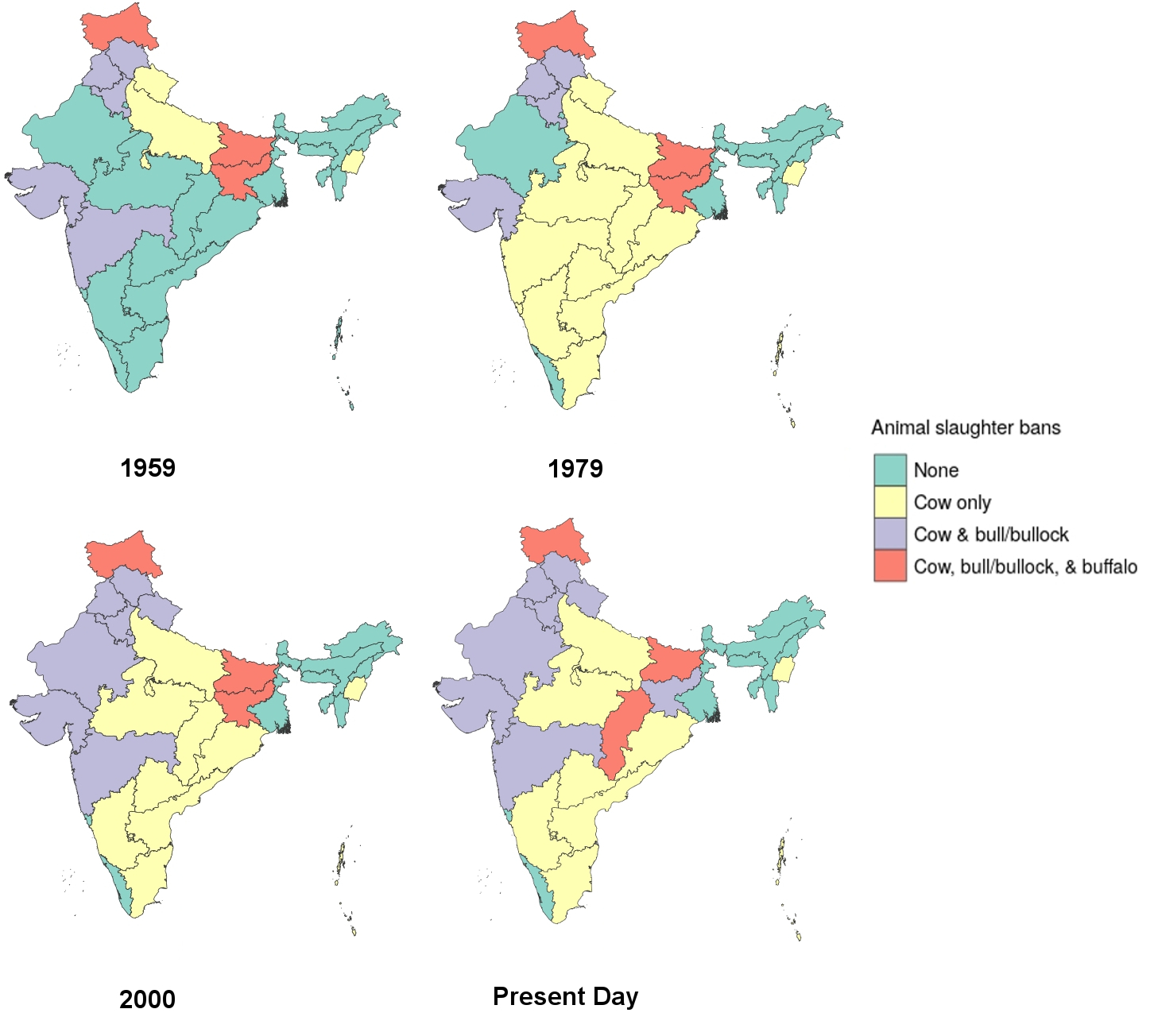
**The rest of the paper is organized as follows. Section 2 descries the historical background of cow slaughter bans. Section 3 describes the data and empirical strategy. Second 4 shows results and section 5 discusses and concludes.**

**2. Historical background of cow slaughter bans**

**Cows have long been revered as sacred in the Hindu faith. The *Rig Veda*, the oldest Hindu scripture (composed between 1500 and 1200 BCE), describes cows as divine, sacred, and worthy of protection.**[[3]](#footnote-3) **The earliest known reference to a legal ban on cow slaughter is an engraving on a stupa in Sanchi (photograph in Appendix B), Madhya Pradesh, dated to 412 CE, during the reign of Chandragupta II of the Gupta dynasty (Ambedkar, 1948).**

**Since the medieval era and the rule of North India by a series of Central Asian Muslim conquerors culminating with the Mughal Empire, cow slaughter has been alternately banned and permitted in different parts of India at different points in time—some Muslim rulers encouraged cow slaughter as a means of enforcing their authority, while others, like the Mughal emperors Akbar and Aurangzeb, prohibited it in the interests of communal harmony (Lodha, 2002). Under British rule, however, cow slaughter was legal and commonplace all over the country, and some anti-colonial uprisings and revivalist movements made cow slaughter bans a central issue (details in Appendix B).**

**When the Constitution of India was being drafted, after a significant debate during which both religious and economic concerns were raised, the issue was left to individual states, with the result that legislation on the issue of cattle slaughter varies significantly by state. Today, eighteen of India’s twenty-nine states ban cattle slaughter to some extent, while eleven states, including Kerala, have no restrictions on cattle slaughter at all. Some, like Assam, permit cows to be slaughtered with a “fit-for-slaughter” certificate, issued if the cow is over a certain age or no longer productive. Still others, like Karnataka, prohibit cow slaughter entirely but allow bulls and oxen to be slaughtered under certain conditions. Others, like Punjab, prohibit the slaughter of cows, bulls, and oxen, but permit the slaughter of water buffalo. Finally, a few states like Chattisgarh also prohibit the slaughter of water buffalo. None of these bans—with the exception of Jammu & Kashmir and Manipur, which were princely states prior to Independence, and had already banned cow slaughter by royal decrees issued in 1932 and 1936, respectively—were in place at the time of Independence. Appendix B provides further legal background, including relevant Supreme Court cases. Figure 1 depicts the status of state-level laws in 1959, 1979, 2000, and the present day.**



**Figure 1: Summary of cattle slaughter bans as of January 1959, 1979, 2000, and present day.   
Note: In 1959, Tamil Nadu permitted slaughter of cows if they were unproductive and had a “fit-for-slaughter” certificate.**

**3. Methods**

**3.1 Sample**

The cattle slaughter ban data for this study was constructed by the authors from primary and secondary sources. The database consists of state-year observations of total cattle slaughter bans by state and year, as set by policy between 1950 and 1991, when the youngest respondents in our sample were born. The main source for the state-level data on cattle slaughter ban laws was the 2002 Report of the National Commission on Cattle, prepared for the Department of Animal Husbandry, Dairying, and Fisheries, a division of the Indian Ministry of Agriculture (Lodha, 2002).We examined individual state-level legislation to fill in the details of amendments and subsequent legislation. The date of publication in the State Gazette is the date a law formally comes into force in India, and that date was used as the date of the legislation. If a cattle slaughter ban was published in a given month in a year, that state was coded as having a ban from that month in that year onwards, for all subsequent years, unless the law was repealed or amended, in which case the coding was reversed from the year of the amendment. When states were divided—for example, the state of Bombay was divided into Maharashtra and Gujarat in 1960, and there are many such examples—the existing law was applied in both states until a state passed its own separate legislation, and we coded the data accordingly.

To estimate the impact of cattle slaughter bans on health outcomes, we used the 2005-06 Indian Demographic and Health Surveys (DHS). The DHS are nationally representative household surveys conducted in LMICs and are designed to collect health and sociodemographic information on women of reproductive age (15-49 years), men (usually aged 15-54 or 15-59), and children ever born (Corsi et al., 2012). The DHS asks women about their birth history, in addition to their socio-economic background, among other topics. Regarding birth history, information about date of birth (month and year) and child's gender is available for all births. Data on hemoglobin levels is also collected, and measured in g/L, which is what we use. We implicitly assume that all respondents reside in the state of their birth.[[4]](#footnote-4)

Our data set contains 103,198 observations on hemoglobin levels for women 15-49 years old, and 64,909 observations on hemoglobin levels for men ages 15-54, alive at the time of the interview, from the 2005-06 DHS survey. We used religion and caste data to clean the data further, dropping Buddhist, Jewish, Zoroastrian, and Donyi Polo respondents, those with no religion, and observations with missing values. Among Hindus, those belonging to scheduled tribes were dropped due to the tremendous heterogeneity between individual tribes. We also dropped the state of Jammu and Kashmir from the dataset[[5]](#footnote-5).

**3.2 Measures**

Our exposure is a dummy variable indicating the presence of a legislative restriction on cattle slaughter in a given state in a particular year—a total ban on cow slaughter, or a ban on cow slaughter and a ban on beef sale, or a ban on cow slaughter and a ban on cattle exports for the purposes of slaughter, or a ban on the slaughter of cows, bulls, and bullocks. We interact this with a dummy for belonging to a community in which beef-eating is traditionally common—Muslims, Dalits (scheduled castes) and Christians. We expect the effects to be primarily centered on the groups whose diet would have been affected, compared to the groups who do not traditionally eat beef—upper-caste Hindus, Sikhs, and Jains—who serve as placebos. The bans vary by time and state. Together with the variation by community, we have a triple difference-in-difference-in-difference model.

For women 15-49 at the time of interview, the DHS provides hemoglobin (Hg) data. Our primary outcome was hemoglobin as well as measures of moderate (Hg<120 g/L) to severe anemia (Hg<80 g/L), which are widely regarded as an important measures of maternal health, nutrition as well as economic well-being**.**

We account for potential confounding by controlling for individual and household characteristics posited to influence the relationship between cattle slaughter bans and Hg. Women's covariates included age, age squared, marital status, age at first marriage, whether currently pregnant, total number of children born, work status, and educational attainment; and their partner's covariates consisted of educational attainment. A dummy indicating urban versus rural residence was also included. Educational attainment was coded as follows: 0 –no education; 1- incomplete primary; 2-compete primary; 3-incomplete secondary, 4-secondary, and 5- higher education. To account for household SES, we controlled for quintiles of the DHS wealth index, which is based on ownership of specific assets (e.g. radio and television), environmental conditions, and housing characteristics (e.g., materials used for housing construction and sanitation facilities), and constructed using a method developed by Filmer and Pritchett (2001; 1999). Tables S1 and S2 contain the summary statistics of all the variables used for women and men respectively.

We see that the average level of hemoglobin, at 117.06, is actually below the anemia threshold (120 g/L), indicating the severity of the problem as a public health issue. Table S1 also shows that about 51% of the respondents (who are all female) are anemic, and 3% are severely anemic (< 80 g/L). This is not true for the men in the DHS sample—the mean hemoglobin level is 143.4, 8% of them are anemic, and only 1% are severely anemic. The average age is 29.2 for women and 31 for men, over 90% are married, and they have about two children on average. About 5% of the female respondents were pregnant at the time of the survey, and we control for this in our regressions due to the negative effect of pregnancy on hemoglobin levels. About 30% of the women have no education at all, and just over 11% have education beyond high school. Meanwhile, only about 21% of their partners have no education, and just under 15% of them have education beyond high school. Over half live in rural areas, and about 34% are currently working.

**3.3 Empirical Strategy**

The following reduced form equation was used to model the impact of cattle slaughter bans:

𝑌i,m,c,t= 𝛼 + 𝛽1Banc,t X Beef consumerc,t+ 𝛽2𝑋i,m,c,t + 𝑔(𝑐, 𝑡) + 𝑈i,m,c,t (1)

where 𝑌 is the outcome of interest (either Hg levels or anemia incidence) for woman *i* born in year *t* belonging to mother *m* in state *c*. 𝛽2 is the parameter of interest as it measures the impact of introduction of a total ban on cattle slaughter in a given state *c*, at time *t* (for cohort *t*) for the treatment sample—Muslims, Dalits, Christians (beef consuming communities) compared to the control group (Hindus, Sikhs,and Jains). Data on state and year specific bans was matched to the year of birth of each girl so that cohort variation in exposure to cattle slaughter bans around birth is exploited for identification of causal effects.

To deal with other factors that may confound the relation between cattle slaughter bans and the health outcome of interest (Hg or Anemia), we flexibly controlled for 𝑋i,m,c,t, which is a vector containing individual and household characteristics. Our identification strategy exploits arguably exogenous timing of changes in rollout of bans with the timing of births. This suggests that our control group is not a different state, but women within the same state at different times and even within same time. We compare beef consuming groups (like Dalit) with control groups to estimate a triple difference in difference exploiting state, time and group variation in bans. We complement our identification strategy with controls for *g(c,t)*—state fixed effects and time trends (women’s year of birth fixed effects).State fixed effects control for any time invariant differences between states that may bias the effects of cattle slaughter bans, whereas the time trends control for unobservable changes in economic conditions over time. Furthermore, we also explore the role of time varying unobservables by including state specific time trends. In stratified models, we also examined heterogeneous effects of cattle slaughter bans by education level, age and economic background of the household (wealth quintiles).

We posit that these effects will be primarily among less educated and poor households as not only they may be more likely to be anemic but they are unable to make sufficient compensatory investments, compared to richer households who may be able to compensate for any early life nutritional loss with compensatory investments over their lifetime.

**4. Results**

To begin with, we plot average hemoglobin levels over the life cycle for women in the two groups, in states with varying cattle slaughter bans, in Figure 2. We can see that hemoglobin levels appear to be higher for prime age women in traditionally beef-eating communities in states which do not restrict cattle slaughter as compared to states which do. Conversely, hemoglobin levels appear higher for women in non-beef-eating communities in states which restrict cattle slaughter as opposed to states which do not.

As an interesting aside, notice that the average hemoglobin level for either group almost never rises above the critical threshold for anemia, 120g/L. This is consistent with other estimates of an extremely high prevalence of anemia in Indian women across the board, and the mean of 117.06 as shown in Table S1.

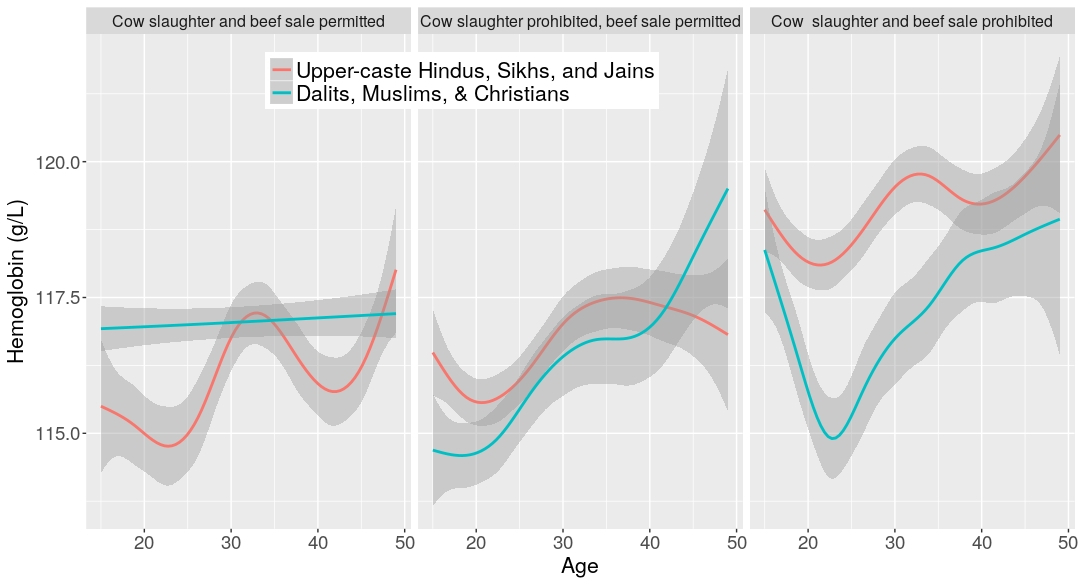


Figure 2: Average hemoglobin levels by age, community, and presence of cattle slaughter restrictions in state of residence. Shaded area represents the 95% confidence interval.

We now turn our attention to the results of the model described in equation (1), summarized in Tables 1, 2, and 3. Table 1 shows effects of three types of bans, with varying levels of strictness. Cattle slaughter bans are the most pervasive. Beef sale bans in addition to cattle slaughter have bans on sales of beef. Export bans in addition to domestic beef bans, prohibit the export of cattle for the purpose of slaughter or export of beef. There are two models explored for each type of treatment. The odd-numbered columns (1, 3, 5) show results for the basic specification with estimates for difference in differences by treatment group and law, with state year and month fixed effects, whereas the even-numbered columns (2, 4, 6) control for a wide range of demographic and SES covariates, including state specific time trends (see table notes for details) and restricts attention to women without schooling in their prime age (15-35). Although the sample restriction to no schooling is restrictive, and decreases our sample size considerably, it emphasizes that our results are most applicable to relatively marginalized groups. We find that all three bans, around the time of births, reduce hemoglobin levels in women among the beef consuming groups in adulthood, with effects particularly strong for the most marginalized women in their prime ages of life when they are most likely to pass on some of these effects to the next generation. The effects vary in magnitude from ~1g/L to 2.3g/L. Panel B studies these effects on men. Interestingly, we do not find any effects of cattle slaughter restrictions on men for any of the models with respect to Hb.

It is important to note that our control group in the models with beef sale bans and export bans includes states with cow slaughter bans but no additional restrictions. Ex ante, one might expect this to weaken our results, but the negative and significant coefficients on hemoglobin, and the positive and significant results on anemia and severe anemia, remain. We are able to measure the effects of stronger restrictions on the margin.

In Table 2 and 3, we explore samples and models as in Table 1, except that now we look at effects of cattle slaughter restrictions on the likelihood of being anemic and severely anemic (< 120 g/L and < 80 g/L respectively), using linear probability models. We find that cattle slaughter bans increase the probability of moderate anemia for women in the affected groups from 3 to 5 percentage points, and the probability of severe anemia by from around 0.3- 09 percentage points. In contrast, we do not find effects on moderate anemia for men, similar to the Hb results, though we do find evidence for effects on severe anemia for men, ranging from 0.3 to 0.9 percentage points. This is a large effect considering that only 1% of the men in the sample are severely anemic.

Table 1A in the Appendix, shows results for hemoglobin but with three alternate bans: bull slaughter bans, buffalo slaughter bans, and beef possession bans. There are very few states which have these laws in addition to the bans we have already studied, so we recommend caution when drawing conclusions for India as a whole based on these results. Nonetheless, these laws may also contribute to reduced red meat availability for the beef eating groups, so we also studied them as part of our analysis. The results have the expected signs and magnitudes, especially for beef possession laws, which are similar to other laws, but we find the estimates are less precise in general. Interestingly, in contrast to earlier results, we find that some laws—buffalo slaughter bans in particular—have large and significant effects on mens’ Hb level ranging from 2.4 to 2.9 g/L.

As a robustness check, we also tested their effects on height, a commonly used indicator of health and nutrition status. Results in tables 2A and 3A show the effects of all six bans on adult height. Although there is some evidence for adverse effects for beef sale bans and export bans on height for women in the vanilla model, these are not present among the most marginalized groups. We interpret this to suggest that people are able to substitute alternative sources of protein in their diet, but unable to adequately do so for iron sources. Our models for men in Panel B, columns 3 and 5 show some evidence of a reduction in height in the vanilla model, but this result is not robust to the addition of covariates.

**5. Discussion and Conclusion**

In 2012, the 65th World Health Assembly committed to halve anemia prevalence in women of reproductive age by 2025. An estimated 300 million Indian women, half all Indian women, are known to suffer from anemia. Although much has been studied about iron supplements as well as deworming programs (Dupas and Miguel 2016), coverage for pregnant women remains low and scientists usually recommend diets rich in iron (Stevens et al. 2013). Food fortification programs are often recommended though there coverage is also low and success is mixed (Banerjee et al 2016).

In this context, this paper contributes by exploiting cattle slaughter bans in India to study the long-terms effects of an iron rich diet (beef) during the perinatal period on the later life prevalence of anemia. It finds that girls exposed to cattle slaughter bans in their year of birth have lower levels of hemoglobin (Hb) and are more likely to be anemic in their prime reproductive ages between 15 and 35, particularly for women who have no schooling. The impact of a cattle slaughter ban on hemoglobin levels is about 1-2.3 g/L. This is about one-tenth to one-fifth the effect of pregnancy, which tends to reduce hemoglobin levels by about 10 g/L across the board. These results are robust to the inclusion of bans of varying degrees of strictness, even as we compare them to a control group of states with cow slaughter bans and states with no restrictions on cattle slaughter.

We do not find statistically significant effects of cattle slaughter bans on anemia and hemoglobin for men, in most of our models. We hypothesize that the difference in the results for men and women stems from the tradition prevalent in many Indian families wherein women eat only after the men and children in the family have eaten, and often do not receive as much nutrition as a result. Behrman (1988), Behrman and Deolalikar (1990) and Das Gupta (1987) also document large differences in childhood nutrition and mortality rates among boys and girls in India, resulting from systematic gender discrimination. Differential mortality rates by gender and cohort may also be driving some of our observed results.

Although we focus on the role of iron deficiency due to the reduced availability of red meat, other plausible mechanisms remain. There may be an income effect due to the reduced option value of cow ownership, changes in access to dairy products, and more. We intend to use NSS data to examine the actual effects of cow slaughter bans on red meat consumption to look at the first stage effects, and to use additional waves of the DHS survey to increase sample size. These estimates also do not control for time-varying state-level economic data such as state GDP, unemployment rates, and access to health facilities, over and above what is captured by the state-specific time trends.

This paper not only helps us get a better understanding of iron rich diets, but builds on recent research of the effects of fasting during pregnancy by exploring the role of nutritional deprivation of a particular food item (beef) during the perinatal period on later life outcomes. In doing so this work strengthens the argument that even moderate changes—those amenable to policy—can have long-term effects in contrast to earlier studies on the fetal origin hypothesis which focused on rare and extreme shocks such as famines and wars.

**Cow slaughter is an extremely sensitive issue in India, and religious sentiments are powerful enough that overturning the bans is probably neither feasible nor desirable. However, the severity of anemia as a public health issue and its dire consequences mean that alternative measures to supplement nutritional deficiencies, particularly for low-SES groups, are essential. Deworming, iron supplementation and food fortification are some relatively cost-effective and simple solutions, with proven success if implemented appropriately (Dupas and Miguel, 2016; Zimmerman and Hurrell, 2007). Despite numerous government initiatives to provide iron supplementation—the 12x12 scheme, Integrated Child Development Services, National Nutrition Policy, the Mid-Day Meal Program (iron-enriched school lunches), Rajiv Gandhi Scheme for Girls Empowerment of Adolescent, the National Rural Health Mission, and many others, coverage remains low—barely 10% of women receive supplements, and only 7.6% of industrially milled wheat flour is fortified. (Anand et al, 2014; Food Fortification Initiative)**

**Although this is beyond the scope of our paper, one possibility is to increase the fortification of popularly consumed cereals, and encouraging the consumption of iron-rich cereals like finger millet. The Public Distribution System (PDS, popularly called ration shops) remains the major source of nutrition for low-income families, and it focuses almost exclusively on wheat, rice, and sugar. Policy makers could work to ensure that all wheat and rice sold through the PDS is fortified with iron and folic acid; that finger millet and other inexpensive iron-rich foods are made available through the system; and that vitamin C supplementation is also prioritized and encouraged. These measures may be combined with widespread education on the importance of consuming iron-rich foods, along with measures to increase their availability through the PDS.**

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**Table S1: Summary Statistics for Women**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Mean | Standard deviation | Min | Max |
| Hemoglobin | 117.06 | 17.54 | 20.0 | 199 |
| Anemic | 0.51 | 0.50 | 0.0 | 1 |
| Severely anemic | 0.03 | 0.18 | 0.0 | 1 |
| Height | 1521.89 | 59.29 | 1003.0 | 1987 |
| Treated | 0.41 | 0.49 | 0.0 | 1 |
| Total ban on cattle slaughter | 0.64 | 0.48 | 0.0 | 1 |
| Beef sale ban | 0.32 | 0.47 | 0.0 | 1 |
| Beef export ban | 0.42 | 0.49 | 0.0 | 1 |
| Beef possession ban | 0.08 | 0.26 | 0.0 | 1 |
| Bull/bullock slaughter ban | 0.18 | 0.39 | 0.0 | 1 |
| Buffalo slaughter ban | 0.06 | 0.24 | 0.0 | 1 |
| Year | 1976.11 | 9.51 | 1956.0 | 1991 |
| Age | 29.21 | 9.50 | 15.0 | 49 |
| Currently work | 0.34 | 0.47 | 0.0 | 1 |
| Urban | 0.47 | 0.50 | 0.0 | 1 |
| Married | 0.94 | 0.24 | 0.0 | 1 |
| Age at first marriage | 18.00 | 3.96 | 3.0 | 45 |
| Number of children | 2.06 | 2.04 | 0.0 | 16 |
| Currently pregnant | 0.05 | 0.21 | 0.0 | 1 |
| *N* | 103198 |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Education | Number | | Percent |
| No education | 31102 | | 30.14 |
| Incomplete primary | 7963 | | 7.72 |
| Complete primary | 6951 | | 6.74 |
| Incomplete secondary | 39406 | | 38.18 |
| Complete secondary | 6551 | | 6.35 |
| Higher | 11215 | | 10.87 |
| Total | 103198 | | 100.00 |
| *N* | 103198 | |  |
|  |  | |  |
| Partner’s education | | | Number | | | Percent |
| No education | | | 16288 | | | 20.97 |
| Incomplete primary | | | 11747 | | | 15.13 |
| Incomplete secondary | | | 36551 | | | 47.06 |
| Complete secondary | | | 1628 | | | 2.10 |
| Higher | | | 11447 | | | 14.74 |
| Total | | | 77661 | | | 100.00 |
| *N* | | | 77661 | | |  |

|  |  |  |
| --- | --- | --- |
| Wealth | Number | Percent |
| 1 | 9625 | 9.33 |
| 2 | 14406 | 13.96 |
| 3 | 19840 | 19.23 |
| 4 | 26112 | 25.30 |
| 5 | 33215 | 32.19 |
| Total | 103198 | 100.00 |
| *N* | 103198 |  |

**Table S2: Summary Statistics for Men**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Mean | Standard deviation | Min | Max |
| Hemoglobin | 143.39 | 18.26 | 22.0 | 199 |
| Anemic | 0.08 | 0.28 | 0.0 | 1 |
| Severely anemic | 0.01 | 0.08 | 0.0 | 1 |
| Height | 1645.69 | 69.00 | 800.0 | 1962 |
| Treated | 0.40 | 0.49 | 0.0 | 1 |
| Total ban on cow slaughter | 0.64 | 0.48 | 0.0 | 1 |
| Beef sale ban | 0.28 | 0.45 | 0.0 | 1 |
| Beef export ban | 0.37 | 0.48 | 0.0 | 1 |
| Beef possession ban | 0.05 | 0.21 | 0.0 | 1 |
| Bull/bullock slaughter ban | 0.13 | 0.34 | 0.0 | 1 |
| Buffalo slaughter ban | 0.03 | 0.17 | 0.0 | 1 |
| Year | 1974.37 | 10.79 | 1951.0 | 1991 |
| Age | 30.97 | 10.79 | 15.0 | 54 |
| Currently work | 0.83 | 0.37 | 0.0 | 1 |
| Urban | 0.53 | 0.50 | 0.0 | 1 |
| Married | 0.98 | 0.14 | 0.0 | 1 |
| Age at first marriage | 23.13 | 4.93 | 1.0 | 52 |
| Number of children | 1.69 | 2.04 | 0.0 | 19 |
| *N* | 64909 |  |  |  |

|  |  |  |
| --- | --- | --- |
| Wealth | Number | Percent |
| 1 | 5240 | 8.07 |
| 2 | 8831 | 13.61 |
| 3 | 13094 | 20.17 |
| 4 | 17357 | 26.74 |
| 5 | 20387 | 31.41 |
| Total | 64909 | 100.00 |
| *N* | 64909 |  |

**Table 1: Effects of Cow Slaughter, Beef Sale and Export Bans on Hemoglobin by Gender**

**Panel A: Women**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | (1) | (2) | | (3) | | (4) | | (5) | | (6) | |
|  | | Hb | Hb | | Hb | | Hb | | Hb | | Hb | |
| **Cow** Slaughter | -1.087\* | | | -1.540\* | |  | |  | |  | |  | |
| X Beef Consumer | (0.579) | | | (0.822) | |  | |  | |  | |  | |
| **Beef** Sale Ban |  | | |  | | -1.260\*\* | | -2.341\*\*\* | |  | |  | |
| X Beef Consumer |  | | |  | | (0.562) | | (0.501) | |  | |  | |
| **Export** Ban |  | | |  | |  | |  | | -1.432\*\* | | -1.800\*\* | |
| X Beef Consumer |  | | |  | |  | |  | | (0.534) | | (0.683) | |
|  |  | | |  | |  | |  | |  | |  | |
| Observations | 93,376 | | | 18,854 | | 93,376 | | 18,854 | | 93,376 | | 18,854 | |
| R-squared | 0.039 | | | 0.069 | | 0.039 | | 0.069 | | 0.040 | | 0.069 | |

**Panel B: Men**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | (1) | | (2) | | (3) | | (4) | | (5) | | (6) | |
| VARIABLES | Hb | | Hb | | Hb | | Hb | | Hb | | Hb | |
| **Cow** Slaughter | | 0.721 | | 1.050 | |  | |  | |  | |  | |
| X Beef Consumer | | (0.631) | | (1.092) | |  | |  | |  | |  | |
| **Beef** Sale Ban | |  | |  | | 0.884 | | 1.221 | |  | |  | |
| X Beef Consumer | |  | |  | | (0.697) | | (0.946) | |  | |  | |
| **Export** Ban | |  | |  | |  | |  | | 0.790 | | 0.579 | |
| X Beef Consumer | |  | |  | |  | |  | | (0.630) | | (1.009) | |
|  | |  | |  | |  | |  | |  | |  | |
| Observations | | 55,943 | | 10,309 | | 55,943 | | 10,309 | | 55,943 | | 10,309 | |
| R-squared | | 0.058 | | 0.077 | | 0.058 | | 0.077 | | 0.058 | | 0.077 | |

Note: Robust standard errors in parentheses\*\*\* p<0.01, \*\* p<0.05, \* p<0.1 .The table shows results for effects on Hemoglobin in Panel A for women and in Panel B for men (partners of women interviewed). Each Panel shows results from three different models from three different treatments: cow slaughter bans, beef sale bans, and beef export bans. The odd columns (1,3,5) show results for basic specification shows estimates for difference in differences by treatment group and law, with state year and month fixed effects. Even columns in Panel A (women) control in addition for: state specific time trends, age, age squared, urban, married, age at first marriage, total births ever, whether currently pregnant, currently working or not, and dummies for partners education and the wealth index. In addition the samples are restricted to those in their prime age (15-35) and those with no education. Even columns in Panel B control for age, age squared, whether currently working, urban, married, age at first marriage, total children and dummies for wealth index. In addition, sample is restricted to fathers without education.

**Table 2: Effects of Cattle slaughter, Beef Sale and Export Bans on Likelihood of Being Anemic by Gender**

**Panel A: Women**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Anemic | Anemic | Anemic | Anemic | Anemic | Anemic |
|  |  |  |  |  |  |  |
| Cow Slaughter X Beef Consumer | 0.027\* | 0.032\* |  |  |  |  |
|  | (0.013) | (0.017) |  |  |  |  |
| Beef Sale Ban X Beef Consumer |  |  | 0.030\*\* | 0.053\*\*\* |  |  |
|  |  |  | (0.014) | (0.012) |  |  |
| Export Ban X Beef Consumer |  |  |  |  | 0.035\*\* | 0.042\*\*\* |
|  |  |  |  |  | (0.013) | (0.014) |
|  |  |  |  |  |  |  |
| Observations | 93,376 | 18,854 | 93,376 | 18,854 | 93,376 | 18,854 |
| R-squared | 0.036 | 0.057 | 0.036 | 0.057 | 0.036 | 0.057 |

**Panel B: Men**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Anemic | Anemic | Anemic | Anemic | Anemic | Anemic |
|  |  |  |  |  |  |  |
| Cow Slaughter X Beef Consumer | 0.000 | 0.008 |  |  |  |  |
|  | (0.012) | (0.019) |  |  |  |  |
| Beef Sale Ban X Beef Consumer |  |  | -0.007 | -0.014 |  |  |
|  |  |  | (0.010) | (0.015) |  |  |
| Export Ban X Beef Consumer |  |  |  |  | -0.003 | 0.005 |
|  |  |  |  |  | (0.010) | (0.019) |
|  |  |  |  |  |  |  |
| Observations | 55,943 | 10,309 | 55,943 | 10,309 | 55,943 | 10,309 |
| R-squared | 0.018 | 0.042 | 0.018 | 0.042 | 0.018 | 0.042 |

Note: Robust standard errors in parentheses\*\*\* p<0.01, \*\* p<0.05, \* p<0.1 .The table shows results for effects on Anemic status in Panel A for women and in Panel B for men (partners of women interviewed). Each Panel shows results from three different models from three different treatments: cow slaughter bans, beef sale bans, and beef export bans. The odd columns (1,3,5) show results for basic specification shows estimates for difference in differences by treatment group and law, with state year and month fixed effects. Even columns in Panel A (women) control in addition for: state specific time trends, age, age squared, urban, married, age at first marriage, total births ever, whether currently pregnant, currently working or not, and dummies for partners education and the wealth index. In addition the samples are restricted to those in their prime age (15-35) and those with no education. Even columns in Panel B control for age, age squared, whether currently working, urban, married, age at first marriage, total children and dummies for wealth index. In addition, sample is restricted to fathers without education.

**Table 3: Effects of Cow Slaughter, Beef Sale and Export Bans on Likelihood of Being Severely Anemic by Gender**

**Panel A: Women**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Severely  Anemic | Severely  Anemic | Severely  Anemic | Severely  Anemic | Severely  Anemic | Severely  Anemic |
| Cow Slaughter X Beef Consumer | 0.008\*\*  (0.004) | 0.009\*  (0.005) |  |  |  |  |
|  |  |  |  |  |  |  |
| Beef Sale Ban X Beef Consumer |  |  | 0.006  (0.004) | 0.006  (0.005) |  |  |
|  |  |  |  |  |  |  |
| Export Ban X Beef Consumer |  |  |  |  | 0.007\*\*  (0.003) | 0.009\*  (0.005) |
|  |  |  |  |  |  |  |
| Observations | 93,376 | 18,854 | 93,376 | 18,854 | 93,376 | 18,854 |
| R-squared | 0.006 | 0.013 | 0.006 | 0.013 | 0.006 | 0.013 |

**Panel B: Men**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Severely  Anemic | Severely  Anemic | Severely  Anemic | Severely  Anemic | Severely  Anemic | Severely  Anemic |
| Cow Slaughter X Beef  Consumer | 0.003\*\*  (0.001) | 0.005\*  (0.003) |  |  |  |  |
|  |  |  |  |  |  |  |
| Beef Sale Ban X Beef  Consumer |  |  | 0.002  (0.001) | 0.009\*\*\*  (0.003) |  |  |
|  |  |  |  |  |  |  |
| Export Ban X Beef  Consumer |  |  |  |  | 0.003\*  (0.002) | 0.008\*\*  (0.003) |
| Observations | 55,943 | 10,309 | 55,943 | 10,309 | 55,943 | 10,309 |
| R-squared | 0.003 | 0.014 | 0.003 | 0.014 | 0.003 | 0.014 |

Note: Robust standard errors in parentheses\*\*\* p<0.01, \*\* p<0.05, \* p<0.1 .The table shows results for effects on Severely Anemic status in Panel A for women and in Panel B for men (partners of women interviewed). Each Panel shows results from three different models from three different treatments: cow slaughter bans, beef sale bans

, and beef export bans. The odd columns (1,3,5) show results for basic specification shows estimates for difference in differences by treatment group and law, with state year and month fixed effects. Even columns in Panel A (women) control in addition for: state specific time trends,

age, age squared, urban, married, age at first marriage, total births ever, whether currently pregnant,

currently working or not, and dummies for partners education and the wealth index. In addition the

samples are restricted to those in their prime age (15-35) and those with no education. Even columns in

Panel B control for age, age squared, whether currently working, urban, married, age at first marriage, total children and dummies for wealth index. In addition, sample is restricted to fathers without education.

**Table 1A: Effects of Bull Slaughter, Buffalo Slaughter and Export Bans on**

**Hemoglobin by Gender**

**Panel A: Women**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Hb | Hb | Hb | Hb | Hb | Hb |
|  |  |  |  |  |  |  |
| Bull Slaughter X Beef Consumer | -0.895  (0.584) | -0.535  (0.886) |  |  |  |  |
| Buffalo Slaughter X Beef Consumer |  |  | -0.960\*\*\*  (0.315) | -0.418  (0.446) |  |  |
| Beef Possess X Beef Consumer |  |  |  |  | -1.325\*\*\*  (0.326) | -1.291\*  (0.669) |
| Observations | 93,376 | 18,854 | 93,376 | 18,854 | 93,376 | 18,854 |
| R-squared | 0.039 | 0.068 | 0.039 | 0.068 | 0.039 | 0.068 |

**Panel B: Men**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | (1) | | (2) | | (3) | | (4) | | (5) | | (6) | |
| VARIABLES | | Hb | | Hb | | Hb | | Hb | | Hb | | Hb | |
| Bull Slaughter X | -1.376\* | | -1.492 | |  | |  | |  | |  | |
| Beef Consumer | (0.796) | | (0.929) | |  | |  | |  | |  | |
| Buffalo Slaughter X |  | |  | | -2.892\*\*\* | | -2.336\*\* | |  | |  | |
| Beef Consumer |  | |  | | (0.389) | | (0.881) | |  | |  | |
| Beef Possess X |  | |  | |  | |  | | 0.562 | | 0.280 | |
| Beef Consumer |  | |  | |  | |  | | (1.107) | | (2.664) | |
|  |  | |  | |  | |  | |  | |  | |
| Observations | 55,943 | | 10,309 | | 55,943 | | 10,309 | | 55,943 | | 10,309 | |
| R-squared | 0.058 | | 0.077 | | 0.058 | | 0.077 | | 0.058 | | 0.077 | |

Note: Robust standard errors in parentheses\*\*\* p<0.01, \*\* p<0.05, \* p<0.1 .The table shows results for effects on Hemoglobin status in Panel A for women and in Panel B for men (partners of women interviewed). Each Panel shows results from three different models from three different treatments: bull slaughter bans, buffalo slaughter bans, and beef possession bans. The odd columns (1, 3, 5) show results for basic specification shows estimates for difference in differences by treatment group and law, with state year and month fixed effects. Even columns in Panel A (women) control in addition for: state specific time trends, age, age squared, urban, married, age at first marriage, total births ever, whether currently pregnant, currently working or not, and dummies for partners education and the wealth index. In addition the samples are restricted to those in their prime age (15-35) and those with no education. Even columns in Panel B control for age, age squared, whether currently working, urban, married, age at first marriage, total children and dummies for wealth index. In addition, sample is restricted to fathers without education.

**Table 2A: Effects of Cow Slaughter, Beef Sale and Export Bans on Adult Height by Gender**

**Panel A: Women**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Height | Height | Height | Height | Height | Height |
|  |  |  |  |  |  |  |
| Cow Slaughter X Beef Consumer | 1.487 | -1.341 |  |  |  |  |
|  | (2.345) | (4.156) |  |  |  |  |
| Beef Sale Ban X Beef Consumer |  |  | 0.346 | 2.996 |  |  |
|  |  |  | (2.635) | (3.165) |  |  |
| Export Ban X Beef Consumer |  |  |  |  | -1.361 | 1.431 |
|  |  |  |  |  | (2.796) | (3.369) |
|  |  |  |  |  |  |  |
| Observations | 99,071 | 19,730 | 99,071 | 19,730 | 99,071 | 19,730 |
| R-squared | 0.054 | 0.079 | 0.053 | 0.079 | 0.054 | 0.079 |

**Panel B: Men**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Height | Height | Height | Height | Height | Height |
|  |  |  |  |  |  |  |
| Cow Slaughter X Beef Consumer | -1.632 | 0.169 |  |  |  |  |
|  | (2.312) | (2.255) |  |  |  |  |
| Beef Sale Ban X Beef Consumer |  |  | -3.864\*  (1.985) | 2.759  (2.471) |  |  |
| Export Ban X Beef Consumer |  |  |  |  | -5.122\*\*  (2.073) | 0.749  (2.664) |
|  |  |  |  |  |  |  |
| Observations | 60,677 | 11,058 | 60,677 | 11,058 | 60,677 | 11,058 |
| R-squared | 0.071 | 0.085 | 0.071 | 0.085 | 0.071 | 0.085 |

Note: Robust standard errors in parentheses\*\*\* p<0.01, \*\* p<0.05, \* p<0.1 .The table shows results for effects on

adult height in Panel A for women and in Panel B for men (partners of women interviewed). Each Panel shows

resultsfrom three different models from three different treatments: cow slaughter bans, beef sale bans, and beef export bans. The odd columns (1, 3, 5) show results for basic specification shows estimates for difference in differences by treatment group and law, with state year and month fixed effects. Even columns in Panel A (women) control in addition for: state specific time trends, age, age squared, urban, married, age at first marriage, total births ever, whether currently pregnant, currently working or not, and dummies for partners education and the wealth index. In addition the samples are restricted to those in their prime age (15-35) and those with no education. Even columns in Panel B control for age, age squared, whether currently working, urban, married, age at first marriage, total children and dummies for wealth index. In addition, sample is restricted to fathers without education.

**Appendix Table 3A: Effects of Bull Slaughter, Buffalo Slaughter and Export Bans on Adult Height by Gender**

**Panel A: Women**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Height | Height | Height | Height | Height | Height |
|  |  |  |  |  |  |  |
| Bull Slaughter X Beef Consumer | -6.080\* | -5.226\* |  |  |  |  |
|  | (3.079) | (2.625) |  |  |  |  |
| Buffalo Slaughter X Beef Consumer |  |  | -2.216 | -3.568\* |  |  |
|  |  |  | (2.241) | (1.937) |  |  |
| Beef Possess X Beef Consumer |  |  |  |  | 5.137 | 1.778 |
|  |  |  |  |  | (3.064) | (3.752) |
|  |  |  |  |  |  |  |
| Observations | 99,071 | 19,730 | 99,071 | 19,730 | 99,071 | 19,730 |
| R-squared | 0.054 | 0.079 | 0.053 | 0.079 | 0.054 | 0.079 |

**Panel B: Men**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | Height | Height | Height | Height | Height | Height |
|  |  |  |  |  |  |  |
| Bull Slaughter X Beef Consumer | -5.479 | 0.382 |  |  |  |  |
|  | (5.127) | (3.777) |  |  |  |  |
| Buffalo Slaughter X Beef Consumer |  |  | -9.698\*\* | -6.317\*\*\* |  |  |
|  |  |  | (4.268) | (1.875) |  |  |
| Beef Possess X Beef Consumer |  |  |  |  | 1.724 | -0.520 |
|  |  |  |  |  | (3.837) | (10.328) |
|  |  |  |  |  |  |  |
| Observations | 60,677 | 11,058 | 60,677 | 11,058 | 60,677 | 11,058 |
| R-squared | 0.071 | 0.085 | 0.071 | 0.085 | 0.071 | 0.085 |

Note: Robust standard errors in parentheses\*\*\* p<0.01, \*\* p<0.05, \* p<0.1 .The table shows results for effects on adult height status in Panel A for women and in Panel B for men (partners of women interviewed). Each Panel shows results from three different models from three different treatments: bull slaughter bans, buffalo slaughter bans, and beef possession bans. The odd columns (1, 3, 5) show results for basic specification shows estimates for difference in differences by treatment group and law, with state year and month fixed effects. Even columns in Panel A (women) control in addition for: state specific time trends, age, age squared, urban, married, age at first marriage, total births ever, whether currently pregnant, currently working or not, and dummies for partners education and the wealth index. In addition the samples are restricted to those in their prime age (15-35) and those with no education. Even columns in Panel B control for age, age squared, whether currently working, urban, married, age at first marriage, total children and dummies for wealth index. In addition, sample is restricted to fathers without education.

1. While vitamin C increases iron absorption, its consumption in the diet of most Indians is too low. Additionally, popular food items like tea and wheat bread contain tannins and phytates respectively, which inhibit iron absorption. Since iron in meat, poultry, and fish (heme iron) is more easily absorbed by the body than non-heme iron, found in plant foods, it is estimated that vegetarians need to increase their iron intake by 80% over omnivores. (Rammohan et. al., 2011) [↑](#footnote-ref-1)
2. Water buffalo slaughter remains legal and widespread in most states, so cow slaughter bans reduce the supply of beef, but do not eliminate it entirely. [↑](#footnote-ref-2)
3. **However, it also describes ritual cow and ox sacrifice in other sections—cows were to be sacrificed on special occasions *because* they were sacred.** [↑](#footnote-ref-3)
4. Munshi and Rosenzweig (2009) document extremely low spatial and marital mobility in India. See also Bhalotra (2008) who estimates that 86% of children born in 1970-97in 15 major Indian states were born in the mother’s current place of residence. [↑](#footnote-ref-4)
5. We drop Jammu and Kashmir, because it is a Muslim-majority state with a cow slaughter ban that was issued as an edict of the king prior to Independence, and we are unsure of the extent to which this ban is enforced—particularly since the king’s edict contained no penalties or enforcement mechanism. [↑](#footnote-ref-5)