Do Parents Selectively Time Birth Relative to Ramadan? Evidence from Matlab, Bangladesh

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Abstract

When evaluating *in utero* nutrition shock, many studies assume parents do not selectively time birth relative to that event of shock. Fasting during Ramadan is one of the nutrition shocks. Using MHSS 1996 data we show that Muslim mothers who received free contraceptives timed the birth of their children relative to Ramadan. We also study birth relative to Ramadan and child height correlations. We find evidence which suggests presence of selection problem may lead to wrong conclusion about the effect of maternal fasting on child health outcomes. **JEL: C52, I12, O15, 017, Z12**

1 Introduction

There is a growing literature based on "Fetal Origin Hypothesis"(Barker 1990) which links adverse environment and the inadequate nutrition *in utero* to later life health outcomes. Numerous evidences from these studies show nine months *in utero* is very critical for individual health (Almond and Currie 2011). Adverse condition *in utero* can have both short term effect such as effect on birth weight and long term effects such as effect on cognition, obesity, cardiovascular disease, diabetes (Almond and Muzumder 2011, Almond

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and Currie 2011, Ewjik 2011). The early studies, however, did not take into account the endogenous exposure to adverse environmental and nutritional condition (Almond and Currie 2011). As a result they could not address the potential confounders appropriately. To establish causal link between *in utero* nutrition shock and health outcomes researchers studied nutrition and health shocks *in utero* exogenous to mothers(Currie 2009). Some of the studies are based on severe historic events such as famine and spread of infectious disease and recent few studies are based on regular occurring event such as Ramadan (Almond 2006; Chen and Zhou 2007; Almond and Muzumder 2011; Ewjik 2011 and Majid 2012). The results from these studies conform with the hypothesis that adverse nutritional environment *in utero* has serious consequences on child health.

However, these studies are not free from limitations. One important methodological limitation is that they are based on the assumption that parents don't selectively time birth relative to those shocks. Thomas(2009) suggests that it is a strong identifying assumption and may not hold. Using data from Bangladesh and USA, he finds that parents who gave birth relative to famine and influenza epidemic in 1918 were systematically different from those who didn't.

Unlike the famine and influenza epidemic, Ramadan is a regular occurring event. Therefore, it might be much easier to time birth relative to Ramadan than other nutrition shocks which are irregular. However, no strong evidence exists on whether parents time birth relative to Ramadan. Perhaps due to lack of strong evidence, studies exploring the effect of maternal fasting on child health and other outcomes assume that parents do not selectively time birth relative to Ramadan. Needless to say that there is an immense need to examine this issue. Around 1 billion alive Muslims on earth today were *in utero* during a period overlapped with Ramadan (Almond and Muzumder 2011). Recent studies (Almond and Muzumder(2011), Ewjik(2011), Majid(2012) and Almond, Muzumder and Ewjik(2014)) find *in utero* exposure to Ramadan has detrimental effects on health outcomes, labor market outcomes and education outcomes. However, all these studies assume that parents do not selectively time birth relative to Ramadan. Failure of this assumption may imply that the effects of maternal fasting on child outcomes are miscalculated. As a result, policies based on these results may not address the issue appropriately and in extreme may be irrelevant.

Using Matlab Health and Socio Economic Survey (MHSS) 1996, we find that parents time birth relative to Ramadan. In October 1977 International Center For Diarrhoeal Disease Research, Bangladesh (ICDDR,B) initiated door to door free contraceptives program in some areas of Matlab. Both the targeted and control areas were very similar in observable characteristics. Using difference-in-difference strategy, we find the women residing in treatment areas are 6-7 % less likely to give birth after 8 to 9 months after Ramadan. We also find that mother with more education are more likely to avoid Ramadan upon receiving free contraceptives. This suggests mothers who give birth relative to different points of Ramadan are different from each other on the average in terms of SES. As a result, evidence from Matlab suggests comparison of the children who were exposed to Ramadan *in utero* with who were not may not be appropriate. Therefore, the studies examining maternal fasting on child health outcomes should take into account the selective timing of birth.

This paper makes some key contributions in the literature. First, we show parents selectively time birth relative to Ramadan using a rich data set. To the best of our knowledge this is the first paper that shows selective timing of birth relative to Ramadan. Secondly, we find that community level time varying characteristics affect timing of birth.This suggests comparison of SES of the parents of an affected child with the parents of a non-affected child may not be adequate to determine selection in birth timing. It might be necessary to interact the community level time varying changes with the parental SES. Thirdly, we show that providing free contraceptives may help Muslim mothers to avoid pregnancy overlapped with Ramadan. Free contraceptives are promoted to reduce fertility and reduce exposure of sexually transmitted disease (STD). This study shows that the unintended benefit of providing free contraceptives to Muslims is that it allows to them to avoid birth relative to Ramadan to an extent. Moreover, past literature has evaluated the free contraceptive program in Matlab on fertility, health and education. This paper is the first to evaluate the family planning program in Matlab in the context fasting during Ramadan. Lastly, this paper compares the height of the children exposed to Ramadan *in utero* with the non-exposed children in both treatment areas (areas which received free contraceptives) and control areas (areas which did not receive free contraceptives). Interestingly, the intent to treat (ITT) analysis shows that the children who were exposed to Ramadan in first trimester and born in treatment areas are shorter (in centimeter) than the non exposed children born in treatment areas. However, in control areas difference in height between children exposed to Ramadan in first trimester and children non-exposed to Ramadan is not statistically significant. Examination of the children who were not exposed to Ramadan shows more educated mothers in treatment areas are more likely to give birth during non-Ramadan period compared educated mothers in control areas. This suggests effect of maternal fasting on health outcomes is also driven by selection.

The rest of the paper is organized as follows. In section 2 we briefly the discuss existing literature on maternal fasting on different outcomes from epidemiology and economics. In section 3 we discuss the background of Matlab Family Planning and Child Health Program. In Section 4 we discuss the MHSS and compare it with other data sets used in the literature. In section 5 the we discuss the empirical strategy to study selective timing of birth relative to Ramadan and also how it affects health outcomes. In section 6 we provide the results and also discuss the contrast and similarity of these results with existing literature. In section 7 we make concluding remarks.

2 Literature Review

The literature on maternal fasting on child health outcomes can be broadly divided into two categories. One category is epidemiological literature and another is economics literature. Almond and Muzumder(2011) presents a nice summary of epidemiological literature in their paper. Several studies suggest that fasting during pregnancy can lead to neurological impairments, higher blood pressure in later life (Hunter and Sadler 1987,Moore et al. 1989, Sheehan et al. 1985, Gluckman and Hanson 2005).

Almond and Muzumder(2011) notes some limitations of epidemiological studies. First of all, most of those studies are based on a small number of observations. Secondly, those studies compare the effect on fasters and non-fasters assuming that decision to fast is exogenous. Thirdly, those studies do not disentangle the fasting effect from the seasonality, as they are based on Ramadan overlapping with only one season.

The application of Intent To Treat (ITT)analysis distinguishes the study of Almond and Muzumder(2011) from the epidemiological studies on Ramadan. They were also the first to study the impact of maternal fasting during Ramadan on child outcomes in the economics literature. ITT anaylsis alllows them to get rid of the compliance problem related to fasting. Under the assumption that parents do not selectively time birth relative to Ramadan, it gives causal estimates of the impact of *in utero* nutrition shock. Moreover, unlike most epidemiological studies, the study of Almond and Muzumder(2011) was also based on a large number of cohorts.

Almond and Muzumder(2011) use data from Michigan, Iraq and Uganda. They study the impact of *in utero* nutrition shock on birth weight using data from Michingan and on various forms of disabilities using census data from

Iraq and Uganda. They find children who were *in utero* during Ramadan have lower birth weights and are more likely to be disabled. Following Almond and Muzumder(2011), Ewjik(2011) finds that maternal fasting during Ramadan may increase the chances of developing health problem such as coronary heart disease and type 2 diabetes. Majid(2012) finds that maternal fasting during Ramadan leads to fewer hours worked and self-employment in later life. Ewjik(2011) and Majid(2012) use Indonesia Family Life Survey(IFLS) wave 3 and wave 4 respectively. Using English register data, Almond Muzumder and Ewjik(2014) finds that maternal fasting during Ramadan leads to lower test scores.

One obvious limitation in those papers is that they assume parents don't selectively time birth relative to Ramadan. Moreover, the above mentioned studies have serious some limitations with data. In Michigan and Iraq data, Almond and Muzumder(2011) didn't know the religion of the mother. They used Arab as proxy for Muslims in their Michigan data. The birth data from Uganda, Iraq and Indonesia were self-reported. This could be a serious problem as misreported birth dates will lead to wrong classification of birth relative to Ramadan. In comparison to past data sets used, with MHSS we can clearly identify the religion of the mother and get reliable birth data in a single data set for a sufficiently large of number of cohorts.

3 Matlab Family Planning and Child Health

Matlab is a *thana* (sub-district) in Chandpur District in Bangladesh. It is located 55 kilometers of South-East of Dhaka. The Demographic Surveillance System(DSS) has been operating in Matlab thana since 1966. Initially 132 villages were included in the system, and 101 villages were added in 1968.All households in the DSS area are within the Monitoring system. A typical village consists of several *baris*, or groups of houses around a central courtyard. In DSS area, the record of birth, death and migration (in and out) are collected from the start of the project. The enumeration of marital union and dissolution began in 1975 (Razzaque and Streatfiled). In October 1977 the DSS area was contracted to 149 villages by excluding 84 villages. The family planning and health project was launched in 70 villages(treatment area)and the remaining villages were comparison area. No report of using randomization mechanism has been found (Schultz 2009). The figure (1)[1] in appendix also shows that the treatment area grouped into clusters. Schultz (2009) argues that the clustering of villages into treatment

[1]Figure 1, table 2 and 3 are reproduced from Bahram (2012)

area retain the spillover effect. Table 3 in appendix presents 1974 census data which shows that the treatment and the comparison area were very similar except for few observable characteristics such as sources of drinking water, number of cows and age of both household head and spouses of household head. In our estimation strategy we will control household and biological sibling fixed effects to account for the household and mother level fixed unobservables.

Barham (2012) also describes the other treatments added to the treatment areas which are documented in Bhatia et al.(1980), Phillips et al.(1984) and Koening et al.(1990). In October 1977, the family planning program began in treatment areas through the provision of modern contraception. From June 1978, pregnant women received tetanus toxoid vaccination and also pregnant women in their last trimester pregnancy received iron and folic acid tablets. From March 1982, the children aged from 9 months to 59 months in treatment area 1 received measles vaccine. This program was expanded to treatment area 2 on November 1985. From January 1986, DPT, polio and tuberculosis immunization were given to children under age 5. Later in 1986, Vitamin A supplementation for children under age 5 and nutritional rehabilitation for those who were nutritionally risky were added to treatment areas. In appendix section, I reproduced the table 1 from Barham(2012) which gives a summary of the programs introduced in the treatment areas and age cohorts the programs have affected.

4 Data

This paper uses Matlab Household and Socioeconomic Survey 1996 which was funded by National Institute of Aging and was collaborative effort of RAND, the Harvard School of Public Health, the University of Pennsylvania and the University of Colorado at Boulder . The primary sample was drawn from a probability sample of 2,883 *baris* from 7,440 *baris* in the DSS 1994 sample frame. *baris* usually consists of cluster of households in close physical proximity. In all *baris*, interviews were completed in 2,781 *baris* out of 2883 eligible *baris*. Within each bari, upto two households were randomly selected. For each *baris*, one household was randomly chosen and designated as primary household or $Status = 1$. If there are more than 2 households, the second household was randomly chosen and designated as $Status = 2$. Otherwise the second household was designated as $Status = 2$. Out of the 2,781 *baris*, 94 *baris* were inappropriately interviewed and therefore disregarded from analysis which leaves us with 2,687 *baris*. Out of these *baris*, 656 are one household *baris* and rest of them have two or more households. Ideally, there should be 2,013 households but the survey team could find only 1,677 households. The remaining $Status = 2$ households are purposive sample based on relationship to the first household. In this paper we limit our studies to only $Status = 1$ households or primary households.

In the survey mothers were asked about birth dates of each their children. Later the birth dates were matched with the DSS data sets for their consistency and accuracy. Although DSS started in 1966, during the data collection process of MHSS the events(i.e. birth, marriage) which took place from 1974 were linked to computerized system of DSS. Therefore, we have reliable birth dates for 22 birth year cohorts from 1974 to 1995. All birth dates before 1974 are self reported (Menken et al. 1999). There are also some other limitations with this data. We get the birth data from the pregnancy history of the women interviewed in the MHSS 1996. This is a limitation because we can know about births prior to 1996, only if the women living in sampled household survived till 1996. Since the treatment area got maternal health care, one might argue that the women who survived in treatment area may not have survived in absence of maternal health treatment. Ronsmans et al.(1997) finds that maternal mortality from all causes declined in both treatment and control area from 1976 to 1993 and the difference is no significant between treatment and control areas. Moreover, if the survival of the women correlates with birth timing relative to Ramadan, this will create a downward bias. To illustrate, let's suppose there are two types of women high type and low type. High type avoids birth and low type doesn't avoid birth relative to Ramadan. The low type is also less likely to survive. The maternal health aspect of the treatment would make it more likely that the low type survives in the treatment area and therefore get included in the sample.

Another limitation of the data is for some births only month and year of birth is known and the birth dates are replaced with zero. It also varies considerably between treatment area and control area. There are 2086 births which had date *zeros* out of 8573 from 1974 to 1995. Out of the 2086 births, the treatment area had 856 births and control area had 1230 births. One possibility is that some of these births took place out of the treatment and control area. Another possibility is these births have date *zeros* because of birth data collection method. We will do the analysis both including and excluding these date zero births.

To study the impact on height we match the birth dates from the mother's pregnancy with the birth month and year of the individual surveyed in the Matlab. We later match anthropometric data for each individual. We limit our study to only single birth. There are few twin births in MHSS. We found only 28 twins in our data.

5 Ramadan Measures

The month of Ramadan is the 9th Month in the Islamic Calender Year. Islamic law does not require a pregnant woman to fast during pregnancy. However, evidence from different Muslim countries suggests that some Muslim mothers fast when they are pregnant(Almond and Muzumder 2011).

For a given year, we construct the dates Gregorian Calender which overlaps with the Ramadan Month of Islamic Calender [2]. From our birth data we only know the date of birth but we don't know the gestation time. We observe how many months after Ramadan the individual 'i' was born. Generally, the gestation time for human is 266 days. For each date of birth we create century day code(CDC) following Almond and Muzumder(2011). We will denote $ramadan\_0$ if the individual 'i' was born during Ramadan, $ramadan\_1$ if the individual 'i' was born within 30 days after Ramadan, $ramadan\_2$ if the individual 'i' was born between 31 days and 60 days after Ramadan and so on. We also define dummy variable 1 if individuals were born between X and Y months after Ramadan as $ramadanXtoY$ where $X < Y$ and 0 otherwise. For example, $ramadan7to9$ would mean anyone who born between 180 to 270 days after Ramadan. $ramadan7to9$ would mean the individuals were most probably in the first trimesters when Ramadan overlapped with pregnancy. Similarly, $ramadan4to6$ and $ramadan1to3$ would mean individuals were most probably in second trimester and third trimester. We prefer to use $ramadan7to9$ in stead of first trimester because we only know the date of birth. At times birth takes place preterm and post-term. As a result, if we denote $ramadan7to9$ as first trimester, we would wrongly classify first trimester overlapped with Ramadan.

For individuals whose date of birth is not known or date of birth is replaced with *zero*, we match the month of Gregorian Calender year with Ramadan Month and replace the month of Gregorian Calender year with 1 if more than 50 percent or more of Ramadan days overlap with the Gregorian Month.

[2]Following Almond and Muzumder(2011), we construct the Ramadan month from Institute of Oriental Studies at University of Zurich using their website http://www.oriold.uzh.ch/static/hegira.html

6 Estimation Strategy

Empirical strategy is divided in two sections. In the first section we would like to examine whether free contraceptives affected timing of birth and whether timing of birth varies by mother education level upon receiving free contraceptives. In the second section we study the impact of maternal fasting of height. Most of the analysis is based on cohorts born from 1974 to 1995 because Schultz(2009) and Schultz and Joshi (2007) find that the treatment and control area were balanced in many dimensions. As a robustness check, analysis on birth cohorts born from 1963 to 1995 was also conducted.

6.1 Timing of Birth

We run the following regression equation to test this assumption:

$$R_{imt} = \beta_0 + \beta_1 Post + \beta_2 Treated + \beta_3 Post * Treated + \beta_4 Hindu + \beta_5 Post * Hindu + \beta_6 Treated * Hindu + \beta_7 Post * Treated * Hindu + \beta_8 X + \gamma_m + \delta_t + \epsilon_{imt} \tag{1}$$

Equation (1) means whether individual i, born in month m and year t, was *in utero* in a time relative to Ramadan (R).γ_m is the month fixed effect, δ_t is the year fixed effect. The $Treated$ value is 1 if the person living in a village which gets the treatment and 0 otherwise. The *post* variable takes value 1 if the individual was born in July in 1978. Although the program started in October,1977, The variable post takes value 1 from July 1978 and 0 otherwise. The reason is those who were born between October 1977 and July 1978 were conceived prior to the program started. We can identify post even with year fixed effect because of the start of the program in middle of the year. To check this does not spoil our results we also define post from 1979 in our robustness analysis. The coefficient β_3 is the coefficient of interest, as it gives effect of contraceptive program on timing of birth relative to Ramadan. To examine that our results are not driven by any noise, we also compare birth pattern of Hindus relative to Ramadan. Since the Hindus do not observe Ramadan, we should not expect any effect of contraceptive program on birth relative to Ramadan. The interaction term of Hindu with $Post$, $Treated$ and $Post * Treated$ allows us to check robustness of the avoidance behavior of Muslim mothers relative to Ramadan. In an extension to this analysis, we also apply household fixed effects and biological mother effects in equation (1). Application of household fixed effects and biological mother fixed effects control time invariant household and mother level unobservables. In equation (1) application of household fixed effect and biological mother fixed effect will absorb the main effect of $Treated$, $Hindu$, $Treated * Hindu$.

R represents several outcome variables. From our discussion on measures of Ramadan, R represents various Ramadan measures $ramadan_0$ to $ramadan_{10}$ and $ramadanXtoY$ for various values of X and Y where $X < Y$.The Hindu dummy is 1 if the the mother is Hindu and 0 otherwise. The variable X represents community variables and interaction of the community level variables with post. The community level variables are whether the village has large market, electricity, post office, primary school and satellite health clinic.

We regress following equation for analysis for interaction between mother education and free contraceptive program:

$$R^M_{ikmt} = \alpha_0 + \alpha_1 P + \alpha_2 P * T + \alpha_3 PR + \alpha_4 Sec + \alpha_5 P * PR + \alpha_6 P * SEC + \alpha_7 T * PR + \alpha_8 T * SEC + \alpha_9 P * T * PR + \alpha_1 0 P * T * SEC + \tau_k + \gamma_m + \delta_t + \varepsilon_{ikmt} \quad (2)$$

Where P denotes post, T denotes Treated, PR denotes Primary and below and SEC denotes secondary and above. The omitted category is the mother with no education. The τ_k, γ_m and $delta_t$ represent village, month and year fixed effects respectively. The main effect of $Treated$ is absorbed by the village fixed effects. Variable $Post$ and $Treated$ are defined as in the equation (1). The benefit of dividing mother education in different level education is that it will capture the heterogeneity if there is any. Therefore, The coefficients of interest are α_2, α_3, α_4, α_9 and $\alpha_1 0$. α_2, α_9 and $\alpha_1 0$ capture various treatment effects by mother education. α_3 and α_4 capture correlations between mother education and timing of birth relative to Ramadan. If these coefficients are statistically significant from zero that would mean that mothers with different level of education choose to give birth at different time points relative to Ramadan. We also compare the results when mother education is measured in years.

6.2 Birth Relative to Ramadan and Child Height Correlations

If we find that parents are selectively timing birth relative to Ramadan, it is important that we study the effect of maternal fasting on child health controlling for selection. Although free contraceptives program is exogenous to households in Matlab, it may affect the child health production through child quality quantity trade off. Therefore, due to exclusion restriction violation free contraceptive program can not be used as instrument for birth time relative to Ramadan in child health outcome function. However, we can study the correlations of child height and birth time relative to Ramadan to find a pattern between maternal fasting and child height correlations in both treatment areas and control areas. If mother with higher SES can avoid birth overlapping with Ramadan upon receiving free contraceptives, we may find the correlations between pregnancy overlapped with Ramadan is negative with child height in the treatment areas. On the other hand, if mothers with higher SES can not time birth relative to Ramadan in control areas because of absence of free contraceptive program, we may not find any correlation between child height and pregnancy overlapped with Ramadan. Under this scenario we should be worried that perhaps selection is driving the results rather than maternal fasting during Ramdan. We regress following equation:

$$\begin{gathered} H_{ijhkmt} = \Gamma_0 + \Gamma_1 ramadan1to3 + \Gamma_2 ramadan4to6 + \Gamma_3 ramadan7to9 \\ + \Gamma_4 Hindu \Gamma_5 ramadan1to3 * Hindu \\ + \Gamma_6 ramadan4to6 * Hindu + \Gamma_7 ramadan7to9 * Hindu + \gamma_m + \delta_t * B + \tau_k + \xi_{iabjhkmt} \end{gathered} \tag{3}$$

Where outcome of interest is child height (H). Ideally, one should examine the child birth weight instead of child height. Unfortunately, MHSS 1996 does not have any information on child birth weight. However, Currie and Vogl(2013) argues that child height is a good proxy for child birth weight. The variables $ramadan1to3$, $ramadan4to6$ and $ramadan7to9$ represent third, second and first trimesters respectively. As before γ_m and τ_k represent month fixed effects and village fixed effects. In Matlab the treatment areas also received other treatments which enter in the health production function. To control for those we include $\delta_t * B$ which is treatment block interacted with year.

7 Results

7.1 Selective Timing of Birth

To study selective timing of birth we regress $ramadan_0$ to $ramadan_{10}$ on post, treated and treatment for Muslims controlling for birth month and year fixed effects. The cohorts under study were born from year 1974 to 1995. The results are presented in table 1. We find that treatment has statistically significant positive effect on individuals being born in $ramadan\_5$ and negative effect on $ramadan\_9$. This leads us to construct variables $ramadan5to6$, $ramadan5to7$ and $ramadan8to9$ where for example $ramadan8to9$ takes value 1 if individual i is born either during $ramadan_8$ or $ramadan_9$ and 0 otherwise and regress these variables with the same independent variables. The birth pattern of Hindus relative to Ramadan works as a robustness check . We should expect the variables Hindu and post, treated and treatment interacted with Hindu should not be statically significant from zero. We also would like to check the robustness of our results with regression specifications with household fixed effects and biological mother fixed effects. The results are presented in table 2. The dependent variables from column 1 to 3, from 4 to 6 and from 7 to 9 are $ramadan5to6$, $ramadan5to7$ and $ramadan8to9$ respectively. All regression specifications include birth month and year fixed effects. In column 1 we find the coefficient of the treatment variable is positive and statistically significant from zero. On the other hand, in column 2 and 3 when household fixed effects and biological mother fixed effects are applied, it is positive but not statistically significant. In column 4 to 6, we find that the treatment coefficient is positive and statistically significant when regression specifications include birth month and year fixed fixed effects as well as household fixed effects. However, it is not statistically significant when biological fixed effects are applied. In column 7 to 9, the treatment coefficient is negative and statistically significant in all fixed effect regression specifications. As we would expect the variable Hindu and interaction terms with Hindu are not significantly different from zero in all columns and all regression specifications. Since $ramadan5to7$ incorporates $ramadan5o6$, we omit the analysis on $ramadan5o6$ in the following results.

In MHSS data we find that more births take place on date 1 than any other dates. Moreover, data shows unusually high amount of birth birth takes place on January 1st than any other day of the year. We try to check the further robustness of our results in table 2 by dropping these dates. In table 3 we replicate our exercise by dropping date 1. We find the the results are robust to dropping these dates. In table 4 we drop the births taken place on January 1st and we find that the treatment coefficient is statically significant for all regression specifications. The results in table 4 is even more robust than the results in table 2. This suggest there might be some misreporting of birth dates in Matlab data. We don't know which birth took place in Matlab and which didn't. It is quite possible some of these births actually took place out of surveillance area and were not registered in DSS.

Recall that we can identify the variable post in our regression equation even though we have year fixed effects because of the timing of the program.

To check whether this does not corrupt our estimates we redefine post where post takes value 1 for 1979 and onward and 0 otherwise. This does not allow us to identify post as the variable post is absorbed by year fixed effects. We do same exercise of table 2 with redefined post variable. The results are presented in table 5. We find that results are consistent with our results in table 2.

So far we have limited our analysis to birth dates known in MHSS. In MHSS data there are some births which have dates recorded zero. The results are presented in table 6. We find that the treatment coefficient is negative for $ramadan8to9$ and positive for $ramadan5to7$ as in table 2. For dependent variable $ramadan5to7$ the treatment coefficient is positive and statistically significant when household fixed effects are included. However, it is not statistically significant in a regression specification with biological mother fixed effects. For variable $ramadan8to9$ the treatment coefficient is negative and significant in regression specification with month and year fixed effects. However, it is not statistically significant when household fixed effects and biological fixed effects are included in the regression specifications.

We again limit our analysis to population whose birth dates are known and further check the robustness by studying the birth cohorts born from 1963 to 1995. This gives us 33 birth year cohorts. Recall that it takes Ramadan around 32 to 33 years to complete a full circuit of western calender. The results are presented in table 7. The results conforms with the findings in table 2.

In table 8 we control for post interacted with village level characteristics and do the same analysis in table 2 for cohorts born from 1974 to 1995. We find that even including village level characteristics and interacting them with post do not alter our findings.

In table 9 we study the relationship between timing of birth relative to Ramadan with different mother education level. The primary takes value 1 if mother education ranges between more than 0 to less than 6 and 0 otherwise. The secondary education takes value 1 if mother has more than 5 years of education and 0 otherwise. The mother education variables are interacted with post treated and interaction of post and treated variables. What we find is that the mothers with primary education and below are less likely give birth during $ramadan8to9$ compared to mothers with no education. The are also more likely to avoid birth using the contraceptive treatment.

In table 10 we study the avoidance behavior with mother education in years. The $mothereduy$ variable takes value the years of education completed by mothers. We find that for variable $ramadan8to9$ the coefficient of

$post * treated$ is negative and statistically significant. However, the interaction terms with mother education in years with post treated and treatment is not statistically significant.

In table 11 we replicate the exercise of table 9 for children born during $ramadan_10$ and $nonramadan$ period where $nonramadan$ incorporates $ramadan_10$. The variable $non-ramadan$ takes value 1 the pregnancy of child 'i' did not overlap with Ramadan and zero otherwise. Interesting we find, the mothers with some secondary education are more likely to give birth during $ramadan_10$ period upon receiving free contraceptives.

7.2 Discussion on Timing of Birth

Based on the results from table 1 to 8 we can conclude that free contraceptives program allow mothers to time the birth of their children relative to Ramadan. Our results show mothers in the treatment area are around 6 percent less likely to give birth 8 or 9 months after Ramadan and more likely to give birth 5 to 7 months after Ramadan. The avoidance results are robust to inclusion of biological mother fixed effects. Biological mother fixed effects control mother level fixed unobservables that might affect the timing of birth and also affect health outcomes of the children. Ewjik(2011) and following Ewjik(2011), Majid(2012) motivates to solve the problem of selective timing of birth by controlling biological mother fixed effects. Our results suggest controlling biological mother time invariant unobservables may not be enough to take care of selection. We find that Muslims mothers are shifting the births few months ahead and avoiding conception just one or two months before Ramadan. The question is why do we observe such pattern? If the mothers worry that fasting during pregnancy could affect the child health negatively, they would choose a time period where the pregnancy doesn't overlap with Ramadan. Perhaps they don't do it because it is really hard to time birth in that way. The gestation time for human is 266 days and the Islamic Calender completes a year in 354 or 355 days. That leaves mothers 88 or 89 days to give birth to completely avoid Ramadan. Another possibility is that mothers are shifting the births ahead to avoid fasting during Ramadan. It could be possible that when child *in utero* is four or five months older at the time of Ramadan, the family members, friends and relatives are less likely to ask the mother to fast during Ramadan

In table 9 we study the association between mother education level with the timing of birth relative to Ramadan. We find the mothers who had some education but less than equal to primary education are more likely avoid conception 1 or 2 months before Ramadan than others. On the other hand, we do not find mothers with more some secondary education is avoiding birth during this period. This points out the avoidance behavior is not linearly related to mother education or in other words more education of mothers doesn't mean that they are more likely to avoid birth relative to Ramadan. However, this shouldn't mean that more educated mothers do not care about their children. It could be possible that they are informed about Islamic rules about fasting for pregnant mothers. According to Islamic law it is not mandatory for Muslims mothers to fast during pregnancy. The mothers with more education are more likely to know about it than mothers with low education. However, if the mothers are somewhat educated like primary or below they might still suffer from the belief that they have to fast during Ramadan even if they are pregnant or they may belong to SES where the social pressure is high for fasting during Ramadan even with pregnancy. The mothers with primary and below education are more likely to avoid birth because they would have some idea about calender and time of Ramadan than mothers with no education. Therefore, they are more likely to use the contraceptive treatment to time birth relative to Ramadan.

Table 10 shows what happens if we study the association between birth relative to Ramadan and mother education measured in years. We find that the interaction of mother education in years and free contraceptive program is not statistically significant. In many studies it is common to compare the means to detect any selection. The exercise in table 9 and table 10 demonstrates that it is important that we also consider non-linear relationship when analyzing selection.

In table 11 we study the relationship between mother education at various level and pregnancies not overlapped with Ramadan. Our results shows mothers with some secondary education are more likely to conceive immediately after Ramadan than mother with no education if they receive free contraceptives. As discussed earlier it is very hard to time pregnancy not overlapping with Ramadan. Therefore, it is no surprise mothers with higher education are more likely time pregnancy not overlapping with Ramadan.

However, we need to reconcile the results of table 9 and table 11 for mothers with some secondary education. On the one hand, we do not observe them to significantly reduce birth 8 to 9 months after Ramadan but on the other hand, we observe them to give more births 10 months after Ramadan. One possible explanation is that everyone on the average is lowering births during 8 to 9 months after Ramadan and mothers with some secondary education is not different from mother with no education in terms of giving birth after 8 to 9 months after Ramadan. However, once Ramadan is over, mother with secondary education are more likely to conceive and hence more likely to give births after 10 months after Ramadan. More education may help them time the conception and birth appropriately.

7.3 Alternative Hypothesis

One limitation in our data set is that we observe only birth dates of the children born in Matlab but we do not know about the gestation period. Therefore, it is important to understand whether premature births of babies can potentially contaminate our regression results. For premature births to explain these results, two things should also take place. Firstly, mothers in treatment areas should give birth prematurely within 7 months after Ramadan after getting the free contraceptives program. Secondly,only Muslim mothers living in the treatment areas should be affected. Chances of both happening is very rare. If anything we should observe more premature births in control areas than in treatment areas because the mothers living in treatment areas not only received free contraceptives but also health care which was not available to control areas. Therefore, the treatment areas should have less premature births relative to control areas and our results should have, if anything,downward bias. Moreover, if any health shocks affecting mothers and leading to premature births in treatment areas, it should affect both Muslims and Hindus living treatment areas. The fact that we do not observe similar birth pattern of Hindus relative to Ramadan attests to our results that health shocks leading to premature births are not responsible for this result.

7.4 Birth Relative to Ramadan and Height Correlation

In table 12 correlations between birth time relative to Ramadan and height are presented for Muslim children born between 1984 to 1995. Column 1 and 2 presents results on boys and girls living in the treatment areas respectively. Column 3 and 4 presents results on boys and girls living in the control areas respectively. We find that girls born after 7 to 9 months after Ramadan are shorter in height compared to girls not exposed to Ramadan. However, we do not find any effect on girls height in the control areas. In table 13, we compare the height of the Muslim children with the Hindu children in the treatment areas. We do not find any effect on height of the Hindu girls living in the treatment area. We extend our analysis to children born in treatment areas between 1981 to 1995 in table 14. We find similar results for girls. Moreover, we find that Muslim boys born after 7 to 9 months have also shorter height compared to Muslim children not exposed to Ramadan. It is important to note that children aged more than 11 years could go through a period of adolescent growth spurt. We, therefore, compare the height of the Hindu children born in the same time period in table 14. We do not observe any such pattern for Hindu boys and girls.

7.5 Discussion on Height

Interestingly, the regression exercise on height shows that children, who were exposed to Ramadan in possible first trimester *in utero* in treatment areas, were shorter in height than non-exposed children. Suppose we only had data available from treatment areas. If we had followed the earlier studies (Almond and Muzumder 2011, Ewjik 2011, Majid 2013, Almond, Muzumder and Ewjik 2014) we might have concluded the children in the treatment areas who were exposed to Ramadan in first trimester have shorter height because of maternal fasting during Ramadan. To make it a causal argument we might have cross checked whether first trimester overlapping with Ramadan had any impact on Hindu children in treatment areas. The results presented in table 13 and 14 would have conformed with our conclusion because we find only effects for Muslims but do not find any effects for Hindus.

However, the absence of any negative effects for pregnancies overlapped with Ramadan in control areas as well as the findings on relation between mother education and birth relative to Ramadan deter us to call our findings in table 13 and 14 as causal. Recall from table 11 that in treatment areas mothers with more education were more likely to have pregnancies not overlapped with Ramadan. However, we could not find any such relations for control areas. Many studies find that mother education is positively correlated with child height (Thomas et al.1991). If more educated mothers give birth in a time period not overlapped with Ramadan, the children not exposed to Ramadan *in utero* would be taller on the average than children exposed to Ramadan. As a result, children exposed to Ramadan *in utero* would be shorter than children not exposed to Ramadan. One can argue why we only find negative effect in first trimester. If mothers with more education are more likely to give birth non-exposed children, they should be significantly taller than children born in second and third trimester as well. One possible explanation to that argument is that pregnancies which are exposed to Ramadan in first trimester are adjacent in time to pregnancies which are not exposed to Ramadan. Suppose mothers are planning their birth of their children around 2 or 3 before Ramadan. If they delay their pregnancy after Ramadan, the time of delay is only 2 to 3 months.

Use of contraceptives would allow them to time birth accordingly. On the other hand, if they are planning for pregnancy in second trimester and third trimester, the time of delay to avoid Ramadan is from 4 to 9 months.

Another explanation for observing negative effects in treatment areas but no effects in control areas is that survival bias could be different between two areas. If children exposed to Ramadan, who might have been shorter on the average, did not survive till the survey period in control area, we might not find any difference in height between children exposed children and non-exposed children. We, however, do not find any difference in mortality of children in treatment and control areas. Moreover, mortality is also an extreme event.

It should be noted that above discussion are based on correlations. Therefore, we should not interpret that maternal fasting has no effect on child height once we control for selection in timing of birth. The aim of above discussions is to point out limitations in existing studies based on maternal fasting during Ramadan and child outcomes and to explain how selection in birth timing may drive the results. The future studies, therefore, should appropriately take into account the selection in birth timing before exploring the effect of maternal fasting during Ramadan on child outcomes.

8 Conclusion

There is little doubt about the welfare implications of the impact of adverse condition *in utero* on health outcomes. We have seen proliferation of studies which have documented the consequences of *in utero* shocks. In the context of Ramadan, this paper shows that mothers with different level of education can time birth relative to Ramadan upon receiving free contraceptives. As a result selection in timing of birth can lead to unequal outcomes between exposed children and non-exposed children. Therefore, comparing the mean outcomes of exposed children with that of non-exposed children, we might come to wrong conclusions about the impact of maternal fasting. Thus, it is important to examine the nature of selection appropriately and then to take care of selection problem when evaluating impact of maternal fasting on child outcomes. Another aspect of the paper is that it shows that free contraceptives program can help Muslim mothers to avoid pregnancy overlapping with Ramadan to an extent. The paper will be extended to explore how mothers learned over time to time birth relative to Ramadan.

Policies are often based on empirical results. However, if the results do not represent the true magnitude of the problem it would be hard to design, target and benefit from policies. Moreover, there is an opportunity cost of every policy. This paper shows presence of selection can contaminate our results and may, therefore, become irrelevant for policy suggestions. Thus, future research should be designed in a way to take care of the selection problem and then get the actual effect maternal fasting on child health outcomes.

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10 Tables

Table 1: Treatment Effect on Birth Timing for Muslims Born from Year 1974 to 1995

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
VARIABLES	ramadan_0	ramadan_1	ramadan_2	ramadan_3	ramadan_4	ramadan_5	ramadan_6	ramadan_7	ramadan_8	ramadan_9	ramadan_10
post	0.194***	0.118***	0.118***	0.139***	-0.0877*	-0.285***	-0.163***	-0.184***	-0.0794**	-0.0603*	0.111***
	(0.0325)	(0.0277)	(0.0329)	(0.0343)	(0.0483)	(0.0444)	(0.0286)	(0.0381)	(0.0353)	(0.0357)	(0.0256)
treated	0.00471	-0.00691	-0.00932	0.0256	-0.0219	-0.0262	-0.00794	-0.00784	0.0217	0.0190	-0.00213
	(0.0203)	(0.0164)	(0.0169)	(0.0215)	(0.0179)	(0.0176)	(0.0145)	(0.0141)	(0.0151)	(0.0155)	(0.0175)
post*treated	0.00639	0.00725	0.0130	-0.0235	0.00913	0.0368*	0.00443	0.0222	-0.0236	-0.0359**	0.00137
	(0.0225)	(0.0181)	(0.0155)	(0.0217)	(0.0201)	(0.0204)	(0.0164)	(0.0160)	(0.0161)	(0.0167)	(0.0201)
Constant	-0.000325	0.0339*	0.0138	0.196***	0.157***	0.122***	0.135***	0.0764***	0.0631***	0.0937***	0.0882***
	(0.0196)	(0.0176)	(0.0178)	(0.0331)	(0.0250)	(0.0249)	(0.0266)	(0.0211)	(0.0175)	(0.0223)	(0.0209)
Month& Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Mean of Dep. Var.	0.083	0.067	0.076	0.092	0.105	.102	0.092	0.094	.078	0.074	.074
Observations	5,935	5,935	5,935	5,935	5,935	5,935	5,935	5,935	5,935	5,935	5,935
R-squared	0.070	0.056	0.054	0.057	0.047	0.060	0.039	0.055	0.043	0.046	0.060

Standard errors in parentheses clustered at village ID level
*** p<0.01, ** p<0.05, * p<0.1

Table 2: Treatment Effect on Birth Timing for cohorts Born from 1974 to 1995

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	ramadan5to6	ramadan5to6	ramadan5to6	ramadan5to7	ramadan5to7	ramadan5to7	ramadan8to9	ramadan8to9	ramadan8to9
post	-0.449***	-0.449***	-0.452***	-0.632***	-0.626***	-0.618***	-0.129***	-0.0814	-0.0747
	(0.0446)	(0.0679)	(0.0693)	(0.0430)	(0.0610)	(0.0642)	(0.0446)	(0.0682)	(0.0692)
treated	-0.0344			-0.0423*			0.0417**		
	(0.0215)			(0.0233)			(0.0207)		
post*treated	0.0408*	0.0527	0.0425	0.0635**	0.0846**	0.0666	-0.0596***	-0.0750**	-0.0658**
	(0.0238)	(0.0388)	(0.0407)	(0.0247)	(0.0412)	(0.0432)	(0.0223)	(0.0337)	(0.0321)
hindu	0.0728			0.138			-0.0632		
	(0.0911)			(0.110)			(0.0617)		
posthindu	-0.0434	-0.0607	0.00529	-0.125	-0.0651	-0.0297	0.0656	0.0373	-0.0335
	(0.0901)	(0.137)	(0.111)	(0.120)	(0.172)	(0.172)	(0.0695)	(0.172)	(0.123)
treatedhindu	-0.0932			-0.134			0.100		
	(0.0980)			(0.120)			(0.0733)		
post*treated*hindu	0.0192	0.0268	0.000281	0.0740	-0.0257	-0.000289	-0.0654	-0.0173	0.0462
	(0.0966)	(0.149)	(0.134)	(0.131)	(0.190)	(0.201)	(0.0871)	(0.186)	(0.145)
Constant	0.254***	0.234***	0.232***	0.337***	0.326***	0.318***	0.154***	0.183***	0.192***
	(0.0345)	(0.0488)	(0.0488)	(0.0340)	(0.0454)	(0.0476)	(0.0254)	(0.0337)	(0.0344)
Month& Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
HH FE	N	Y	N	N	Y	N	N	Y	N
Mother FE	N	N	Y	N	N	Y	N	N	Y
Mean of Dep Var.	0.192	0.192	0.192	0.287	0.287	0.287	0.154	0.154	0.154
Observations	6,474	6,474	6,474	6,474	6,474	6,474	6,474	6,474	6,474
R-squared	0.099	0.381	0.402	0.144	0.429	0.449	0.082	0.386	0.403

Standard errors in parentheses clustered at village ID level
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Treatment Effect on Birth Timing for cohorts Born from 1974 to 1995 (Date 1 dropped)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ramadan5to7	ramadan5to7	ramadan5to7	ramadan8to9	ramadan8to9	ramadan8to9
post	-0.678***	-0.709***	-0.702***	-0.190***	-0.125	-0.120
	(0.0484)	(0.0643)	(0.0670)	(0.0497)	(0.0792)	(0.0809)
treated	-0.0360			0.0570**		
	(0.0251)			(0.0254)		
post*treated	0.0568**	0.0912*	0.0743	-0.0748***	-0.0904**	-0.0829**
	(0.0280)	(0.0461)	(0.0475)	(0.0274)	(0.0408)	(0.0395)
hindu	0.212			-0.00907		
	(0.173)			(0.0716)		
posthindu	-0.194	-0.0910	-0.0440	0.0115	-0.0189	-0.0726
	(0.185)	(0.266)	(0.249)	(0.0708)	(0.188)	(0.166)
treatedhindu	-0.212			0.0580		
	(0.180)			(0.0833)		
post*treated*hindu	0.152	0.00470	0.00750	-0.0152	0.0798	0.130
	(0.192)	(0.285)	(0.280)	(0.0910)	(0.204)	(0.186)
Constant	0.347***	0.334***	0.327***	0.175***	0.206***	0.216***
	(0.0396)	(0.0566)	(0.0609)	(0.0309)	(0.0412)	(0.0433)
Month& Year FE	Y	Y	Y	Y	Y	Y
HH FE	N	Y	N	N	Y	N
Mother FE	N	N	Y	N	N	Y
Mean of Dep. Var.	0.290	0.290	0.290	0.155	0.155	0.155
Observations	5,754	5,754	5,754	5,754	5,754	5,754
R-squared	0.147	0.447	0.467	0.086	0.417	0.432

Standard errors in parentheses clustered at village ID level
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Treatment Effect on Birth Timing for cohorts Born from 1974 to 1995 (Jan 1 Dropped)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ramadan5to7	ramadan5to7	ramadan5to7	ramadan8to9	ramadan8to9	ramadan8to9
post	-0.705***	-0.731***	-0.727***	-0.156***	-0.0943	-0.0883
	(0.0436)	(0.0580)	(0.0607)	(0.0469)	(0.0748)	(0.0766)
treated	-0.0375			0.0484**		
	(0.0238)			(0.0224)		
post*treated	0.0571**	0.0915**	0.0729*	-0.0649***	-0.0864**	-0.0767**
	(0.0257)	(0.0401)	(0.0428)	(0.0241)	(0.0367)	(0.0349)
hindu	0.194			-0.0505		
	(0.141)			(0.0674)		
posthindu	-0.177	-0.104	-0.0747	0.0437	0.00390	-0.0297
	(0.150)	(0.198)	(0.193)	(0.0683)	(0.160)	(0.139)
treatedhindu	-0.201			0.0830		
	(0.150)			(0.0795)		
post*treated*hindu	0.139	0.0444	0.0834	-0.0392	0.0500	0.0776
	(0.159)	(0.216)	(0.225)	(0.0878)	(0.175)	(0.159)
Constant	0.346***	0.326***	0.318***	0.182***	0.212***	0.224***
	(0.0351)	(0.0512)	(0.0556)	(0.0266)	(0.0380)	(0.0388)
Month& Year FE	Y	Y	Y	Y	Y	Y
HH FE	N	Y	N	N	Y	N
Mother FE	N	N	Y	N	N	Y
Mean of Dep. Var.	0.285	0.285	0.285	0.154	0.154	0.154
Observations	6,317	6,317	6,317	6,317	6,317	6,317
R-squared	0.146	0.435	0.455	0.083	0.394	0.410

Standard errors in parentheses clustered at village ID level
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Treatment Effect on Birth Timing for cohorts Born from 1974 to 1995 (Post Defined 1979)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ramadan5to7	ramadan5to7	ramadan5to7	ramadan8to9	ramadan8to9	ramadan8to9
treated	-0.0341			0.0415**		
	(0.0231)			(0.0185)		
post*treated	0.0553**	0.0605	0.0393	-0.0610***	-0.0649**	-0.0549*
	(0.0253)	(0.0426)	(0.0446)	(0.0201)	(0.0316)	(0.0306)
hindu	0.0238			-0.00843		
	(0.0280)			(0.0318)		
treatedhindu	-0.0253			0.0377		
	(0.0512)			(0.0480)		
post*treated*hindu	-0.0466	-0.105	-0.0477	0.0102	0.0176	0.0114
	(0.0485)	(0.0752)	(0.0998)	(0.0496)	(0.0680)	(0.0739)
Constant	0.350***	0.338***	0.330***	0.156***	0.185***	0.195***
	(0.0341)	(0.0450)	(0.0480)	(0.0243)	(0.0340)	(0.0348)
Month& Year FE	Y	Y	Y	Y	Y	Y
HH FE	N	Y	N	N	Y	N
Mother FE	N	N	Y	N	N	Y
Mean of Dep.Var.	0.287	0.287	0.287	0.154	0.154	0.154
Observations	6,474	6,474	6,474	6,474	6,474	6,474
R-squared	0.127	0.418	0.437	0.080	0.385	0.403

Standard errors in parentheses clustered at village ID level
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Treatment Effect on Birth Timing for Born from cohorts 1974 to 1995 including date zero

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ramadan5to7	ramadan5to7	ramadan5to7	ramadan8to9	ramadan8to9	ramadan8to9
post	-0.738***	-0.718***	-0.720***	-0.108**	-0.0676	-0.0501
	(0.0348)	(0.0446)	(0.0454)	(0.0416)	(0.0607)	(0.0620)
treated	-0.0339			0.0316*		
	(0.0213)			(0.0178)		
post*treated	0.0509**	0.0594*	0.0509	-0.0475**	-0.0437	-0.0385
	(0.0228)	(0.0353)	(0.0385)	(0.0192)	(0.0294)	(0.0319)
hindu	0.184*			-0.0853		
	(0.105)			(0.0579)		
posthindu	-0.151	-0.0862	-0.0588	0.0583	0.0151	-0.0476
	(0.110)	(0.130)	(0.136)	(0.0663)	(0.122)	(0.0910)
treatedhindu	-0.218*			0.155**		
	(0.113)			(0.0673)		
post*treated*hindu	0.158	0.0885	0.115	-0.0983	-0.0320	0.0193
	(0.116)	(0.151)	(0.167)	(0.0803)	(0.134)	(0.112)
Constant	0.322***	0.303***	0.298***	0.199***	0.231***	0.231***
	(0.0307)	(0.0399)	(0.0439)	(0.0258)	(0.0319)	(0.0337)
Month& Year FE	Y	Y	Y	Y	Y	Y
HH FE	N	Y	N	N	Y	N
Mother FE	N	N	Y	N	N	Y
Observations	7,914	7,914	7,914	7,914	7,914	7,914
R-squared	0.144	0.413	0.435	0.102	0.379	0.400

Standard errors in parentheses clustered at village ID level
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Treatment Effect on Birth Timing for cohorts Born from 1963 to 1995 on Muslims

post	-0.586***	-0.549***	-0.537***	-0.234***	-0.209***	-0.211***
	(0.0442)	(0.0563)	(0.0577)	(0.0453)	(0.0607)	(0.0616)
treated	-0.0431***			0.0133		
	(0.0162)			(0.0109)		
post*treated	0.0598***	0.0640**	0.0481	-0.0333**	-0.0411*	-0.0251
	(0.0183)	(0.0301)	(0.0329)	(0.0134)	(0.0241)	(0.0265)
Constant	0.248***	0.234***	0.265***	0.234***	0.278***	0.296***
	(0.0484)	(0.0639)	(0.0685)	(0.0543)	(0.0762)	(0.0765)
Month& Year FE	Y	Y	Y	Y	Y	Y
HH FE	N	Y	N	N	Y	N
Mother FE	N	N	Y	N	N	Y
Observations	7,475	7,475	7,475	7,475	7,475	7,475
R-squared	0.071	0.328	0.357	0.027	0.294	0.317

Standard errors in parentheses clustered at village ID level
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Treatment Effect on Birth Timing for cohorts Born from 1974 to 1995 (Control Village Characteristics)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ramadan5to7	ramadan5to7	ramadan5to7	ramadan8to9	ramadan8to9	ramadan8to9
post	-0.697***	-0.678***	-0.659***	-0.0953*	-0.0478	-0.0400
	(0.0572)	(0.0838)	(0.0886)	(0.0554)	(0.0788)	(0.0784)
treated	-0.0465*			0.0378*		
	(0.0277)			(0.0220)		
post*treated	0.0576*	0.0635	0.0407	-0.0555**	-0.0826**	-0.0715*
	(0.0296)	(0.0470)	(0.0484)	(0.0234)	(0.0378)	(0.0369)
hindu	0.105			-0.0583		
	(0.123)			(0.0765)		
posthindu	-0.0960	0.00471	0.0317	0.0575	0.0491	-0.0379
	(0.137)	(0.207)	(0.215)	(0.0885)	(0.213)	(0.153)
treatedhindu	-0.106			0.0883		
	(0.131)			(0.0843)		
post*treated*hindu	0.0536	-0.0797	-0.0475	-0.0523	-0.0185	0.0580
	(0.145)	(0.222)	(0.241)	(0.100)	(0.224)	(0.169)
Constant	0.405***	0.329***	0.322***	0.119***	0.179***	0.188***
	(0.0543)	(0.0459)	(0.0487)	(0.0409)	(0.0345)	(0.0349)
Month& Year FE	Y	Y	Y	Y	Y	Y
HH FE	N	Y	N	N	Y	N
Mother FE	N	N	Y	N	N	Y
Additional Comm. Var.	Y	Y	Y	Y	Y	Y
Mean of Dep. Var.	0.286	0.286	0.286	0.155	0.155	0.155
Observations	6,431	6,431	6,431	6,431	6,431	6,431
R-squared	0.145	0.430	0.449	0.084	0.386	0.403

Standard errors in parentheses clustered at village ID level
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Effect of Mother Education on Birth Timing for cohorts Born from 1974 to 1995

VARIABLES	(1) ramadan5to7	(2) ramadan8to9
post	-0.693***	-0.128**
	(0.0581)	(0.0595)
treated	-0.0345	0.0232
	(0.0381)	(0.0306)
post*treated	0.0396	-0.0343
	(0.0386)	(0.0314)
primary	-0.00160	-0.0729**
	(0.0499)	(0.0335)
postprimary	0.00462	0.0851**
	(0.0519)	(0.0332)
treatedprimary	-0.0266	0.0656
	(0.0628)	(0.0482)
Post*treated*primary	0.0353	-0.0891*
	(0.0679)	(0.0486)
secondary	0.0197	0.0269
	(0.0903)	(0.0793)
postsecondary	-0.0377	-0.00502
	(0.0919)	(0.0713)
treatedsecondary	0.0721	-0.0626
	(0.112)	(0.0915)
post*treatment*secondary	-0.0409	0.0489
	(0.122)	(0.0865)
Constant	0.403***	0.141***
	(0.0559)	(0.0455)
Month& Year FE	Y	Y
Additional Comm. Var.	Y	Y
Observations	5,838	5,838
R-squared	0.145	0.084

Standard errors in parentheses clustered at village ID level
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Effect of Mother Education on Birth Timing for cohorts Born from 1974 to 1995

	(1)	(2)
VARIABLES	ramadan5to7	ramadan8to9
post	-0.692***	-0.119*
	(0.0622)	(0.0612)
treated	-0.0371	0.0423*
	(0.0304)	(0.0228)
post*treated	0.0466	-0.0627**
	(0.0314)	(0.0243)
mothereduy	-0.00195	-0.00128
	(0.00236)	(0.00192)
postmothereduy	0.000721	0.000453
	(0.00241)	(0.00198)
treatedmothereduy	0.00140	0.000345
	(0.00283)	(0.00217)
post*trearted*mothereduy	-0.000712	-0.000954
	(0.00287)	(0.00236)
Constant	0.405***	0.146***
	(0.0588)	(0.0468)
Month& Year FE	Y	Y
Observations	5,629	5,629
Additional Comm. Var.	Y	Y
R-squared	0.144	0.086

Standard errors in parentheses clustered at village ID level
*** p<0.01, ** p<0.05, * p<0.1

Table 11: Effect of Mother Education on Birth Timing for cohorts Born from 1974 to 1995

	(1)	(2)	(3)	(4)
VARIABLES	ramadan_10	ramadan_10	nonramadan	nonramadan
post	0.113***	0.133***	0.291***	0.305***
	(0.0243)	(0.0250)	(0.0379)	(0.0399)
treated	0.00927		0.0141	
	(0.0186)		(0.0258)	
treatment	-0.00941	-0.0106	-0.0208	-0.0273
	(0.0206)	(0.0221)	(0.0273)	(0.0284)
primary	0.0134	0.0125	0.00902	0.00503
	(0.0238)	(0.0235)	(0.0313)	(0.0310)
postprimary	-0.00202	0.000671	-0.00360	0.00214
	(0.0276)	(0.0273)	(0.0337)	(0.0342)
treatedprimary	-0.0146	-0.0152	0.000840	-0.00811
	(0.0301)	(0.0304)	(0.0435)	(0.0440)
treatmentprimary	0.0101	0.0120	-0.00238	0.00906
	(0.0340)	(0.0346)	(0.0454)	(0.0469)
secondary	0.0247	0.0265	0.0163	0.0160
	(0.0384)	(0.0362)	(0.0432)	(0.0433)
postsecondary	-0.0426	-0.0437	-0.0433	-0.0444
	(0.0425)	(0.0431)	(0.0406)	(0.0433)
treatedsecondary	-0.0857**	-0.0833**	-0.0738	-0.0701
	(0.0419)	(0.0397)	(0.0601)	(0.0607)
treatmentsecondary	0.101**	0.105**	0.0908	0.0938
	(0.0489)	(0.0495)	(0.0602)	(0.0641)
Constant	0.0857***	0.0918***	0.110***	0.121***
	(0.0204)	(0.0166)	(0.0282)	(0.0245)
Observations	5,840	5,840	5,840	5,840
R-squared	0.061	0.080	0.098	0.122
Month & Year FE	Y	Y	Y	Y
Vill FE	N	Y	N	Y

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 12: Fasting Effect on Height(cm) for cohorts Born from 1984 to 1995 for Muslims

VARIABLES	(1) B-T	(2) G-T	(3) B-C	(4) G-C
ramadan1to3	-1.023	-3.427	0.654	0.334
	(1.201)	(2.489)	(2.152)	(1.676)
ramadan4to6	-2.389*	-3.000	1.018	2.009
	(1.396)	(2.184)	(2.019)	(1.508)
ramadan7to9	-1.981	-3.575**	-0.282	0.772
	(1.427)	(1.676)	(1.813)	(1.313)
Constant	106.5***	111.9***	100.9***	111.4***
	(1.734)	(2.708)	(3.167)	(1.976)
Observations	445	416	509	496
R-squared	0.910	0.891	0.858	0.851
Month FE	Y	Y	Y	Y
Vill FE	Y	Y	Y	Y
Block*Year	Y	Y	Y	Y

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 13: Fasting Effect on Height(cm) for cohorts Born from 1984 to 1995 for Muslims

VARIABLES	(1) B-T	(2) G-T
ramadan1to3	-2.988*	-3.275
	(1.713)	(2.541)
ramadan4to6	-3.321	-2.433
	(1.993)	(2.468)
ramadan7to9	-2.415	-3.752**
	(1.932)	(1.868)
Hindu	-2.446	-2.884
	(3.022)	(1.988)
Hindu*ramadan1to3	2.617	0.00703
	(2.455)	(3.861)
Hindu*ramadan4to6	2.500	2.068
	(2.950)	(3.579)
Hindu*ramadan7to9	1.216	2.158
	(3.904)	(2.700)
Constant	109.7***	108.6***
	(1.779)	(3.433)
Observations	407	384
R-squared	0.905	0.886
Month FE	Y	Y
Vill FE	Y	Y
Block*Year	Y	Y

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 14: Fasting Effect on Height(cm) for cohorts Born from 1981 to 1995

VARIABLES	(B-T) height	(G-T) height
ramadan1to3	-1.193	-3.472*
	(1.085)	(1.911)
ramadan4to6	-2.543	-2.974
	(1.651)	(1.943)
ramadan7to9	-2.771***	-4.264**
	(0.983)	(1.859)
Hindu	0.101	-3.843*
	(2.536)	(1.951)
Hindu*ramadan1to3	1.603	-0.622
	(2.098)	(3.579)
Hindu*ramadan4to6	-1.590	3.069
	(2.324)	(2.782)
Hindu*ramadan7to9	0.366	3.799*
	(2.903)	(2.272)
Constant	106.8***	106.9***
	(1.600)	(2.454)
Observations	575	543
Month FE	Y	Y
Village FE	Y	Y
Block*Year	Y	Y
Mean	114.52	114.38
R-squared	0.922	0.912

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

11 Appendix

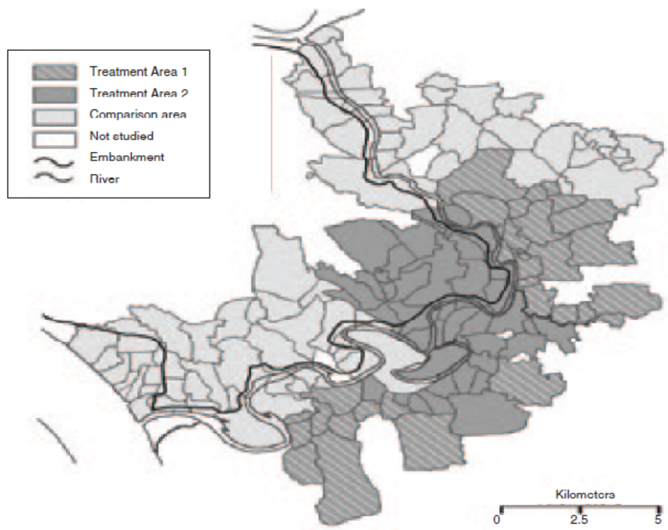

FIGURE 1. MAP OF MATLAB STUDY AREA

Table 3—1974 Baseline Characteristics

	Treatment Area			Comparison Area			Difference in Means		
	Mean	SD	Obs.	Mean	SD	Obs.	Mean	T-stat	Mean/SD
Panel A. Full Sample									
Family size	7.01	(5.15)	2,124	6.82	(4.20)	2,548	0.18	1.34	0.04
Owns a lamp (=1)	0.65	(1.18)	2,124	0.61	(0.92)	2,548	0.04	1.37	0.04
Owns a watch (=1)	0.16	(0.94)	2,124	0.16	(0.62)	2,548	0.00	0.05	0.00
Owns a radio (=1)	0.08	(0.63)	2,124	0.08	(0.47)	2,548	0.00	0.15	0.00
Wall tin or tinmix (=1)	0.32	(1.08)	2,124	0.31	(0.78)	2,548	0.01	0.27	0.01
Tin roof (=1)	0.83	(0.66)	2,124	0.84	(0.69)	2,548	0.00	−0.10	0.00
Latrine (=1)	0.83	(0.78)	2,124	0.85	(0.86)	2,548	−0.03	−1.22	−0.03
Number of rooms per capita	0.21	(0.15)	2,124	0.21	(0.18)	2,548	0.00	0.39	0.01
Number of cows	1.55	(3.30)	2,124	1.37	(3.05)	2,548	0.19	2.02	0.06
Number of boats	0.68	(1.50)	2,124	0.68	(1.42)	2,548	−0.01	−0.20	−0.01
Drinking water, tubewell (=1)	0.31	(1.41)	2,124	0.16	(0.93)	2,548	0.15	4.35	0.11
Drinking water, tank (=1)	0.38	(1.72)	2,124	0.33	(1.68)	2,548	0.05	1.01	0.03
Drinking water, other (=1)	0.31	(2.21)	2,124	0.51	(1.84)	2,548	−0.20	−3.39	−0.09
HH age	47.8	(22)	2,124	46.5	(22)	2,548	1.28	1.97	0.06
HH years of education (edu.)	2.52	(6.72)	2,124	2.34	(5.25)	2,548	0.17	1.25	0.02
HH works in agriculture (=1)	0.61	(0.89)	2,124	0.59	(0.99)	2,548	0.02	0.79	0.02
HH works in fishing (=1)	0.05	(0.53)	2,124	0.06	(0.49)	2,548	−0.01	−0.57	−0.02
HH spouse's age	37.0	(17)	2,124	36.2	(16)	2,548	0.86	1.72	0.05
HH spouse's years of edu.	1.14	(3.58)	2,124	1.21	(2.56)	2,548	−0.07	−0.95	−0.02
Panel B. Age 8–14									
Family size	6.59	(3.09)	188	6.87	(3.20)	304	−0.27	−0.97	−0.08
Owns a lamp (=1)	0.63	(0.52)	188	0.60	(0.69)	304	0.03	0.63	0.05
Owns a watch (=1)	0.16	(0.71)	188	0.17	(0.43)	304	−0.01	−0.13	−0.01
Owns a radio (=1)	0.09	(0.51)	188	0.09	(0.29)	304	0.01	0.14	0.01
Wall tin or tinmix (=1)	0.29	(0.72)	188	0.32	(0.43)	304	−0.03	−0.49	−0.05
Tin roof (=1)	0.81	(0.45)	188	0.88	(0.52)	304	−0.07	−1.57	−0.14
Latrine (=1)	0.85	(0.39)	188	0.85	(0.52)	304	−0.01	−0.13	−0.01
Number of rooms per capita	0.21	(0.08)	188	0.21	(0.18)	304	0.00	0.09	0.01
Number of cows	1.52	(2.51)	188	1.38	(2.22)	304	0.14	0.60	0.06
Number of boats	0.67	(0.98)	188	0.67	(0.92)	304	−0.01	−0.07	−0.01
Drinking water, tubewell (=1)	0.27	(0.71)	188	0.13	(0.58)	304	0.14	2.28	0.21
Drinking water, tank (=1)	0.37	(0.84)	188	0.31	(0.99)	304	0.06	0.75	0.07
Drinking water, other (=1)	0.36	(1.12)	188	0.56	(0.97)	304	−0.21	−2.09	−0.18
HH age	48.9	(17)	188	46.3	(18)	304	2.58	1.61	0.15
HH years of education	1.92	(3.84)	188	2.10	(3.15)	304	−0.18	−0.61	−0.05
HH works in agriculture (=1)	0.67	(0.45)	188	0.55	(0.67)	304	0.12	2.29	0.19
HH works in fishing (=1)	0.07	(0.35)	188	0.07	(0.38)	304	0.00	0.11	0.01
HH spouse's age	37.6	(15)	188	35.8	(14)	304	1.82	1.37	0.13
HH spouse's years of edu.	1.00	(1.39)	188	1.20	(1.58)	304	−0.20	−1.58	−0.12

Table 1—MCH-FP Program Eligibility by Birth Year

Birth cohorts	Birth cohort label[a]	Program eligibility[b]
October 1947–September 1972	25–49	*Pre-intervention group*
October 1972–September 1977	20–24	*No interventions, potential sibling competition*
		i. Not eligible for child health interventions and unlikely to use family planning and maternal health interventions. ii. Potentially affected by the program through sibling competition.
October 1977–February 1982	15–19	*Intensive family planning and maternal health interventions*
		i. Mother eligible for family planning, tetanus toxoid vaccine, folic acid, and iron in last trimester of pregnancy. ii. Children under age five eligible for mainly late measles vaccination in Treatment Area 1. iii. Potentially affected by sibling competition from younger groups.
March 1982–December 1988	8–14	*Child health interventions added*
March 1982–October1985	12–14	*Child health interventions added in Treatment Area 1* i. Mother eligible for family planning, tetanus toxoid vaccine, folic acid, and iron in last trimester of pregnancy. ii. Children under age five eligible for on-time measles vaccination in Treatment Area 1, but for late DPT, polio, and tuberculosis vaccination in entire treatment area.
November 1985–December 1988	8–11	*Child health intervention extended to entire treatment area* i. Mother eligible for family, tetanus toxoid vaccine, folic acid and iron in last trimester of pregnancy. ii. Children under age five eligible for on-time vaccination (measles, DPT, polio, tuberculosis) and vitamin A supplementation. iii. Nutrition rehabilitation for children at risk.