Long-run Cognitive and Education Impacts of Early Life Public Health Intervention: Evidence from Safe Motherhood Program in Indonesia

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Abstract: Between 1990 and 1996, over 54,000 midwives were introduced in most of Indonesia's 68,000 villages as part of its safe motherhood strategy. I combine the quasi-experimental nature of the program with the panel dimension of Indonesian Family Life Survey to carefully examine the long run impacts of the program on cognition and education. This paper empirically tests and corroborates the findings in the medical literature that environmental influences while in *utero* and during the first two years of life mark the most critical periods that influence later human capital. Estimates suggest that the safe motherhood program led to an increase of about 0.28 to 0.45 years of education and 0.15 to 0.36 s.d. on standardized cognitive test scores depending on intensity of exposure of the child to the program.

JEL Classification: I1, J13, O15, O22

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1. Introduction

The past decades have seen a growing interest in public health investments in children at early stages of development. This is primarily due to the growing knowledge and awareness of the importance of environmental influences during the earliest childhood years on human capital achievement and success later in life. Yet except for a few studies including the ones that are mainly based on the INCAP experiment in Guatemala (study design and main results are described in Maluccio et. al. (2009) and Behrman (2003), among others), very little evidence establishes a direct link between early life public health intervention and long run human capital outcomes. Also, although it is widely documented in the medical literature that health and nutrition while in utero and during early childhood years have important influences in later life conditions, majority of the studies provide evidence on the importance of either only the fetal period (see, among others, Berhman and Rosenzweig, 2004; Almond, 2006; Almond et. al., 2009) or early childhood years (see, among others Alderman, 2006; Maluccio et. al., 2009; Yang and Maccini, 2009) and thus still little is known about the relative importance of each period. Furthermore, compared to height, the span of critical period for cognitive development during early life is less well understood.[1]

This paper exploits the ambitious safe motherhood intervention implemented in Indonesia during the early 1990s to evaluate the effects of the public health intervention on later human capital outcomes: cognition and education. Between 1990 and 1996, over 54,000 nursing school graduates with one year of midwifery training were introduced in most of Indonesia's 68,000 villages. Beyond providing skilled and safe delivery services to mothers, the village midwives

[1]The critical period for height growth is more established as many studies provide evidence that nutritional inputs while in the womb and during the first 2-3 years have long lasting impacts on adult height and therefore adult health (see among others, Barker, 1990; Martorell et. al., 1995; Victora et. al., 2008). Related studies made assumptions that this critical period of age 0 to 2 or 3 (or preschool years) also apply for other aspects of human capital such as cognition and schooling (Alderman et. al., 2006; Maluccio et. al., 2009).

implemented safe motherhood protocols that include providing prenatal, obstetric, postnatal and general primary health care to mothers and their children. Earlier studies find evidence of the impact of the program on the short run health outcomes: improved antenatal care and postnatal care; better height-for-age of young children (aged 1 to 4) as well as improved body mass index of the reproductive age women in the communities (see among others Frankenberg and Thomas, 2001; Frankenberg et. al., 2005, 2009).

This paper adds to the earlier studies on safe motherhood by examining the long run impact of the program on cognition and education. While the IFLS offers a rich set of other outcomes to study, I focus specifically on these two markers of human capital. First, there is a strong biological basis for the linkage between early life health and later cognitive ability. For instance, nutrition studies show that protein energy malnutrition or poor nutrition during the critical years of development results to permanent changes in neural cells in the cerebrum and thus results in later cognitive deficit (Politt and Granoff, 1963; Scrimshaw and Gordon, 1968). Structural magnetic resonance imaging studies of human brain development reveal that the large increase in brain volume during the first two years of life (particularly during the first year) suggests that this is a critical period in which disruption of brain processes may have long-lasting and permanent effects on brain structure and function (Knickmeyer et. al., 2008; Utsonomiya et. al., 1999). While cognitive ability is not widely studied (as few datasets have cognitive measures) recent study notes that more than height, it is cognitive ability that contributes to labor market success (see Case and Paxson, 2008). Besides cognition, I also examine educational attainment. Education is a widely recognized measure of human capital and countless studies have examined the linkage between educational attainment and other outcomes including income, productivity and bargaining power (see Strauss and Thomas (1995) for survey of literature).

Beyond safe motherhood, my findings contribute to the growing literature of longitudinal studies that examine the long run impact of early life health and nutrition on later human capital (see for example Alderman et. al., 2006; Glewwe et. al., 2001; Maluccio et. al., 2009). While the relative advantage of these studies over other studies (i.e., Almond, 2006) in the literature is the availability of rich data on household and community background characteristics that help to address issues of selection, a common limitation is the substantial amount of attrition in their longitudinal surveys.[2] Other limitations include the use of instruments by the two former studies (Alderman et. al., 2006; Glewwe et. al., 2001) which may be correlated with later schooling and health outcomes. The well known INCAP experiment has several other weaknesses including having a small sample size with only four villages and having no pure control group (see Strauss and Thomas (2008) for more detailed discussions).

In this study I use the Indonesian Family Life Survey (IFLS) which is a high quality, long-running longitudinal socio-economic survey of individuals, households and communities. I combine the quasi-experimental nature of the safe motherhood program with the panel dimension of IFLS to carefully examine the long run impacts of the program on outcomes of children at the time when they are continually developing (at ages 11 to 17). This paper finds that the safe motherhood program led to an increase of about 0.28 to 0.45 years of education and 0.15 to 0.36 s.d. of cognitive test scores depending on intensity of exposure of the child to the

[2] For instance, the data used by Alderman et. al. (2006) has around 40% attrition by the 2000 wave when adolescent outcomes were measured while the Cebu Longitudinal and Health Survey data used by Glewwe et. al. (2001) has around 30% attrition when they followed up 8 to 11 years later. The INCAP study also has very high attrition rate with about 25%-30% attrition in 1988-1989, approximately two decades since its inception and about 40% by 2002-2004, approximately more than three decades since its inception.

program. My results are consistent with the findings in the medical literature that environmental influences while in *utero* and during the first two years of life mark the most critical periods that could influence later human capital. In addition, the results seem to suggest that the health and nutritional status of the mother months or years prior to conception may be one of the most important periods that could influence later human capital.

The rest of the paper is organized as follows. Section 2 provides the background on Safe Motherhood Program. Section 3 discusses the data and outcomes. Section 4 presents the econometric strategy and results. Section 5 concludes.

2. Indonesia's Safe Motherhood Program

In this section I briefly review the history and the features of the first comprehensive Safe Motherhood Intervention in Indonesia drawing broadly from World Bank (1991), Frankenberg et. al. (2005), Frankenberg and Thomas (2001) and Sweet et. al. (1995). In 1987, the Safe Motherhood Initiative was launched by United Nations in cooperation with international maternal and child health organizations. The initiative issued a call to action for national governments, funding agencies, and non-governmental organizations (NGOs) to make maternal health an urgent health priority. Thus in 1989, sparked by this global event and by the desire to reduce maternal mortality of 450 deaths per 100,000 live births (based on 1985 Indonesian Household Survey), the Indonesia Ministry of Health (MOH) launched its first comprehensive safe motherhood intervention that aimed to train and deploy a large number of community midwives locally known as *bidan desa* throughout the nonmetropolitan villages in Indonesia. Between 1990 and 1996, over 54,000 nursing school graduates with one year of midwifery training were gradually deployed in most of Indonesia's 68,000 villages with the objective of exponentially increasing women's access to health care and safe delivery services (Sweet et al., 1995, Family Care International, 2005). The Indonesian Family Life Survey (IFLS) data reflects the remarkable expansion of this program. As Figure 1 in Appendix shows, while a little over 5 percent of the IFLS communities have midwives in 1992, this fraction has risen to about 47 percent by 1996 indicating the rapid expansion of the program.

This safe motherhood strategy is based on the principle that the village midwife will act as a 'linchpin' of safe motherhood activities at the community level. Beyond providing access to safe and medically oriented delivery services, the village midwife serves as a health resource person in the community providing antenatal, postnatal and general health care, working with traditional birth attendants and referring complicated obstetric cases to health centers and hospitals. Her duties include promoting community participation in health as well as educating families on family planning, on proper nutrition and other health-promoting behaviors. The village midwife particularly offers a number of services that could affect children's health. This includes provision of curative care and medicines such as antibiotics and cough syrup as well as children's immunizations and vitamins and mineral supplements.

Once assigned to a community, the village midwife is given a salary by the Government of Indonesia for three to six years in the expectation that this will lead to a permanent private practice in the community. She maintains a public practice during normal working hours and is allowed to practice privately after that. Based on the IFLS community level data, on average there are about 1.25 village midwives in the communities that received the program by 1997.

Both Frankenberg and Thomas (2001) and Frankenberg et. al. (2005) illustrate the non-random placement of the program. That is, communities that received the program midwife by 1997 were more likely to have poorer infrastructure and poorer economic and health status. This non-random placement of the program makes the evaluation less straightforward. Thus in later sections I employ a set of robustness and falsification checks to ensure that the outcomes are indeed attributable to the program and not to some other contemporaneous effects driven by the nonrandom allocation of the program.

Safe Motherhood studies in Indonesia

Since the safe motherhood program is primarily motivated by the long standing problem with maternal mortality in Indonesia, many studies examine the effect of the above intervention on maternal health. For instance, studies find that women in communities that received village midwives by the time of their conception were more likely to receive antenatal care, receive iron tablets during their pregnancy and obtain medically oriented delivery (Frankenberg et. al., 2009; Hatt et. al, 2007). In general, the availability of village midwives in the communities also improved the nutritional status of women of reproductive age (Frankenberg, 2001; Setyowati, 2003). Other studies examine the effects of the program on the outcomes of the children in their early life. For example, Shresthra (2007) finds that the introduction of the program led to lower infant mortality while Frankenberg, Suriastini and Thomas (2005) show that program improved the nutritional status of children aged 1 to 4 (as measured by height-for-age).

3. Indonesia Family Life Survey (IFLS)

The data come from the four waves of the Indonesian Family Life Survey (IFLS) conducted in 1993, 1997, 2000 and 2007 (known as IFLS1, IFLS2, IFLS3 and IFLS4, respectively). The IFLS is a large-scale ongoing longitudinal survey that collects information at individual, household, community and facility level. The IFLS began with a sample of 7,224 households and 22,000 individuals in 13 provinces and represents 83% of the Indonesian population. One of the exceptional features of the data set is the high re-contact rate, including among those who relocate. The re-contact rates were high, with 94.4% of IFLS1 households re-contacted in IFLS2, and 95.3% of the original IFLS1 households re-contacted in IFLS3. In IFLS4 (nearly 15 years since IFLS1), 90.6% of the IFLS1, IFLS2 and IFLS3 were re-contacted and 87% of original IFLS1 households. These rates are high compared to other long-running longitudinal surveys in developing countries.[3]

In the analysis I focus on children born to mothers in IFLS1 and IFLS2, in particular those cohorts born between 1983 and 1996 in the original IFLS communities. In addition, I also examine the cohorts born in 1976 to 1982 in a falsification exercise. I match these children to their community of birth based on their mothers' location at the time of their birth. I supplement that information with the individual responses of children who are aged 15 and above by 2007 (born 1983 to 1992) regarding their place of birth. I utilize the detailed information on migration patterns of individuals in IFLS to track these children from the time of their birth and determine when they move and where they move.

Identifying Presence of Village Midwife

In each IFLS wave, the village head and the head of the PKK (Village Women's Group) were asked about the presence of village midwife in each community. In IFLS2, IFLS3 and IFLS4, more detailed information were asked including when the first village midwife arrived in the community, how long has the village midwife been in the community, when the village midwife left the community and how many village midwives are there in the community. The

[3] See Frankenberg and Karoly (1995), Frankenberg and Thomas (2000), Strauss et. al. (2004) and Strauss et. al. (2009) for a full description of IFLS1, IFLS2 and IFLS3 and IFLS4, respectively.

information in these modules is cross-checked against information from the volunteers at the village health post about where women obtain prenatal care and delivery assistance in order to evaluate the consistency of reporting on the village midwife's presence in the community. An index of the presence of midwives in the community and when they arrived is then constructed by combining information from these multiple sources.

Cognitive and Education Outcomes

I examine both the education level completed (in years) and cognition (expressed as z-scores with mean 0 and standard deviation 1 within the sample) of individuals when they are aged 11 to 17. In IFLS3 and IFLS4 survey waves administered the same cognitive test to individuals aged 7-24 to assess general cognitive level using Raven's Colored Progressive Matrices (CPM) questions as well as mathematics skills through a set of mathematics questions. The Raven’s CPM assessment is commonly used in medicine and psychology as a measure of general intelligence, and is accepted as the single best measure of Spearman's general intelligence factor g (Kaplan and Saccuzzo, 1997). This test consists of pattern-matching exercises wherein the respondent is asked to identify the ‘missing piece’ that best match the shown patterns (see an example in Figure 3).

4. Econometric Strategy and Results

The econometric approach exploits variation in the availability and timing of the arrival of the program across communities and cohorts. I estimate two basic specifications: first using a crude measure of exposure to the program and another using a finer exposure measure.

I begin with the simple difference-in-difference framework where I examine the difference in the outcomes of children born during the program expansion (1990 to 1996) and children born prior to the program expansion (1983 to 1989) in the communities that received the safe motherhood program and in the communities that did not receive the program. This suggests estimating the following reduced-form equation:

$$Y_{ijt} = c_1 + \beta(VM_j * EXP1_{it}) + \delta_t + \gamma_j + \theta X_{ijt} + \mu Z_{jt} + \varepsilon_{ijt} \qquad (1)$$

where Y_{ijt} is the outcome of interest of individual i born in community j in year t, VM_j is a dummy indicating the village received a safe motherhood program midwife by 1997, $EXP1_i$ denotes whether the child is *exposed to the program* or born during the program expansion period 1990-1996, δ_t is the cohort of birth fixed effect while γ_j is the community of birth fixed effect. X_{ijt} is some vector of individual and parental characteristics including gender, age at the time of measurement, birth order, mother's and father's education and mother's height. Controlling for parental characteristics is important as this helps to address the issue of selection into fertility when analyzing the effect of early life health shock on later outcomes (Rasmussen, 2001; Brown, 2011). Z_{jt} is a vector of time-varying community characteristics including a composite indicator of positive events (such as construction of new schools, new health facilities, among others), a composite indicator of negative events (such as drought, famine, among others) and the availability of child development services over time across communities.[4] These time-varying community controls helps to address concerns on contemporaneous trends or programs that might be correlated with the allocation of the village midwives in the communities.

[4] A section in the community surveys of IFLS1 and IFLS2 ask the village heads to indicate the important events that occurred in the communities in the last 5 years (for IFLS2) and since 1980 for IFLS1, including information of when the event occurred and how it impacted the welfare of the local population. The questionnaire provides a list of 16 commonly occurring positive events (such as construction of new school, new health facility, new roads, etc.) and negative events (drought, famine, earthquake, crop failure etc.) in the communities. Any other event that is not mentioned is provided by the village head. Also the questionnaire administered to posyandu (community health center) asks question on the availability and timing of provision of child development services in the community.

Since I am examining the outcomes of individuals during the period (age 11 to 17) when they are still developing at the cognitive and behavioral level as well as still attending school, it is crucial to compare *treatment* and *control* individuals whose outcomes were measured at the same age. Thus I exploit the panel dimension of IFLS and in particular the seven years gap between IFLS3 (2000) and IFLS4 (2007) to take into account of age-dependent variation on education level attained and cognition.[5] To examine the effect of the program, I compare the outcomes of the *treatment* cohorts born in 1990 to 1996 (who are aged 11 to 17 in 2007) with the outcomes of *control* cohorts born in the prior years 1983 to 1989 (who are aged 11 to 17 in 2000).

Specification (1) will produce biased estimates of the program impact if the children born 1983 to 1989 are partially exposed to the program during their critical years of development. Research to date indicates that nutrition insults while in utero and during the first three years of life have long-lasting effects to adult well-being (Barker 1990; Martorell, 1995; Maluccio et. al., 2009). As less than 5 percent of the sample have received the program midwife by 1992 and at that time the youngest cohort (1989) is already about three years of age, the estimates may be only slightly underestimated. Nevertheless I supplement the above empirical strategy with another strategy that takes into account of these partial exposures.

As a second empirical strategy, I take advantage of the phased-in deployment of the safe motherhood program in the communities and combine it with the timing of birth of the child to come up with relatively finer exposure measures. I define intensity of exposure of individual i born in community j and year t as function of village midwife's arrival to the community with respect to her year of birth:

[5] Frankenberg et. al. (2005) also exploited the panel dimension of IFLS1 and IFLS2 such that they compare the height-for-age of children aged 1-4 in 1997 with the height-for-age of children aged 1-4 in 1993.

$EXP2_{ijt}$ = birth year – year of village midwife's arrival in community

where $EXP2_{ijt}$ ranges from -13 to +6.[6] The lower bound -13 is based on the difference between the oldest cohort's (1983) birth year and the latest year that the village midwife arrived (1996) in this sample. The upper bound +6 is based on the difference between the youngest cohort's (1996) birth year and the earliest year the village midwife arrived (1990).

I first estimate the following *unrestricted* regression to empirically investigate the critical period for cognitive development:

$$Y_{ijt} = c_1 + \beta_l \sum_{l=-11}^{\geq 2} EXP2_{ijtl} + \delta_t + \gamma_j + \theta X_{ijt} + \mu Z_{jt} + \varepsilon_{ijt} \qquad (2)$$

where $EXP2_{ijtl}$ is a dummy that indicates whether individual i born in community j at year t has l length of exposure to the program. Given the patterns of arrival of the program in the communities there are fewer individuals with exposure to program midwife +3 or more and so I group them altogether under the exposure of +2 or more years (>=2). Individuals with -12 or -13 years of exposure are omitted to form the control group along with children in the communities that have not received the program midwife by 1997.[7] The results of these unrestricted regressions for the outcomes of interest during young adulthood are given in Appendix Table 6. To ensure that my empirical results are not influenced by changes in the composition of the "treatment" and "control" villages induced by the program, I do separate analyses using various sample compositions: using the full sample, then restricting only to those children who did not move out of their village before age 5, and finally, restricting to those children who never moved out of their village at any age.[8] Figure 4 plot the coefficients β_l based on the sample restricted to

[6] A negative number means that the child has already been born when the village midwife arrived while a positive number means that the child has not yet been born when the program midwife arrived.
[7] Using these two exposure measures (-12 and -13) instead of just -13 helps to reduce the impact of cohort effect.
[8] I restricted the sample to those who did not move before age 5 as previously related literature show that nutritional and health inputs during the first 3 years of life or during the pre-school age have important effects on cognition and education (Maluccio et.al., 2009, Alderman et. al., 2006).

children who never moved out of their village. Each dot on the solid line is the coefficient of the intensity of exposure to the safe motherhood program (the broken lines show the 95 percent confidence interval). The coefficients tend to fluctuate near zero until about -3 (child is aged 3 when the village midwife arrived) and start increasing after that. As shown in column 3 of Appendix Table 6, these coefficients are not precisely estimated but using the full sample (column 1) and restricting the sample only to those who did not move out of the village before age 5 (column 2) show that coefficients are significantly different from zero starting -2 or -1. These initial results seem to confirm the results in the medical literature that nutritional and health status while in the womb or during infancy (particularly during the first two years of life) have persistent effects on later outcomes.

I then ran the following restricted regression to further test the restriction that the program should only benefit children who are at most age 3 (following the assumptions used in earlier literature that ages 0 to 3 mark the most critical years for later well-being):

$$Y_{ijt} = c_1 + \beta_l \sum_{l=-3}^{\geq 2} EXP2_{ijtl} + \delta_t + \gamma_j + \theta X_{ijt} + \mu Z_{jt} + \varepsilon_{ijt} \quad (3)$$

In this case the omitted group is comprised of individuals who were approximately aged 4 to 13 when the village midwife came along with the children in the communities who have not received the program by 1997.

4.1 Results

Table 2 reports the results of estimating the impact of the program on cognition and educational attainment of adolescents. Panel A show the estimates for the interaction of being born during the program expansion (1990 to 1996) and the availability of village midwife in the community by 1997. In column 1, the specification controls only for birth year and community of birth fixed effect. The results suggest that the program increased the cognitive test scores of these children by 0.21 standard deviations and that the program increased the educational attainment of the children born during the program expansion by 0.20 years. These coefficients do not change much when other individual and parental controls (in column 2) as well as the time varying community events (in column 3) are included. When I restrict the sample composition to children who did not move before age 5 (column 4), the effect is about the same for cognitive test score while the coefficient for years of education attained slightly decreases to 0.14 years.

In Panel B, I examine the impact of the program by intensity of exposure which is based on the timing of the arrival of village midwife in the community and the timing of child's birth. In both cognitive test scores (columns 1-4) and educational attainment (columns 5-8), the coefficients generally increase as exposure to the village midwife increases. In particular, children who received the village midwife about 2 or more years prior to their birth benefit the most from the program (increasing educational attainment by about 0.45-0.47 years and cognitive test scores by 0.36-0.40 standard deviations (s.d.)). Frankenberg and Thomas (2001) showed earlier that the additions of village midwives to the communities improved the health status (as indicated by increased body mass index) of women of reproductive age. This earlier finding combined with my results seems to suggest that women's health status during the period prior to the conception could also play an important role in shaping child's later outcomes. For cognitive test scores the coefficients are statistically significant until about 2 years after birth. For education level attained, coefficients are statistically significant until about one year after birth. Similar to the results in Panel A, the estimates are robust to the inclusion of other individual, parental and community characteristics as well as to the restriction of the sample to those who did not move before age 5.

To gain more insights on the difference in the pattern of estimates in cognition and education, I examine the impact of the program on the subcomponents of cognitive test, which includes assessments on mathematics (a primary subject studied in schools) and on Raven's CPM (a general measure of intelligence). The cognitive test is comprised of about 80% Raven's CPM test questions and 20% mathematics questions; I examine the test scores for these two components separately in Table 3. Similar to the findings in cognitive test scores in panel A of Table 2, I also find positive effects of the program in both the Mathematics and Raven's CPM test scores based on difference-in-differences specification. As shown in panel B, the coefficients in Mathematics test scores are statistically significant until about 1 year after birth which is similar to the pattern observed in educational attainment. If Mathematics ability is essential to making progress in schooling then this could perhaps explain the pattern of coefficients in educational attainment. On the other hand, Raven's CPM test is a more general measure of one's IQ and is believed to be a measure of educative ability (Maluccio et. al., 2009). As shown in columns 5 to 8 of table 3 in general the pattern shows that the program increases the Raven's test scores for those who received the village midwife until about 2 years after birth although some coefficients are less precisely estimated.

4.2 Robustness and Falsification Checks

To ensure that results are not driven by the unobserved characteristics of the families whose children were born during period 1990 to 1996 in the villages that received the midwife, I use mother fixed effects instead of community fixed effects. In particular, I apply the difference-in-difference approach to a sample restricted to mothers who had at least one child born during the program expansion period (1990 to 1996) and at least one child born in 1983 to 1989. Using the mother fixed effects is equivalent to comparing the outcomes (measured during age 11 to 17) of the individuals born during the program expansion with those of their siblings who are born prior this period. As shown in panel A of Table 4, using mother fixed effects yields about the same positive effects as seen earlier in panel A of Table 2 although the estimate for educational attainment is not statistically significant. In panel B I also apply mother fixed effects in the intensity of exposure estimation, this time restricting the sample to mothers with at least two or more children. As shown in columns 1 to 3 in panel B of Table 4, the estimates for cognitive scores are somewhat similar to the results in panel B of Table 2, although the coefficients for exposures *1 year before birth* and *2 years after birth* are smaller and less precisely estimated. On the other hand, the coefficients for education level attained in columns 4 to 6 show similar patterns as those presented in panel B of Table 4, with slightly bigger coefficients. These results suggest that earlier estimates are not driven by systematic heterogeneity across families.

I also examine the possibility that results could have been influenced by pre-existing trend or that the program might have been placed in those areas that are likely to have increasing trend in education and cognitive test scores even in the absence of the program due to mean reversion. To investigate this I ran the difference-in-differences specification as if the program expansion occurred in 1983 to 1989. In this case, I treat the cohorts born in 1983 to 1989 as the *pseudo-exposed* cohorts and the cohorts born in 1976 to 1982 as the *pseudo-non-exposed* cohorts. For educational attainment, the *pseudo-exposed* cohorts are measured in 2000 when they are aged 11 to 17 while the *pseudo-non-exposed* cohorts are measured in 1993 when they are of same age. For cognition, since there were no cognitive tests administered in 1993, instead of examining the cognitive test scores of these individuals when they are aged 11 to 17, I examine their cognitive test scores when they are aged 18 to 24. This would be a valid exercise as long as the development of these cohorts' cognition follows the same trend over time. In this case, the cognitive test scores of the *pseudo-exposed* cohorts (born 1983 to 1989) are measured in 2007 when they are aged 18 to 24 while the *pseudo-non-exposed* cohorts (born 1976 to 1982) are measured in 2000 when they are about the same age. As shown in panel C of Table 4, the estimates are quite small and non-significant for cognitive test score and educational attainment. Also Figure 4B plots the coefficients for the intensity of exposure to the program in the cognitive test score equation using the unrestricted regression (specification 2) for the cohorts 1976 to 1989.[9] In general, compared to the pattern of coefficients in Figure 4A, the coefficients in Figure 4B tend to fluctuate near zero for all exposure measures. These results seem to suggest that mean reversion is not driving the estimates shown earlier.

4.3 Linkage between Early Life Exposure to Safe Motherhood and Later Educational Attainment

While there's biological basis for the linkage between environmental influences during the earliest childhood years and later cognition, the linkage between environmental influences during early life and later schooling attainment is less intuitive. Thus in table 5, I examine the mechanisms that might be driving the relationship between early life exposure to safe motherhood program and later educational attainment. I consider two possible mechanisms. First, I examine how the program might have impacted the child's age of entry in primary school.[10] Earlier studies show that early child health affects age of school entry and later cognitive and school performance (see Glewwe and Jacoby, 1995; Glewwe, Jacoby and King,

[9] For this falsification test, I construct intensity of exposure measures based on the arrival of the midwife 7 years ago. For example, if the midwife arrived in 1990, it would be coded as 1983 for this exercise.
[10] In Indonesia, children typically enter elementary school at age 6 or 7.

2000; and Alderman et. al., 2001). Thus I examine whether the children who were exposed to the program have greater likelihood of starting school early (by age 6) compared to children who were not exposed to the program. Columns 1 and 2 of Table 5 provide no evidence to this hypothesis. Estimates are positive until about 1 year after birth which is similar to the pattern of estimates in educational level attained but they are not significant. This seems plausible since in the context of Indonesia even malnourished children may enter elementary school on time unless they are too sick to go physically. However the next question is whether such type of children keeps going to school. To get some insights on this, I examine how exposure to program during early life affects the likelihood that children would keep attending school by their teenage years. It could be that children who perform better in school (particularly in difficult subjects such as Mathematics) tend to stay longer in school while those who perform poorly drop out earlier. As shown in the last two columns (columns 3 and 4) of Table 5, while estimates are not significant using the crude difference-in-differences framework, estimates based on the intensity of exposure show positive probabilities until about a year after birth and negative after that. Although estimates are significant only for exposures prior to birth, these pattern of estimates are somewhat similar to that of education level attained and may partly explain the linkage between early life exposure to public health program and later educational attainment.

5. Conclusion

The first comprehensive safe motherhood intervention in Indonesia that allocated over 54,000 midwives in most of nonmetropolitan villages in Indonesia led to an increase in both cognition and educational attainment of individuals at age 11 to 17. On average, the estimates indicate that the program led to an increase of about 0.14 to 0.20 years of education (and 0.19 to

0.21 s.d. of cognitive test scores). These findings are robust to using alternative specification based on intensity of exposures which yield higher estimates (about 0.25 to 0.46 years of education and 0.12 to 0.36 s.d. of cognitive test scores). A number of specification checks as well as robustness and falsification checks support the causal interpretation of these estimates.

These results are consistent with the findings in the medical literature that environmental influences while in *utero* and during the first two years of life mark the most critical periods that could shape later human capital outcomes. In addition, the results also indicate that the mother's health status years prior to conception is also one of the most important periods that could influence later development. This is not surprising as the mother's nutritional status and health behavior prior to conception are likely to be correlated with her nutritional status and health behavior while the child is in utero and even after the child's birth.

This study is one of the very few studies that examined the long run impact of early life public health intervention on later human capital (during adolescence). Examining whether these benefits persist into adulthood and translate into higher productivity will be the subject of future work.

REFERENCES

Alderman, H., Behrman, J.R., Lavy, V. and Menon, R. (2001b). “Child health and school enrollment: a longitudinal analysis”, *Journal of Human Resources* 36(1): 185–205.

Alderman, H., Hoddinott, J. and Kinsey, B. (2006). “Long-term consequences of early childhood malnutrition”, *Oxford Economic Papers* 58(3): 450–74.

Almond, D. (2006). “Is the 1918 Influenza pandemic over? Long-term effects of *in utero* exposure in the post-1940 US population”. Journal of Political Economy 114 (4), 672–712.

Behrman, J. (1996). "The Impact of Health and Nutrition on Education", *World Bank Research Observer,* 11(1):23-37.

Case, A. and C. Paxson (2008). “Stature and Status: Height, ability, and labor market outcomes”, *Journal of Political Economy* 116(3): 499 – 532.

Daniels, M. and L.S. Adair (2005). “Breast-Feeding Influences Cognitive Development in Filipino Children”, *Journal of Nutrition*, 135.11:2589-2595.

Dewey K.G. (2001). “Nutrition, growth, and complementary feeding of the breastfed infant”, *Pediatric Clinics of North America*: 48:87–104.

Dewey K.G., R.J. Cohen, K.H. Brown, L.L.Rivera (2001). “Effects of exclusive breastfeeding for four versus six months on maternal nutritional status and infant motor development: results of two randomized trials in Honduras”, *Journal of Nutrition* 131:262–7.

Frankenberg, E., W. Suriastini and D. Thomas (2005). “Can Expanding Access to Basic Healthcare Improve Children's Health Status? Lessons from Indonesia's 'Midwife in the Village' Program” *Population Studies*, 59(1): 5-19.

Frankenberg, E., and D. Thomas (2001). Women’s health and pregnancy outcomes: Do services make a difference? *Demography,* 38(2): 253-265.

Glewwe, P., Jacoby, H. and King, E.M. (2000). “Early childhood nutrition and academic achievement: a longitudinal analysis”, *Journal of Public Economics* 81(3): 345–68.

Glewwe, P. and King, E.M. (2001). “The impact of early childhood nutrition status on cognitive achievement: does the timing of malnutrition matter?”, *World Bank Economic Review* 15(1): 81–114.

Hull, W., A. Raharto, and B. Setiawan (1998). Village Midwives in Maluku, Policy Paper 1. Jakarta: Center for Population and Manpower Studies, Indonesia Institute of Sciences.

Hull, T.H., R. Rusman, and A.C. Hayes (1998). Village Midwives and the Improvement of Maternal and Infant Health in Nusa Tenggara Timur and Nusa Tenggara Barat. Sydney: Australian Agency for International Development.

Klein, R. E., H. E. Freeman, J. Kagan, C. Yarbrough, and J.P. Habicht. 1972. "Is big smart? The relation of growth to cognition." *Journal of Health and Social Behavior* 13: 219-225.

Knickmeyer, R., S. Gouttard, C. Kang, D. Evans, K. Wilber, J. K. Smith, R. Hamer, W. Lin, G. Gerig, and J. Gilmore (2008). "A Structural MRI Study of Human Brain Development from Birth to 2 Years", *The Journal of Neuroscience* 28(47):12176 –12182.

Kretchmer, Norman, John L. Beard and Susan Carlson. 1996. "The Role of Nutrition in the Development of Normal Cognition." *American Journal of Clinical Nutrition* 63: 997S-1001S.
.
Lynn, R. 1989. "A nutrition theory of the secular increases in intelligence, positive correlation between height, head size and IQ." *British Journal of Educational Psychology* 59: 372-77.

Maluccio, J., J. Hoddinott, J. Behrman, R. Martorell, A. Quisimbing and A.Stein (2009). "The Impact of Improving Nutrition during Early Childhood on Education Among Guatemalan Adults", *The Economic Journal* 119(April): 734-763.

Martorell, R. and G. Arroyave (1988). Malnutrition, work output, and energy needs, in K. J. Collins and Derek F. Roberts (eds.), *Capacity for Work in the Tropics*, Society for the Study of Human Biology Symposium 26. Cambridge: Cambridge University Press, pp. 57-76.

Martorell, R., L. Kettel Khan and D.G. Schroeder. (1994). "Reversibility of Stunting: Epidemiological Findings in Children from Developing Countries." *European Journal of Clinical Nutrition* 48: S45-S57.

Ministry of Health (MoH) (1994). Pedoman pembinaan teknis bidan di desa [Technical manual for village midwives], Report. Jakarta: Directorate General of Community Health, Republic of Indonesia.

Martorell, R., J. Rivera, and H. Kaplowitz. 1990. "Consequences of Stunting in Early Childhood for Adult Body Size in Rural Guatemala." Annales Nestlé 48: 85-92.

Persico, Nicola, Andrew Postlewaite and Dan Silverman. 2004. "The Effect of Adolescent Experience on Labor Market Outcomes: The Case of Height." *Journal of Political Economy* 112 (October): 1019-1053.

Setyowati, M. (2003). "The Role of Village Midwives and Cadres in Improving Nutritional Status of Pregnant Women in Selected Rural Villages in Two Districts, Banten Province Indonesia". Doctoral Thesis, University of Technology, Sydney, Australia.

Stein, Z., M. Susser, G. Saenger, and F. Marolla (1975). *Famine and Human Develop-ment: The Dutch Hunger Winter of 1944-45*. New York: Oxford University Press.

Strauss, J. and D. Thoma (2007). "Health Over Life Course." Handbook of development economics, 4, p. 3375.

Supratikto, G., M.E. Wirth, E. Achadi, S. Cohen and C Ronsmans (2002). A district-based audit of the causes and circumstances of maternal deaths in South Kalimantan, Indonesia. *Bulletin of the World Health Organization*, 80(3).

Taguchi, N., M. Kawabata, M. Maekawa, T. Maruo, Aditiawaman, and L. Dewata (2003). Influence of socioeconomic background and antenatal care programmes on maternal mortality in Surabaya, Indonesia. *Tropical Medicine and International Health*, 2003, 8(9): 847-852.

Utsunomiya H, Takano K, Okazaki M, Mitsudome A (1999) "Development of the temporal lobe in infants and children: analysis by MR-based volumetry", *American Journal of Neuroradiology* 20:717–723.

Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, Sachdev HS. (2008). Maternal and child undernutrition: consequences for adult health and human capital. Lancet 371:340–357.

Table 1. Individual-level Summary Statistics

Variables	Whole sample	By Presence of Midwife: Present by 1997	None by 1997
Cognitive Test Score (%), cohorts 1990-1996	70.34	69.24	71.88
	(19.61)	(19.91)	(19.08)
Cognitive Test Score (%), cohorts 1983-1989	67.18	64.22	71.17
	(22.42)	(22.95)	(21.03)
Math Questions Score (%), cohorts 1990-1996	56.49	55.21	58.27
	(28.38)	(28.56)	(28.04)
Math Questions Score (%), cohorts 1983-1996	57.98	54.72	62.39
	(29.03)	(28.99)	(28.49)
Raven's CPM Questions Score (%), cohorts 1990-1996	77.73	76.77	79.06
	(20.84)	(21.19)	(20.29)
Raven's CPM Questions Score (%), cohorts 1983-1989	72.12	69.31	75.92
	(24.80)	(25.86)	(22.77)
Completed education level (in years), cohorts 1990-1996	7.41	7.28	7.60
	(2.10)	(2.11)	(2.07)
Completed education level (in years), cohorts 1983-1989	6.87	6.59	7.24
	(2.26)	(2.25)	(2.22)
Age of entry in elementary school, cohorts 1990-1996	6.31	6.37	6.24
	(0.69)	(0.69)	(0.69)
Age of entry in elementary school, cohorts 1983-1989	6.53	6.60	6.43
	(0.93)	(0.91)	(0.95)
Still attending school (%), cohorts 1990 - 1996	83.99	80.59	88.74
	(36.68)	(39.56)	(31.62)
Still attending school (%), cohorts 1983 - 1989	80.06	76.46	84.93
	(39.96)	(42.43)	(35.79)
Control Variables (cohorts 1983-1996)			
Age at the time of measurement (in years)	14.16	14.12	14.20
	(2.06)	(2.03)	(2.11)
Male	0.51	0.51	0.52
	(0.50)	(0.50)	(0.50)
Birth order	2.79	2.88	2.68
	(2.00)	(2.05)	(1.93)
Mother's education	5.69	5.07	6.55
	(4.13)	(3.99)	(4.16)
Father's education	6.65	5.95	7.60
	(4.37)	(4.25)	(4.37)
Mother's height	150.38	150.11	150.74
	(5.45)	(5.27)	(5.66)
Observations	6307	3650	2657

Note: Outcomes for cohorts born 1983-1989 are measured in 2000 when they are aged 11 to 17 and outcomes for cohorts born 1990-1996 are measured in 2007 when they are aged 11 to 17. Variable means displayed to the right of variable names. Standard deviations displayed below the mean in parentheses. Sample consists of children of the mothers in IFLS1 and IFLS2; born between 1983 to 1996 in the original IFLS communities.

Table 2.Impact of Safe Motherhood Program on Later Cognitive and Educational Achievement: Coefficients based on Simple Difference-in-Differences Estimation and Intensity of Exposure Estimation

	Cognitive Test Score (z-score)				Education Level Attained (in years)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Difference-in-Difference Specification: For cohorts born 1990 to 1996 or cohorts born 1983 to 1989								
Has Village Midwife by 1997 x Born 1990-1996	0.21***	0.20***	0.19***	0.20***	0.20**	0.17**	0.16**	0.14*
	[0.05]	[0.05]	[0.05]	[0.05]	[0.08]	[0.08]	[0.08]	[0.08]
Panel B. Intensity of Exposure based on timing of village midwife's arrival								
2 or more years before birth [2]	0.36***	0.36***	0.36***	0.40***	0.45***	0.47***	0.46***	0.45***
	[0.08]	[0.08]	[0.08]	[0.08]	[0.13]	[0.13]	[0.13]	[0.14]
1 year before birth [1]	0.19**	0.19**	0.19**	0.21***	0.42***	0.45***	0.43***	0.45***
	[0.08]	[0.08]	[0.08]	[0.08]	[0.13]	[0.13]	[0.13]	[0.14]
At year of birth [0]	0.23***	0.22***	0.22***	0.22***	0.29**	0.28**	0.27**	0.24*
	[0.07]	[0.07]	[0.07]	[0.08]	[0.12]	[0.12]	[0.12]	[0.13]
1 year after birth [-1]	0.15**	0.13*	0.12*	0.13*	0.28**	0.25**	0.24**	0.26**
	[0.07]	[0.07]	[0.07]	[0.07]	[0.12]	[0.11]	[0.11]	[0.12]
2 years after birth [-2]	0.15**	0.16**	0.16**	0.16**	0.03	0.07	0.07	0.03
	[0.07]	[0.07]	[0.07]	[0.07]	[0.12]	[0.11]	[0.11]	[0.12]
3 years after birth [-3]	0.03	0.02	0.03	0.02	-0.01	-0.03	-0.03	-0.06
	[0.07]	[0.07]	[0.07]	[0.07]	[0.12]	[0.11]	[0.11]	[0.11]
Controls:								
birth year and community fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
individual and parental characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes
time-varying community characteristics	No	No	Yes	Yes	No	No	Yes	Yes
Sample Composition:								
whole sample	Yes	Yes	Yes	No	Yes	Yes	Yes	No
sample restricted to those who did not move out of the village before age 5	No	No	No	Yes	No	No	No	Yes
Observations	6307	6307	6307	5903	6307	6307	6307	5903

Note: Raw Cognitive test score standardized within the sample. Individual and parental characteristics include mother's and father's education, mother's height, birth order, age at the time of measurement and sex. Time-varying community characteristics include a composite indicator of positive events (i.e., building a new school, a new road, etc.), a composite indicator of negative shocks (i.e., natural disasters such as drought, earthquake, etc.), and the timing of the availability of child development services in the communities over the period 1983 to 1996. Standard errors adjusted for clustering at the community level in brackets.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3.Impact of Safe Motherhood Program on the Mathematics and Raven's CPM Test Questions' Scores: Coefficients based on Simple Difference-in-Differences Estimation and Intensity of Exposure Estimation

	Mathematics Questions Score (z-score)				Raven's CPM Questions Score (z-score)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A.Difference-in-Difference Specification: For cohorts born 1990 to 1996 or cohorts born 1983 to 1989								
Has Village Midwife by 1997 x Born 1990-1996	0.17***	0.16***	0.16***	0.16***	0.18***	0.17***	0.17***	0.17***
	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]
Panel B. Intensity of Exposure based on timing of village midwife's arrival								
2 or more years before birth [2]	0.31***	0.32***	0.31***	0.34***	0.30***	0.29***	0.29***	0.33***
	[0.08]	[0.08]	[0.08]	[0.08]	[0.08]	[0.08]	[0.08]	[0.08]
1 year before birth [1]	0.21***	0.23***	0.22***	0.26***	0.13*	0.13*	0.13	0.15*
	[0.08]	[0.08]	[0.08]	[0.08]	[0.08]	[0.08]	[0.08]	[0.08]
At year of birth [0]	0.19***	0.19***	0.19***	0.16**	0.20***	0.18**	0.18**	0.20***
	[0.07]	[0.07]	[0.07]	[0.08]	[0.07]	[0.07]	[0.07]	[0.08]
1 year after birth [-1]	0.15**	0.14**	0.14**	0.15**	0.12*	0.09	0.09	0.09
	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]
2 years after birth [-2]	0.02	0.04	0.04	0.03	0.20***	0.21***	0.20***	0.21***
	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]
3 years after birth [-3]	0.03	0.02	0.03	0.02	0.03	0.01	0.02	0.02
	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]
Controls:								
birth year and community fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
individual and parental characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes
time-varying community characteristics	No	No	Yes	Yes	No	No	Yes	Yes
Sample Composition:								
whole sample	Yes	Yes	Yes	No	Yes	Yes	Yes	No
sample restricted to those who did not move out of the village before age 5	No	No	No	Yes	No	No	No	Yes
Observations	6307	6307	6307	5903	6307	6307	6307	5903

Note: Raw Mathematics questions' score and Raven's CPM questions' score standardized within the sample. Individual and parental characteristics include mother's and father's education, mother's height, birth order, age at the time of measurement and sex. Time-varying community characteristics include a composite indicator of positive events (i.e., building a new school, a new road, etc.), a composite indicator of negative shocks (i.e., natural disasters such as drought, earthquake, etc.), and the timing of the availability of child development services in the communities over the period 1983 to 1996. Standard errors adjusted for clustering at the community level in brackets.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4. Robustness Check Using Mother Fixed Effects and Falsification Check Using Older Cohorts

	Cognitive Test Score (z-score)			Education Level Attained (years)		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Difference-in-difference specification using mother fixed effects						
(cohorts born 1990 to 1996 or cohorts born 1983 to 1989)						
Has Village Midwife by 1997 x Born 1990-1996	0.16**	0.16***	0.17***	0.14	0.14	0.16
	[0.08]	[0.06]	[0.06]	[0.13]	[0.13]	[0.14]
Observations	3446	3446	3446	3446	3446	3446
Panel B. Intensity of Exposure based on timing of village midwife's arrival using mother fixed effects						
(cohorts born 1990 to 1996 or cohorts born 1983 to 1989)						
2 or more years before birth [2]	0.41***	0.40***	0.39***	0.51***	0.54***	0.53***
	[0.10]	[0.10]	[0.10]	[0.18]	[0.18]	[0.18]
1 year before birth [1]	0.10	0.09	0.08	0.47***	0.50***	0.49***
	[0.10]	[0.10]	[0.10]	[0.18]	[0.18]	[0.18]
At year of birth [0]	0.28***	0.28***	0.27***	0.29*	0.31*	0.30*
	[0.09]	[0.09]	[0.09]	[0.17]	[0.17]	[0.17]
1 year after birth [-1]	0.20**	0.20**	0.20**	0.29*	0.30**	0.30**
	[0.08]	[0.08]	[0.08]	[0.15]	[0.15]	[0.15]
2 years after birth [-2]	0.11	0.11	0.11	-0.02	0	0.01
	[0.08]	[0.08]	[0.08]	[0.15]	[0.14]	[0.14]
3 years after birth [-3]	-0.09	-0.09	-0.08	-0.1	-0.11	-0.1
	[0.08]	[0.08]	[0.08]	[0.14]	[0.14]	[0.14]
Observations	5071	5071	5071	5071	5071	5071
Panel C. Falsification Test (cohorts born 1983 to 1989	*Age 18 to 24*			*Age 11 to 17*		
or *cohorts born 1976 to 1982)*						
Has Village Midwife by 1997 x Born 1983-1989	0.06	0.06	0.06	0.02	0.04	0.05
	[0.06]	[0.05]	[0.06]	[0.11]	[0.10]	[0.10]
Observations	4873	4873	4873	4591	4591	4591
Controls:						
birth year and community fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
individual and parental characteristics	No	Yes	Yes	No	Yes	Yes
time-varying community characteristics	No	No	Yes	No	No	Yes

Note: All results are based on full sample. For panel A, specifications exclude parental level characteristics. Individual and parental characteristic include mother's and father's education, mother's height, birth order, age at the time of measurement and sex. Time-varying community characteristics include a composite indicator of positive events (i.e., building a new school, a new road, etc.), a composite indicator of negative shocks (i.e., natural disasters such as drought, earthquake, etc.), and the timing of the availability of child development services in the communities over the period 1983 to 1996. Standard errors adjusted for clustering at the community level in brackets.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5. Examining the Mechanisms for Educational Attainment: Impact of Safe Motherhood Program on Age of Entry in Elementary School and School Attendance (at the time of interview)

	Whether Entered Elementary School by Age 6 (%)		Whether still attending school (%)	
	(1)	(2)	(3)	(4)
Panel A. Difference-in-Difference Specification: For cohorts born 1990 to 1996 or cohorts born 1983 to 1989				
Has Village Midwife by 1997 x Born 1990-1996	2.55	1.68	0.58	0.57
	[2.43]	[2.54]	[1.76]	[1.91]
Panel B. Intensity of Exposure based on timing of village midwife's arrival				
2 or more years before birth [2]	4.41	4.39	11.06***	11.24***
	[3.96]	[4.22]	[2.87]	[3.33]
1 year before birth [1]	2.61	0.66	5.91**	8.53***
	[4.02]	[4.27]	[2.91]	[3.29]
At year of birth [0]	2.06	2.16	2.43	2.62
	[3.73]	[3.96]	[2.70]	[3.01]
1 year after birth [-1]	1.78	1.26	2.56	3.54
	[3.53]	[3.68]	[2.56]	[2.75]
2 years after birth [-2]	-4.03	-4.47	-1.06	-1.14
	[3.44]	[3.59]	[2.50]	[2.68]
3 years after birth [-3]	-3.26	-3.91	-1.26	-0.44
	[3.46]	[3.54]	[2.52]	[2.62]
Whole sample	Yes	No	Yes	No
Sample include those who did not move out of village before age 5	No	Yes	No	Yes
Observations	6202	5800	6307	5903

Note: Outcomes are estimated using linear probability model. All specifications include community of birth fixed effects, year of birth fixed effects, mother's education, father's education, mother's height , birth order, age at the time of measurement, sex and time varying community characteristics. Standard errors adjusted for clustering at the community level in brackets.
* significant at 10%; ** significant at 5%; *** significant at 1%

APPENDIX

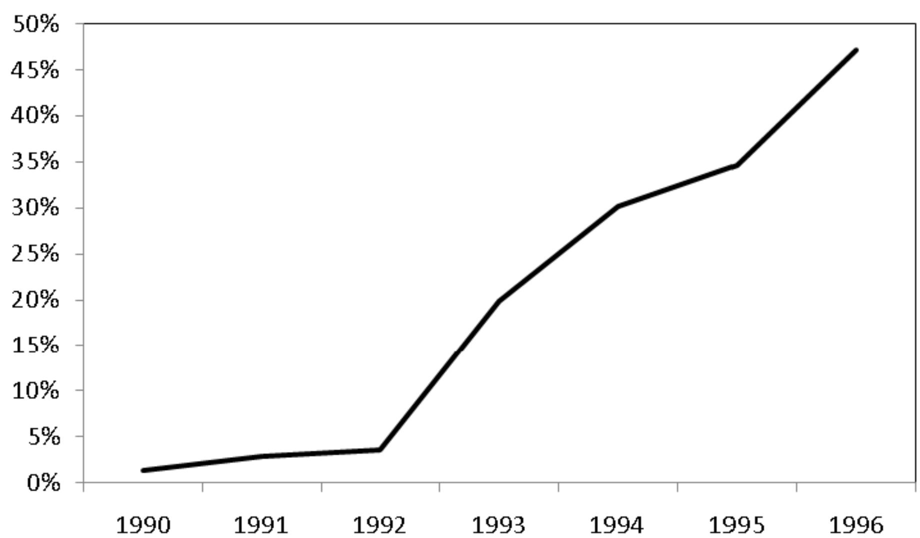
Table 6. Unrestricted Estimates of the Impact of Safe Motherhood Program on Cognitive Test Scores

Intensity of Exposure based on timing of village midwife's arrival	For cohorts born 1990 to 1996 or cohorts born 1983 to 1989			Falsification: cohorts born 1983 to 1989 or cohorts bon 1976 to 1982	
	(1)	(2)	(3)	(4)	(5)
2 or more years before birth [2]	0.45***	0.54***	0.35**	0.07	0.07
	[0.13]	[0.14]	[0.15]	[0.09]	[0.14]
1 year before birth [1]	0.35***	0.38***	0.18	0.09	0.08
	[0.13]	[0.13]	[0.15]	[0.10]	[0.15]
At year of birth [0]	0.32***	0.37***	0.2	0.08	0.03
	[0.12]	[0.13]	[0.14]	[0.16]	[0.16]
1 year after birth [-1]	0.27**	0.29**	0.17	0.08	0.02
	[0.12]	[0.12]	[0.14]	[0.16]	[0.16]
2 years after birth [-2]	0.17	0.29**	0.11	0.01	-0.05
	[0.12]	[0.12]	[0.14]	[0.15]	[0.15]
3 years after birth [-3]	0.16	0.17	0.00	0.15	0.08
	[0.12]	[0.12]	[0.14]	[0.15]	[0.16]
4 years after birth [-4]	0.15	0.18	0.07	0.09	0.05
	[0.12]	[0.12]	[0.13]	[0.15]	[0.16]
5 years after birth [-5]	0.2	0.19	0.08	-0.04	-0.08
	[0.13]	[0.12]	[0.13]	[0.15]	[0.16]
6 years after birth [-6]	0.14	0.18	0.03	0.01	-0.02
	[0.11]	[0.12]	[0.13]	[0.15]	[0.15]
7 years after birth [-7]	0.1	0.08	-0.06	-0.05	-0.09
	[0.11]	[0.12]	[0.12]	[0.15]	[0.15]
8 years after birth [-8]	0.07	0.11	-0.02	0.05	0.02
	[0.11]	[0.12]	[0.12]	[0.15]	[0.16]
9 year after birth [-9]	0.09	0.18	0.06	0.00	-0.03
	[0.11]	[0.11]	[0.12]	[0.15]	[0.15]
10 years after birth [-10]	0.13	0.11	0.02	0.06	0.00
	[0.11]	[0.11]	[0.11]	[0.15]	[0.15]
11 years after birth [-11]	0.07	0.17	0.08	0.17	0.10
	[0.12]	[0.12]	[0.12]	[0.17]	[0.17]
Sample Composition:					
whole sample	Yes	No	No	Yes	No
sample restricted to those who did not move out of the village before age 5	No	Yes	No		
sample restricted to those who never moved	No	No	Yes	No	Yes
Observations	6307	5903	4696	4873	4551

Note: All specifications include community of birth fixed effects, year of birth fixed effects, mother's and father's education, mother's height, birth order, age at the time of measurement, sex and time-varying community characteristics. Standard errors adjusted for clustering at the community level in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%

FIGURES

Figure 1 . Expansion of the Safe Motherhood Program over the period 1990 to 1996



Source: Indonesian Family Life Survey

Figure 2. Raven's CPM Sample Exercise

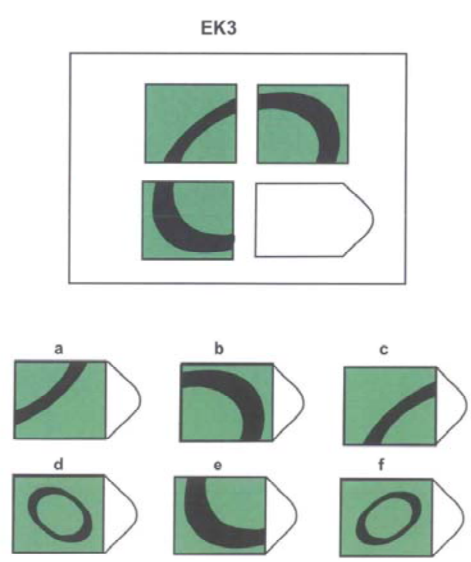
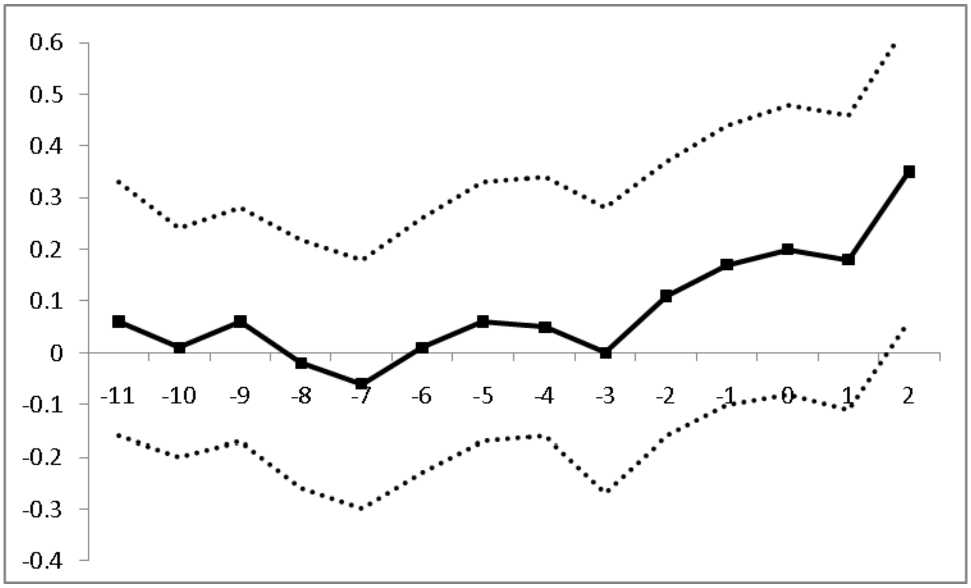
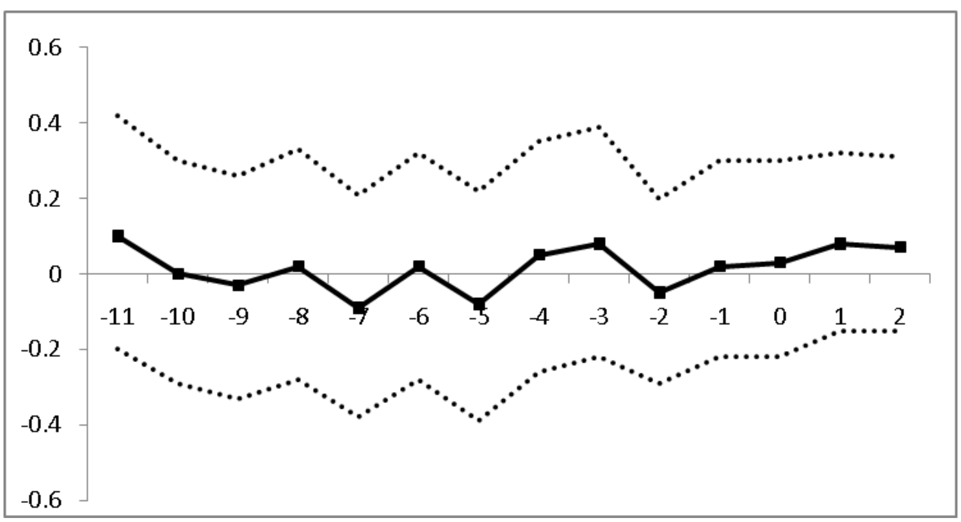


Figure 4A. Coefficients of the Intensity of Exposure to Safe Motherhood Program in the Cognitive Test Score Equation (Cohorts born 1983 to 1996)



Note: Plotted using sample restricted to never movers. The x-axis corresponds to intensity of exposure, where exposure = birth year – year of village midwife's arrival in community j. For example, -11 means the midwife arrived when the child is approximately 11 years old.

Figure 4B. Falsification Test: Coefficients of the Intensity of Exposure to Safe Motherhood Program in the Cognitive Test Score Equation (Cohorts born 1976 to 1989)



Note: Plotted using sample restricted to never movers. The x-axis corresponds to intensity of exposure, where exposure = birth year – year of village midwife's arrival in community j (7 years ago). For example, -11 means the midwife arrived when the child is approximately 11 years old.