

Long-term Effects of Family Planning and Child Health Interventions on Adolescent Cognition: Evidence from Matlab in Bangladesh.¹

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Abstract: Early childhood health interventions, such as vaccinations, improve the health status of young children in developing countries. It is unclear, however, whether the benefits of these interventions are long-term, continuing into adolescence and adulthood, especially in environments where there are many competing health risks. This paper exploits a quasi-random placement of the Matlab Maternal and Child Health Project in Bangladesh to determine if typical family planning and early childhood health interventions received in childhood have lasting effects on cognition in older children. Single and double difference as well as mother fixed-effects models are used to determine the intent-to-treat effects of the program. Depending on the method, eligibility for the program in childhood leads to between a 6 and 13 percent increase in cognition for children 8-14 years of age. The effects include controls for education, so represent impact on cognition that are distinct from education.

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1. Introduction

The health of young children is of importance not only for the immediate improvement in their well-being but also because of the longer-term impacts on children's physical and cognitive development. It is believed that improvements in cognition may lead to improved educational achievements and labor market opportunities in the future. Economic theories of human capital development and reduction of inter-generational transmission of poverty rely on this link. Yet, in developing countries, where there are many competing health risks, it is unclear if the benefits of health interventions early on in life will continue through into adolescence and adulthood. Estimating the causal effect of early childhood health interventions on later stocks of human capital, such as cognition, is important from a theoretical point but also to development policy. This paper takes advantage of a quasi-random placement of the Matlab Child Health and Family Planning Program (MCH-FP) intervention to evaluate the causal impact of important early childhood health interventions (such as vaccinations) in Matlab Bangladesh on the cognition of those same children when they become adolescents.

Presently, there is a lack of empirical research from developing countries documenting the causal effect of early childhood health interventions on indicators of human capital (such as cognition) later in life. The association between health and human capital has most commonly been empirically examined as it pertains to height, educational outcomes, and income (Strauss and Thomas, 1998; Glewwe and Kremer, 2005; Mendez and Adair, 1999; Glewwe et al., 2001; Alderman et al., 2001; Bloom, Canning, and Seiguer, 2005; Alderman et al., 2006). Experimental studies in these areas evaluated the contemporaneous effects on health. Research on cognitive development as an example of human capital formation is limited. The experimental research thus far in developing countries has focused mainly on cognition of young children to examine the immediate impacts, rather than the longer-term effects on adolescents (Paxson and Schady, 2007; Macours et al., 2008).

To contribute to this needed body of research, this study takes advantage of the quasi-random placement of children's health interventions in the Matlab area of Bangladesh in the 1980s. The Bangladesh Maternal and Child Health and Family Planning (MCH-FP) started in 1977 with a family planning program. In 1982 and 1985 vaccinations (measles, DPT², and polio) for children under five were also introduced. The intent-to-treat effects are estimated using single and double difference estimators as well as a mother fixed-effect models to control for potential unobservables. Depending on the model, there is between a 6 and 13 percent increase in cognition as a result of the MCH-FP program. These findings are over and above the effect that education may have on cognition.

The rest of the paper proceeds as follows. In section 2, we describe the MCH-FP program and the mechanisms through which this program may affect cognition. Section 3, describes the various data sources and variables used in the analysis. We present the identification strategy in section 4 and results and conclusions in sections 5 and 6 respectively.

2. Background

2.1. *The Matlab Child Health and Family Planning Program*

In the early 1960s, ICDDR,B (formerly known as International Center for Diarrhoeal Disease Research, Bangladesh) began the Matlab Health and Demographic Surveillance System (HDSS) in the a rural region of Bangladesh called Matlab. This study site covered approximately

² The DPT vaccine protects against diphtheria, pertussis (whooping cough), and tetanus.

200,000 people and provided at least monthly data on important demographic events such as births, deaths and migration (Faveau, 1994). In 1977, ICDDR,B started a Maternal and Child Health and Family Planning (MCH-FP) program in approximately half of the HDSS site, leaving the other half as a comparison area. The main goal of the MCH-FP program was to reduce fertility rates by hiring local female community health workers (CHW) to visit each household regularly in the treatment area. During these visits CHWs provided women with a variety of contraceptives and regularly followed up to encourage continued use. In addition, CHWs provided some simple health interventions such as administering tetanus toxoid shots to pregnant women, providing iron and folic acid tablets, and providing advice on nutrition and breastfeeding (Faveau, 1994).

Starting in 1982, ICDDR,B phased-in a number of child health interventions in all or some of the treatment area in order to reduce mortality and morbidity among children. The treatment area was further split into four blocks (A, B, C, and D). The comparison area is block E. In particular, in blocks A and C in 1982 measles vaccination was provided to all children between the ages of 9 months and five years, tetanus toxoid immunization was expanded to all women of reproductive age (as apposed to just pregnant women), and antenatal care was provided in blocks A and C. In 1986, all interventions were expanded to blocks B and D. At the same time, vaccination against diphtheria, pertussis, and tetanus (DPT), polio, tuberculosis, and vitamin A supplementation and nutrition rehabilitation were introduced in the treatment area for children aged 5 and under. In 1988, control for acute respiratory infections and dysenteric diarrhea was also introduced in the treatment area (Faveau, 1994). While government health services were available in treatment and comparison areas, the comparison area did not receive the intensive care provided by the home visits, nor did they have access to the vaccinations in government clinics until after 1988. Data on coverage for measles from the HDSS Record Keeping System (RKS) displayed in Figure 1 demonstrates that the program was implemented according to planned time line. The RKS data is only available for the treatment area, and no data is available from the comparison area before 1991.

The analysis will take advantage of both the geographic variation of the program (treatment versus comparison area) as well as the phasing-in of the MCH-FP over time within the treatment area. Table 1 summarizes program eligibility by year of birth for the various interventions and provides the age of each group in the 1996 MHSS survey. Children who were eligible for the child health interventions are split into two groups; the “non-intensive” and “intensive” child health groups. Children in the “non-intensive” child health group are aged age 15-19 in the 1996 MHSS survey. Mother’s of these children were eligible for the family planning interventions and these children became eligible for the measles vaccine past the recommended age of one, but were not eligible for the other vaccines or health interventions.³ In particular, children in this group were only eligible for the measles vaccine between the ages of 2 and 5. The children in the “intensive” child health group are less than age 15. These children were eligible to receive all the vaccines at the recommended age or by age 3 or 4. Those aged 10 or younger were eligible for all their vaccinations by the recommended age and may have benefited from the non-vaccination child health interventions. For the analysis we examine the effects on the 6 to 7 year olds separate since some of the same child health interventions were available in the comparison area a this time so the effect of the MCH program may be smaller.

³ Some children in blocks A and C may have been eligible for the other vaccines at age 5 depending on their birth date and when the program reached their area during the year.

2.2. Mechanisms through which the MCH-FP affect cognition

Child health and the family planning interventions are believed to positively impact human capital formation (Ahlburg, 1998, Bloom et al., 2004). There are both direct and indirect pathways in which the interventions could impact cognition. The child health interventions will have a direct effect through the reduced childhood morbidity and malnutrition which can have long-term effects on physical and cognitive development (Haas et al. 1996; Martorell 1995 & 1999; Martorell et al. 1994). In addition, reducing the incidence of measles is important since it can lead to encephalitis causing brain damage or impaired learning.

Each element of the MCH-FP program may also have indirect effects through changes in parental investment in children. For instance, the family planning program could drive a quality/quantity tradeoff (Becker 1960; Becker and Lewis 1973; Becker and Thomas 1976), with low fertility parents bringing greater resources to bear on the remaining children. Both family planning and maternal health interventions could lead to improved maternal survival, which could in turn lead to greater nurturing from mothers as well as a more favorable allocation of resources towards children. Lastly, children that are healthier as a result of the child health interventions may receive greater parental investment (in the form of quality time or money) because of the increase in the potential future returns of this child. This increase in investment in the child who received the interventions may come from the increase in total household resources as a result of the program (i.e. time and money gained from children not being sick or having less children), or from a reduction in investment in the siblings that did not receive the interventions (what we will call sibling competition). If sibling competition is present, it is possible that the program could have a negative impact of the cognition of children who received no or less intensive child health interventions (i.e. those aged 15 or older according to the age groups in Table 1)

3. Data

3.1. Data Sources

Our paper draws on a rich set of data available on the Matlab area and benefits from the ability to link each of the datasets. The 1996 Matlab Health and Socioeconomic Survey (MHSS) provides data on cognition and large number of other demographic and socio-economic variables. These data are publicly available from the Rand website (<http://rand.org/labor/FLS/MHSS/>). Census data is available from ICCDR,B for all HDSS households (i.e. all treatment and comparison households) for 1974, 1982 and 1993. Finally, the ICCDR,B Record Keeping System (RKS) provides data on actual receipt of the interventions provided under the MCH-FP program in the treatment area. At present, data is available only on the date of vaccination receipt for each type of vaccine in the treatment area. No data is available of vaccination receipt before 1991. A great advantage of these datasets is that they all contain unique identifiers that allow individuals and households to be linked across each of the datasets.

The 1996 Matlab Health and Socioeconomic Survey (MHSS) is a comprehensive household survey covering a wide array of topics typical of large households surveys in developing countries. Unlike most household surveys before 2000, it also includes a measure of cognition, the Mini Mental State Exam (MMSE). It is a random sample of approximately one third (2,687) of the *baris* (residential compound which include a number of households who live together) in the treatment and comparison areas. Within each *bari*, a primary household was selected at

random. A second household from each bari was also selected purposively. We use both the households in each bari to provide as large a sample size as possible.

The MMSE should have been collected for household members greater than age 6 in the MHSS. Due to a mistake in the field, the MMSE was not collected from children ages 6 to 14, except from the last quarter of households surveyed. In order to obtain a random sample of children for the cognitive test, a 10 percent random sample of the bari's was selected and the MMSE was administered to the appropriate respondents in those bari's. As a result, there are a total of 11,218 observations for those aged 6 and older with some cognitive data and that have unique individual identifiers used for matching to other dataset. We further restrict the sample to those less than aged 60 because 91 percent of these observations do not have any mother information and would be dropped from the sample when the controls or mother fixed effects are included. This leaves a sample of 9,598 6 to 59 year olds however only 9,164 of these have non-missing information on all parts of cognition (see Section 3.3). Approximately 47 percent (4,333) of these observations are from the treatment area.

The MHSS data was designed to be linked to the census data collected by ICCDR,B for demographic surveillance. Census data are available for the pre-intervention period (1974) and during the start of the child health interventions (1982). These data include information on household location, composition, assets, employment, and education. They provide the opportunity to test the similarity of the treatment and comparison areas at baseline, to control for pre-program household characteristics in the analysis, and to determine program eligibility based on the individual's household location prior to the interventions since individuals 1996 location may be endogenous.

3.2. Dependent Variable: The Mini Mental State Exam (MMSE)

The measure of cognition used for the analysis is the MMSE. It examines five areas of cognitive functioning: orientation, attention-concentration, registration, recall, and language. The results present data for the total score as well as for each area of cognitive functioning separately. The MMSE was originally developed to assess the cognitive status of geriatric patients. However, research has shown adaptations of the MMSE for children are effective at evaluating the cognitive development of children as young as 3 years (Jain and Passi, 2005; Ouvrier et al., 1993). The MMSE was adapted for the study so that it would not depend on literacy skills and would be culturally- and age-appropriate.

The MMSE in the MHSS asks 33 questions and each question is given one point if the respondent correctly answers the question for a maximum score of 33. For example the recall section asks respondent remember three words (orange, house, cat) and then asks the respondent to repeat those words a few minutes later. They would get one point for each word remembered. There are a total of 9,598 observations in which at least one of the 33 questions was answered. In some cases one or more responses to the cognitive questions were coded as don't know or missing. All don't knows are coded as zeros since they did not correctly answer the question. However, it is unclear how to handle the missing observations. If the data is missing because the respondent refused to answer the questions this is likely because the respondent did not know the answer in which case they should be coded as zeros. However, the missing could reflect a mistake by an enumerator who accidentally skipped some of the questions. Each area of cognitive function had less than 200 missing observations with the exception of recall which had more than a 1,000 missing observations. This is likely a result of lack of clarity in the survey instruments and documentation since the majority of the missing observations have no code at all

(not even a missing code) in the public data. Our best guess is that they indicate the respondent could not remember any of the three objects so should be coded as zero. Since it is unclear how to code the recall section, the MMSE score used for the analysis excludes the recall section so the total score is out of 30. For the final analysis, missing observations for any part of the test were not recoded, leaving a final sample of 9164 observations. As a robustness check we also recoded the missing to zeros and include the recall section. The results were similar but slightly larger so we present the more conservative results.

Tests to determine the break point indicating cognitive impairment by age were not performed on the version of the MMSE used in the MHSS survey. However, higher scores clearly represent enhanced cognitive ability. Kabir and Herliz (2000) designed a different MMSE for Bangladesh which is referred to as the Bangla Adaptation of the Mini-mental State Examination (BAMSE). The BAMSE was also adapted for an illiteracy population and cultural relevance to Bangladesh. The BAMSE is very similar to the MMSE used in the MHSS. Kabir and Herliz implemented both the BAMSE and the MMSE used by a literate population in Bangladesh and found that the correlation between the MMSE and the BAMSE was good, indicating that the changes made to adapt the instrument for an illiterate population do not change the ranking of scores.

3.3. *Intent-to-Treat Indicator*

An individual is eligible for the MCH-FP interventions if the household resides in a treatment village and they meet the age requirement outlined in section 2.1. Creating a variable to indicate which households are eligible for the MCH-FP program based on 1996 MHSS household village location may be endogenous since households could have moved to the treatment area to benefit from the MCH-FP program. To avoid this potential endogeneity, 1974 location information is used to create the intent-to-treat variable, *Eligible*, which takes on the value 1 if the individual (or household if the individual was not born) resided in a treatment area in 1974, and zero otherwise.⁴

4. Identification Strategy and Empirical Specifications

We seek to determine the intent-to-treat (ITT) or overall program effects of the Matlab MCH-FP program on cognition. We take advantage of the variation in the program implementation across location (treatment versus comparison areas) and by age in the treatment area. We first use 1974 census data to show that the treatment and comparison areas are similar with respect to many observable characteristics and may indeed mimic a randomized intervention. We then present a number of different models to estimate the ITT effect and discuss the possible biases of each of these models. It is important to note that since the family planning and child health interventions were not randomly introduced in a factorial design, it is difficult to determine their effects separately. Nevertheless, the analysis tries to better isolate the effect of the child health interventions by controlling for the percent of reproductive years the child's mother was eligible for the family planning and maternal health interventions and by the mother's age and her child's birth.

4.1. *Quasi-Random Program Design*

⁴ 1974 individual or household information was not available for 592 observations. For these observations 1982 location information was used. The results do not change if these 592 observations are excluded.

A comparison group was built into the design of the MCH-FP program, however, randomization was not used to determine which households or villages belonged to the treatment and comparison areas. Instead, the treatment and comparison groups are contiguous geographic areas (Figure 2). It is possible that village randomization was not used in order to mitigate the possible spill-over effects to the comparison area from the positive externalities created by the vaccines. Prior research shows that the MCH-FP and comparison areas are indeed similar with respect to a number of pre-intervention variables including prior rates of mortality and fertility (Koenig et al., 1990; Menken & Phillips 1990; Joshi & Schultz, 2007). This is important as it shows that the MCH-FP program was probably not placed first in areas that had poor child health or high fertility – a potential targeting criteria for such programs. For this reason prior papers using these data argue that the treatment and comparison areas mimic a randomized evaluation or was quasi-randomly placed. However, it is important to note that even if the observable characteristics look similar, without randomization it is not clear that the unobservable characteristics are similar.

We would like to be able to show that the level of cognition was similar between treatment and comparison areas in the pre-intervention period. Since there is no pre-intervention data on cognition, we instead examine differences in the MMSE score for those age 25 and older since their cognition was unlikely to have been affected by the MCH-FP program (those age 20 and older were born before the program began) and any potential sibling competition (those who are at least 5 years older than an eligible younger sibling). Panel C of Table 1 shows that the mean MMSE score for this group was almost exactly the same at approximately 29 out of 30.

Panel C in Table 1 also highlights that mother's in the treatment and comparison area have a similar level of education. While this data is not available for the pre-intervention period, it is likely that almost all these mothers would have finished their education prior to the program. This is important since mother's education is usually correlated with child health which affects cognition. In addition, more education mothers may be a signal of better cognition which may be pass onto the child through their genetic make-up.

We further test the areas are similar using a wider array of household and household head characteristics from the 1974 census. Table 1 displays the means and standard errors of each characteristic for the treatment and comparison area as well as the difference in the means between the two areas. It demonstrates that the areas are not statistically different for approximately 80 percent of the variables. However, households in the treatment area owned more quilts, had a larger Hindus population, and were more likely to use tube well water for drinking. There is a fairly large difference in the use of tube well water for drinking of 12 percent between treatment and comparison areas. Indeed, shallow tubewells were introduced by donors and the government starting in the 1970s and served 95 percent of the Bangladeshi population by the mid-1990s. Usually tube well water is cleaner than other sources of water resulting in a healthier population which could potentially bias the estimates of the effect of the program on cognitions upwards. However, there is widespread groundwater arsenic contamination in the tube wells in Matlab and Bangladesh (Smith et al. 2000) which is a serious health concern (Chowdhury et al. 2000; MM Rahman et al. 2001; Alam et al. 2002) and may actually lead the results to be downward bias as a result of greater access to tube well water.

4.2. ITT Single and Double Differences Models.

We first ordinary least square to estimate single difference model. The assumption of this model is that the mean MMSE score would have been the same between the treatment and

comparison group in the absence of the MCH-FP program. This is not a testable assumption, however it seems likely given that the mean MMSE for those who likely did not benefit from the program, the 25 plus age group, were similar. The estimation equation is:

$$(1) \quad C_{imv} = \beta_1(E_v * AG_{imv}^{6-7}) + \beta_2(E_v * AG_{imv}^{8-14}) + \beta_3(E_v * AG_{imv}^{15-19}) + \beta_4(E_v * AG_{imv}^{20-24}) \\ + \beta_5(E_v * AG_{imv}^{25+}) + \delta_1 FP_{imv} + \alpha_a + \tau_s + X'Z + v_{imv},$$

where C is a measure of cognition of person i , of mother m in village v . E is a binary variable which takes on the value 1 if person i or i 's household was from a treatment village in the pre-interventions period, and 0 if in a control village. AG^Y is a binary variable used to indicate if the person i is or is not in age group Y . Thus, the β 's are the single difference ITT effect for the various age groups. The ITT effect for the group of children who received the most intensive health interventions during the time period when the interventions were likely not available in the comparison area, age 8 to 14, is given by β_2 . β_3 is the ITT estimate for the age group who received the less intensive child health interventions. FP is the percent of reproductive years up to 1996 person i 's mother, m , was eligible for the family planning program. α_a represents age fixed effects to control for differences in cognition due to age as well as other events which may be correlated with age and common to the study population. λ_s are school level fixed-effects to control for differences in cognition that may be due to differences in years of education completed. Due to the potential endogeneity of schooling attainment (i.e. there may be reverse causality between cognition and education level) results are presented with and without school level fixed-effects. X is a vector of individual, mother controls including age, sex, education and religion as well as baseline household and household head characteristic presented in Table 2. Including these variables controls for any observable pre-intervention differences resulting from the quasi-random design, and may increase statistical precision. It also allows us to check if the few differences between treatment and comparison area found at baseline are biasing the results.

The error term $v_{imv} = \varepsilon_i + \varepsilon_m + \varepsilon_v + \varepsilon_{imv}$ is a composite of three terms: ε_i , which represents an individual effects such as genetics; ε_m , which captures time invariant mother characteristics and household environment such as if the child had stimulating parents that might have enhanced the child's cognition; ε_v , any village or treatment area variable that may be correlated cognitive development when the child was young for example, exposure to arsenic in the tube-well; and ε_{imv} , an idiosyncratic error term. This model assumes that various individual, mother, household, and village or treatment area unobservables are not correlated with E_v due to the quasi-random placement of the program. Standard errors are clustered at the treatment group-year level to account for the likely intra-cluster correlation in the error term.

Equation 1 does not take into account potential indirect effects of the MCH-FP due to sibling competition. Future versions of this paper will try to determine if those sibling competition is indeed an issue.

Even when interventions are successfully randomized, there is a chance that the particular outcome of interest will vary slightly during the pre-intervention period between MCH-FP and comparison areas. In this case a *double-difference estimator* may be more appropriate because it takes into account these pre-program differences. In addition, this estimator will control for non-time varying unobservables that may differ between the treatment and comparison areas, such as level of arsenic in the wells, and could be correlated with the eligibility variable, E_v . Given the long time span between the pre- and post-intervention time period and that the cognition data is only available post-intervention in the MHSS, it is not possible to examine the difference in

cognition on any one individual pre- and post-intervention. Instead, the analysis will use the 25 year and older group to determine pre-intervention difference between treatment and control areas. The double difference estimator can be determined using the following linear regression:

$$(2) C_{imv} = \beta_1 E_v + \beta_2 (E_v * A G_{imv}^{6-7}) + \beta_3 (E_v * A G_{imv}^{8-14}) + \beta_4 (E_v * A G_{imv}^{15-19}) + \beta_5 (E_v * A G_{imv}^{20-24}) + \delta_1 FP_{imv} + \alpha_a + \tau_s + X'Z + v_{imv}$$

Where the variables are defined as in Equation (1) but the interpretation differs because the 25+ age group is not interacted with T . Therefore, β_1 provides the difference in means between the treatment and comparison area for the 25+ years olds, or the differences in the treatment and comparison groups in the pre-intervention period.

4.3. Maternal Fixed-Effect Model

The single and double difference models will be bias if unobservable mother or household characteristics are not similar between the treatment and comparison. As discussed in section 3.1, most of the observable baseline characteristics as well as mother's education are similar. However, we are still concerned that there may be unobservables that are biasing the results. We include mother fixed-effects to the double difference model to partial out the ε_m component of the error term in Equation (1). This model identifies the effect of the MCH-FP program by comparing siblings who were and were not eligible for interventions but born to the same mother. The sample size is smaller for these models since the mother identification code is missing for some individuals because their mother is dead (3,849 observations)⁵, and because some individuals do not have any siblings in the dataset (3,715 observations).

4.4. Other Econometric Issues

Three potentially important econometric issues in this context are attrition bias, and spillover effects, and spatially correlated errors. Two prominent causes of attrition are mortality and migration. Even if the MCH-FP were truly randomized, the program itself is likely to cause mortality and migration to differ between MCH-FP and comparison areas over time, potentially biasing the results. For example, if frailer individuals (or those with lower health endowments) are more likely to survive in the MCH-FP area, then there will likely be a higher probability of observing someone with a lower level of cognition in the MCH-FP than in the comparison area in the follow-up period, biasing the results downwards. Differential mortality is likely to cause the treatment effect to also be biased downwards. Since migration from rural areas in Matlab tends to occur among families with few resources (Kuhn 2003, 2006b), the MCH-FP program will likely encourage worse off families who might have migrated to stay in the treatment area as the program subsidizes the cost of raising children. This type of endogenous migration will leave a higher proportion of children who likely have lower human capital (since they come from worse off families) in eligible versus ineligible areas biasing the results downwards. In both of these cases the individual and mother fixed-effect components of the error term in Equation (1) are likely to be correlated with the treatment variable E_v . Since we do not have access to data on those who were benefited from the program but died or migrated before the 1996 MHSS, we control for non-time varying household variables that may be correlated with the attrition by using a maternal fixed-effect model.

⁵ Efforts were made to obtain identification codes for mothers who had died prior to 1996 by using the census data. Approximately 50 percent of the observations with missing mother information was under the age of 43.

Spillover effects occur when the program indirectly affects non-program participants and will bias the ITT effects. Spillover effects could affect the untreated in MCH/FP or comparison villages due to the positive externalities of some of the interventions such as vaccinations (i.e. if most children in an area are vaccinated against polio then the non-vaccinated children in the area will be less likely to contract polio) or informational spillovers. In the comparison area, spillovers are likely to occur in those areas that border the MCH-FP villages since knowledge about the programs would be spread by word-of-mouth or occur as a result of marriage. In future versions of this paper we will include a variable which indicates the proportion of children in a village that received vaccinations to control for the possible within treatment area spill-over as well as examine if there are spillovers in comparison area villages which boarder the treatment area.

Since the MCH-FP and comparison area are contiguous geographic areas, it is possible that errors are spatially correlated, biasing the treatment effects. This could arise for example if there was a health shock, such as a famine or a disease outbreak, in a given year in the comparison but not the MCH-FP area. Since these outbreaks are likely to affect younger children's human capital development more than those who are older, even the double difference models will be biased as they only control for time invariant unobservables between treatment and comparison area. Future versions of this paper will check if the errors are spatially correlated and will control for some village level variables such as access to health clinics and education facilities and any other known major outbreaks.

5. Results

5.1. Summary Statistics

Figure 3 displays the mean MMSE score by age groups of interest. The 95 percent confidence interval lines are no included as they make the figure difficult to read and because the regression analysis will examine if these lines are statistically different or not. The figure highlights how the level of cognition is higher in the treatment area than in the comparison area for children who were eligible for various interventions in the MCH-FP program (i.e. those under the age of 19). Surprisingly, the level of cognition is lower in the MCH-FP program area than in the comparison area for the 20 to 24 year old group. It is possible that this difference is a result of sibling competition as these individuals are at most 5 years beyond the eligibility age. However, it could also reflect some negative shock that took place in the comparison area that affected the development of cognition of the 20-24 year old age group when they were children. For the rest of the age groups the mean MMSE score are essentially the same between the treatment and comparison groups.

5.2. Regression Results

The regression results for the various models are presented in Table 3. Columns one through five presents the results for the single difference model. Results in column 1 shows that there is a very small and negative effect of the program on the age 15 to 24 year olds, which is significantly at the 5 percent level for the 15-19 year olds. The MCH-FP program also lead to a statistically significant increase in the MMSE score of 1.2 point for age 8-14 year olds and of 1.1 points for the age 6-7 year olds. Given that the mean level of cognition for the 8-14 year olds was 20.7 in the control area, the increase in 1.2 points represents a 6 percent increase in cognition. It important to note how the point estimates remain almost unchanged for all age groups with the inclusion of the variables to control for the family planning program (columns 2)

and the various controls (columns 3 and 4). This provides some confidence that the differences at baseline in some of the household characteristics (such as access to tube well water) are not biasing the results. Finally, controlling for the level of education led to a slight increase in the impact for the 8 to 14 year old to 1.4 points or 7 percent, showing that the MCH-FP program has a separate effect on cognition than on education.

Double difference estimates without and with the mother fixed-effects are presented in columns 6 to 8. The results without the fixed effects are exactly the same as the single difference estimates except the coefficients for the 15-24 years olds is now marginally significance at the 10 percent level. Column 7 presents the double difference estimates without the maternal fixed-effects but for the same sample that is used when the fixed effects are included to separate out the changes in the coefficient that are due to the smaller sample versus the addition of the mother fixed-effects. With the exception of the effect on the 8-14 year olds, the results for the smaller sample are very similar, though the point estimates for the 15-24 years olds are even smaller and no longer significant. However, the point estimate for the smaller sample is almost double, 2.4 as compared to 1.3, that of the full sample and is still statistically significant at the 1 percent level.

Adding the maternal fixed-effect marginally changes the effect of the program for most of the age groups. For the children that received the most intensive health interventions (age 8 to 14 year olds) the MCH-FP program led to a 2.6 point increase in the MMSE score, or a 13 percent increase over the average score for children of the same age group in the comparison areas. Surprisingly, the addition of the maternal fixed effect lead to the coefficient for the 20 to 24 year old age group to become much larger, showing the program led to a statistically significant decrease in their cognition of 2.1 points. However, further controlling for the education group, the size of this coefficient become fairly small -0.8 and is no longer statistically significant. Including the education controls also resulted in an increased in the coefficient for the 8 to 14 year old age group to 3.1, which represents a 15 percent increase in cognition.

6. Conclusion

This paper examines the effect of a family planning and child health program that took place in the late 70s and 80s in rural poor area of Matlab Bangladesh on the cognition of those same children when they are between the ages of 6 and 14. The analysis takes advantage of the quasi-random placement of this program and demonstrates that the treatment and comparison areas look similar with respect to most baseline characteristics. The paper uses single and double difference models and demonstrates that the program led to an approximately 6 percent increase in cognition. The effect of the program increased to 15 percent with the addition of mother and school group fixed effects. Therefore, the finds on cognition are in addition to any effects the program may have had on education. It is difficult to credibly separate out the effects of the family planning and child health interventions. The analysis includes variables to control for the family planning program (percent of a woman's fertile years she was eligible for the program at mothers age at birth). The results are very similar with and without these controls, so the effects are likely to be mainly from the child health interventions. Future versions of this paper will use matching methods and examine the effect of treatment on the treated.

These finds are important for a number of reasons. First, they show that typical health interventions in developing countries (i.e. family planning, diarrhoeal control, vaccinations) may have lasting benefits on cognition, even in high disease environments. They also provide evidence of an important link between health in childhood and better educational and labor market outcomes in the future.

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Figures

Figure 1: Proportion of children aged 12-59 months who received the measles vaccination by year and treatment block

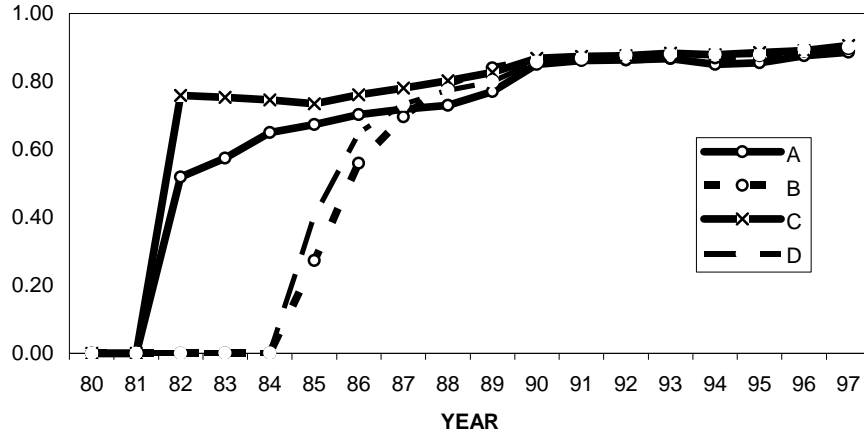


Figure 2: Map of Matlab study area

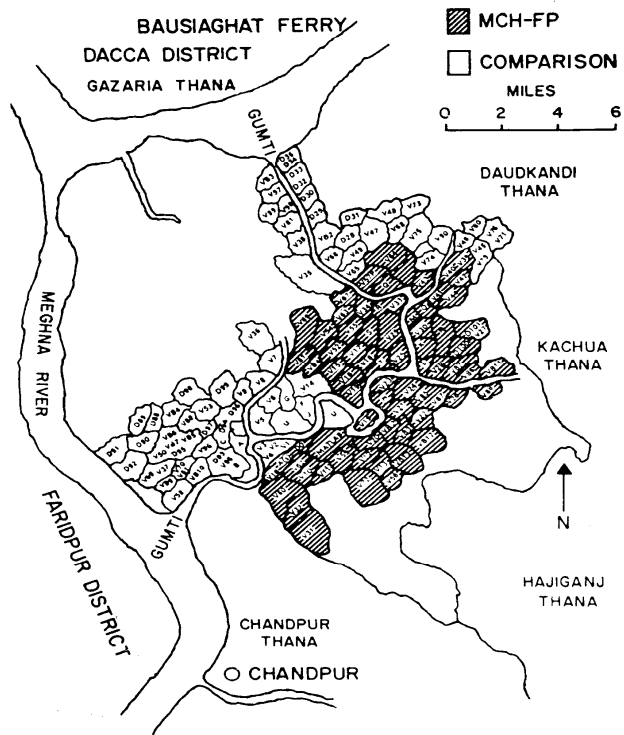
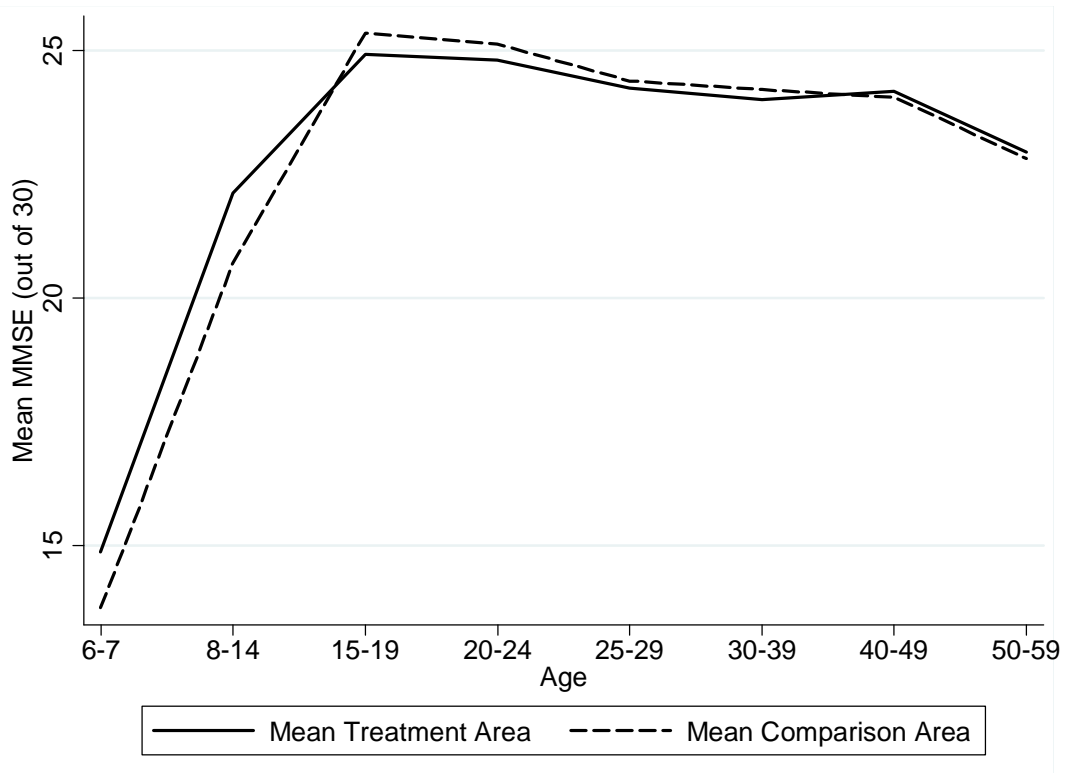


Figure 3: Mean MMSE Score by Age Group and Eligibility Status



Tables

Table 1: MCH-FP Eligibility by Age

Eligibility	Year Born	Age in MHSS
Not eligible for MCH-FP.	Pre 1938	59
Reproductive age during MCH-FP program, eligible for FP and MH.	1938-1973	23-58
Born during MCH-FP program, eligible for CH.	1977-1989	7-19
<i>Non-intensive treatment:</i> FP, ORT, mainly late measles vaccination.	1977-1981	15-19
<i>Intensive treatment:</i> FP, ORT, on-time or late measles/DPT/polio/BCG, vitamin A.	1982-1988	8-14
Some interventions now available in comparison area.	1989-2010	0-7

Notes: FP=family planning; MH=maternal health; CH=child health; ORT=Oral Rehydration Therapy; DPT=Diphtheria-Pertussis-Tetanus; BCG=Bacille Calmette-Guerin (vaccine against tuberculosis).

Table 2: Differences in Means between Treatment and Comparison Area

	Treatment Group			Comparison Group			Difference		T-stat
	Mean	SE	Obs	Mean	SE	Ob	Mean	SE	
Household Characteristics from 1974 Census									
Family size	7.04	0.10	4108	6.86	0.10	4494	0.18	0.14	1.34
Owens a quilt (=1)	0.41	0.03	4108	0.34	0.02	4494	0.07	0.03	2.55
Owens a lamp (=1)	0.66	0.03	4108	0.61	0.02	4494	0.05	0.03	1.44
Owens a watch (=1)	0.18	0.02	4108	0.16	0.01	4494	0.01	0.02	0.77
Owens a radio (=1)	0.08	0.01	4108	0.08	0.01	4494	0.00	0.01	-0.27
Wall made of tin (=1)	0.09	0.01	4094	0.07	0.01	4458	0.02	0.01	1.11
Roof made of tin (=1)	0.82	0.02	4095	0.83	0.01	4459	-0.02	0.02	-0.86
Latrin in household compound (=1)	0.83	0.02	4108	0.85	0.02	4494	-0.02	0.02	-0.95
Number of rooms per capita	0.21	0.00	4108	0.21	0.00	4494	0.00	0.00	0.13
Number of cows	1.51	0.07	4108	1.39	0.07	4494	0.13	0.10	1.29
Number of boats	0.69	0.04	4106	0.69	0.03	4494	0.00	0.04	0.06
Drinking water from tube well (=1)	0.30	0.03	4108	0.17	0.02	4491	0.12	0.04	3.48
Drinking water from a ditch (=1)	0.11	0.02	4108	0.08	0.02	4491	0.03	0.03	0.99
Drinking water from river or canel (=1)	0.20	0.04	4108	0.42	0.04	4491	-0.22	0.05	-3.92
Drinking water from tank (=1)	0.39	0.04	4108	0.33	0.03	4491	0.06	0.05	1.26
Household Head Characteristics 1974 Census									
Age	47.10	0.51	4099	46.46	0.43	4489	0.64	0.66	0.97
Hindu (=1)	0.17	0.03	4053	0.05	0.01	4462	0.12	0.03	3.34
Years of education	2.56	0.13	4108	2.39	0.10	4494	0.17	0.13	1.29
Primary occupation is agriculture (=1)	0.61	0.02	4108	0.61	0.02	4494	0.00	0.03	0.00
Characteristics from 1996 MHSS									
MMSE for 25+ age group	23.84	0.19	2996	23.87	0.17	3223	-0.03	0.24	-0.14
Age	33.06	0.43	4333	32.31	0.32	4831	0.75	0.54	1.40
Female (=1)	0.57	0.01	4333	0.55	0.00	4831	0.02	0.01	2.40
Hindu (=1)	0.16	0.03	4333	0.05	0.01	4831	0.11	0.03	3.41
islamic	0.84	0.03	4333	0.95	0.01	4831	-0.11	0.03	-3.41
Years of education	3.50	0.20	4310	3.06	0.10	4807	0.44	0.18	2.48
Mother's age at birth	26.39	0.16	4022	26.91	0.18	4544	-0.52	0.24	-2.18
Mother's years of education	1.07	0.11	4217	0.92	0.06	4718	0.15	0.10	1.58
% of mother's fertility years eligible for MCH-FP	0.41	0.01	4209	0	0	4707	0.41	0.01	61.68

Notes: Standard errors clustered at the village level; SE = standard error, Obs = observation; T-stat = T- statistic.

Table 3: Regression Results

	Single Difference					Double Difference				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Eligible (=1)						0.0 (0.1)	0.0 (0.1)	-0.0 (0.6)	-0.0 (2.9)	1.6 (3.1)
Eligible*(Age 25+)	0.0 (0.1)	0.0 (0.2)	0.1 (0.1)	0.0 (0.1)	-0.0 (0.1)					
Eligible*(Age 20-24)	-0.2 (0.2)	-0.3 (0.3)	-0.3 (0.3)	-0.4 (0.3)	-0.3 (0.3)	-0.4+ (0.2)	-0.3 (0.2)	-0.3 (0.6)	-2.1** (0.7)	-0.8 (0.8)
Eligible*(Age 15-19)	-0.4* (0.2)	-0.4 (0.3)	-0.3 (0.3)	-0.3 (0.3)	-0.3 (0.3)	-0.4+ (0.2)	-0.3+ (0.2)	-0.1 (0.6)	0.9 (1.1)	1.4 (1.0)
Eligible*(Age 8-14)	1.2** (0.1)	1.2** (0.3)	1.2** (0.3)	1.3** (0.3)	1.4** (0.3)	1.3** (0.2)	1.4** (0.2)	2.4** (0.6)	2.6** (1.0)	3.1** (1.0)
Eligible*(Age 6-7)	1.1* (0.5)	0.7 (0.7)	0.6 (0.7)	0.7 (0.7)	0.6 (0.7)	0.7 (0.7)	0.6 (0.6)	1.3 (0.8)	-0.6 (1.5)	-0.9 (1.5)
% of fertile years mother eligible		-0.0 (0.4)	-0.3 (0.4)	-0.3 (0.4)	-0.5 (0.4)	-0.3 (0.4)	-0.5 (0.4)	-1.2 (1.5)	0.7 (2.8)	-1.0 (3.0)
Mother's age at child's birth		-0.0 (0.0)	0.0 (0.0)	-0.0 (0.0)	-0.0 (0.0)	-0.0 (0.0)	-0.0 (0.0)	-0.0+ (0.0)	-0.0 (0.0)	-0.0 (0.0)
Mother's years of education			0.5** (0.0)	0.3** (0.0)	0.2** (0.0)	0.3** (0.0)	0.2** (0.0)	0.4** (0.0)	0.3 (0.2)	0.2 (0.2)
Age fixed-effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Individual characteristics	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Baseline characteristics	N	N	N	Y	Y	Y	Y	Y	Y	Y
Education group dummies	N	N	N	N	Y	N	Y	N	N	Y
Mother fixed-effect sample	N	N	N	N	N	N	N	Y	Y	Y
Mother fixed-effects	N	N	N	N	N	N	N	N	Y	Y
Observations	9164	8566	8447	8447	8404	8447	8447	1845	1845	1837
Adjusted R-Squared	0.21	0.21	0.25	0.28	0.35	0.28	0.35	0.38	0.57	0.60

Notes: Standard errors are clustered at the treatment-age level. An asterisks indicates that the difference in the coefficient from zero is statistically significant at the 95 percent confidence level, and + at the 90 percent confidence level. Individual characteristics include a dummy for female and being islamic. Baseline characteristics include all household and household head characteristics from 1974 presented in Table 2.