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The Unintended Consequences of the Village Midwife Program in Indonesia *

Md Nazmul Ahsan[†]
Univ. of Southern California

Riddhi Bhowmick[‡]
Univ. of Southern California

PRELIMINARY

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Abstract

Evidence from epidemiological literature suggests that male fetuses are more susceptible to changes in maternal health and nutritional status than female fetuses. In 1989, Indonesian government initiated the Village Midwife Program which has improved the nutritional status of reproductive age women. Using all four waves of the Indonesian Family Life Survey (IFLS) and a difference-in-difference strategy, we find that the provision of a midwife in a community increases the probability of a male birth by 4 percentage points. These results are mostly driven by mothers with at most primary education. We also find that provision of midwives leads to decrease in birth weight for male children while no change is observed for female children. These two results together imply that positive nutrition shock may lead to increase in survival of poor quality fetuses. Thus a policy that improves maternal health can have negative consequences for future human capital formation and can also make gender-reversal possible. Our findings underscore the importance of accounting for selection into live births to examine the impact of *in utero* shocks on later life outcomes.

Keywords: selection, gender, health, human capital, endowments

JEL Classifications: I15, I18, C52, J13, J15

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[†]University of Southern California, Department of Economics, 3620 South Vermont Avenue, KAP 300. Email: mdnazmua@usc.edu.

[‡]University of Southern California, Department of Economics, 3620 South Vermont Avenue, KAP 300. Email: rbhowm@gmail.com.

1 Introduction

It is well documented that *in utero* environment and nutrition have important implications for human and health capital formation of an individual (see Almond and Currie (2011) for a review). Exogenous environmental and nutritional shocks to mothers are used as identification strategies to get the relevant causal estimates. However, less is known if the composition of the quality of children changes at birth because of selection in live birth, due to those shocks[1]. This issue is of interest on its own because of two reasons. Firstly, this has direct implications on human capital formation due to *in utero* shocks. Secondly, this also has serious implications for behavioral models which examine parental response to *in utero* shocks. Economists are long interested in whether the investment decision by parents are compensatory or complementary to such shocks (Almond and Mazumder, 2013). If changes in quality of children at birth occur due to these shocks, it would imply that selection in live birth due to these shocks should be directly incorporated in the associated empirical modeling exercise.

There is a substantial biological, medical and epidemiological literature which find strong associations between maternal health (both short and long term nutritional status) and pregnancy outcomes[2]. Eriksson et al. (2010) point out that maternal health and nutrition matter more for male than female births. Given the weight of placenta, the authors argue, boys tend to be bigger at birth than girls. As a result, the boy's placentas are more efficient but may have less reserve capacity. In situations of environmental stress, this confers girls a pre-birth survival advantage.

However, there are not too many quality causal studies in developing countries, which directly link maternal nutritional status to fetal health quality. In this paper, we try to provide one of the first causal estimates of the same. For this purpose, we consider the Indonesian Midwife (*Bidan Desa*) program which was introduced in the late eighties to improve the high maternal mortality rates in Indonesia. It is specifically aimed at improving the health of women of reproductive age. Using a difference in difference strategy, Frankenberg and Thomas (2001) show that the program

[1]The quality of children at birth can be thought as their birth endowments. Studies mostly consider birth endowment as uni dimensional and take birth weight as a key measure (Almond and Mazumder, 2013). Ahsan and Bhowmick (2015) discuss some other measures of birth endowments to be birth size as well as gender of the child.

[2]These outcomes include live birth, miscarriage, still birth, gestational age and ectopic pregnancy.

was successful in increasing the BMI (body mass index) of the women of reproductive age, especially for women who had lower initial BMI[3]. Further, they calculate the estimated positive impact of gaining a village midwife on birth weight to be 80 grams.

The novelty of this paper is that it tests the epidemiological insight on male fragility *in utero* with the help of the provision of a Village Midwife Program. More specifically, we calculate the causal effects of *Bidan Desa* on the likelihood of male births, along with other birth outcomes of male children relative to female children by using the timing of the midwife placement in the community as our identification strategy[4]. Using a difference-in-difference strategy, and all four waves of the Indonesian Family Life Surveys (IFLS), we document three main results. Firstly, we find that placement of a midwife in a community leads to an increase in likelihood of a male birth by 4 percentage points at any birth order. The results are even stronger for first order births. Secondly, the increase in male births due to midwife program is more pronounced among mothers who have lower education. Thirdly, midwife program placement is associated with lower birth weight for male children but not for female children. We do not find any fertility selection or any change in gender-specific reporting bias due to midwife program. Thus, the effect of midwife program placement on male births and birth outcomes can be regarded as causal. Based on these three results, we conclude that *in utero* shocks may not have same the effect across the socio-economic status and may alter the composition of quality of children born.

The current paper makes some key contributions to a number of literature. Firstly, this paper makes a basic methodological contribution in early life studies of developing countries[5]. In order to describe underlying mechanisms linking *in utero* shocks and later life outcomes, many studies implicitly assume a monotonic relationship between these shocks and birth endowments without formally testing them[6]. Our results underscore the foremost need to account for selection into live birth before interpreting the associations as causal, especially for better understanding the eco-

[3]It should be noted that BMI is a non-linear measure of health status. An increase in BMI for those who have low BMI implies an improvement in health status.

[4]We only consider "reduced form" effect because the program may have spill over effect on other family members including adult males (see Frankenberg and Thomas (2001).

[5]In the context of the US, selection into live birth may account for a large proportion of the observed association between offspring sex and divorce which was earlier thought to be due to son preference (Hamoudi and Nobles, 2014).

[6]The reader may refer to the studies by Maccini and Yang (2009), Shah and Steinberg (2013) etc.

nomics of human capital formation. Our recommendations are in line with similar studies in the literature on developed countries that the empirical economic modeling has to integrate evidence and techniques from other fields like reproductive biology, sampling design, demography and the like.

Secondly, our findings also contribute to the literature of gender discrimination. Under the assumption that sex of the child is random at birth, the mean difference in outcome between boys and girls can be attributed to gender discrimination (Hamoudi and Nobles, 2014; Schultz, 2007; Rosenblum, 2013). For such studies, researchers typically rely on important, yet untested assumptions about dynamics of selection into live birth to draw inferences about gender dynamics from the gender/outcome associations (Hamoudi and Nobles, 2014). The results in our paper add to the growing evidence that sex of the off-spring at birth is not random, especially in developing countries where socio-economic background can affect the sex specific survival rates of the fetus during gestation (Ahsan and Bhowmick, 2015). Moreover, likelihood of male child being positively associated with maternal nutritional status implies the estimate of mean difference in say, child investments between boys and girls may have a bias. In the absence of son preference, if parents compensate for poor birth endowments, then our results imply the direction of bias will be positive. There is another interesting (and paradoxical) implication of our finding that more male children are born to less-educated mothers due to the Village Midwife Program. Since son preference is not strong in Indonesia, this may imply "gender-reversal" in human capital formation in future as there is ample evidence showing inter generational transmission of the same[7]. In fact, gender reversal may simply happen if parents try to reinforce birth endowments. Since sons are born with poor birth endowments (as measured by birth weight), parents may invest less in them in absence of any son preference. This is a serious possibility as most of the recent studies on parental response to birth endowments find parents to engage in a reinforcing behavior (see Almond and Mazumder (2013) for a review).

Lastly, this study provides evidence on how a well-intended health intervention for mothers may entail adverse health outcomes for the off-springs. One usually expects betterment in mater-

[7]See the studies by Bhalotra and Rawlings (2013, 2011) and the literature cited there.

nal health will help improve child health in all dimensions. Almond et al. (2011) raise the possibility of a paradoxical situation. They argue the composition of births could change as a result of the same forces which improve fetal health. Because of improved *in utero* environment, marginal fetuses have improved survival chances and thus, will have negative compositional consequences on different birth outcomes (in our case, birthweight for male children). This could bias downward the estimated effects of any such program which improves maternal health on a variety of fetal quality measures. To our knowledge, we are the first to report such unintended consequences of any maternal health intervention program. We hypothesize such perverse consequences should be more common in developing countries as there are fewer coping mechanisms for smoothing fertility and health behavior, as compared to developed countries [8].

The rest of the paper is organized as follows. Section 2 gives a background on the Village Midwife Program in Indonesia. Section 3 provides a literature review. Section 4 discusses the survey data and measurements we use. Section 5 sets out the empirical strategy. Section 6 discusses the results. Section 7 is concluding discussion.

2 Village Midwife Program in Indonesia

The primary objective behind introduction of the Village Midwife Program in the late 80s, as stated by Indonesian Ministry of Health (DepKes), was to improve maternal health with a special emphasis on reducing maternal mortality in rural areas (Frankenberg and Thomas, 2001). According to a World Bank report, the initiative expanded rapidly throughout Indonesia, from nearly 5,000 workers in 1987 to 80,000 in 2009 (Weaver et al., 2013). Weaver et al. (2013) report the percentage of IFLS communities with a village midwife increased from 9.6 to 46.3 percent between 1993 and 1997 which rose to around 60 percent in 2007. At the beginning, village midwives were typically recruited from nursing programs and received one additional year of training on midwifery. Later this was changed to require that village midwives attend a three-year midwifery academy. The village midwives were largely in their early twenties and single at the entry level and were usually placed in their province of origin. Initially midwives practices were stationed at village delivery post; home

[8]Indeed, a number of studies on developed countries which looked for such paradoxical program impacts of *in utero* exogenous shocks, did not find any (Almond et al., 2011, 2009)

of the village leader acted as the delivery post if no such station existed in the village (Weaver et al., 2013). After assignment to a community, village midwives were guaranteed a government salary for at least three years. They should engage in public practice during normal working hours, while they can have a private practice after hours. The goal was to help the midwives sustain their practice without a government salary, once the government contract ends (Frankenberg and Thomas, 2001).

The primary goals of a village midwife include affecting reproductive health of women by providing a variety of health and family planning services. She should work with traditional birth attendants, and act as a link to formal health care delivery systems (eg by referring complicated obstetric cases to health centers and hospitals). Unlike the formal health delivery systems, a midwife should pro-actively seek out for patients and visit their homes. As is evident from a number of studies, she acts as a general health resource in a community - advising different health promoting behaviors including sanitation and nutrition, dispensing medications, immunizations, well-child care, and a variety of acutecare services such as sick-patient visits, the administering of antibiotics, and attending to wounds etc (Frankenberg and Thomas, 2001; Weaver et al., 2013).

3 Literature Review

A number of studies examine the impact of Village Midwife Program on a variety of health outcomes. Frankenberg and Thomas (2001) find communities receiving village midwives between 1993 and 1997 are associated with a significant increase in body mass index in 1997 relative to 1993 for women of reproductive age. Other successes include higher usage of antenatal care during first trimester of pregnancy among women with lower levels of education, increases in receipt of iron tablets and less reliance on traditional birth attendants for birth delivery (Frankenberg et al., 2009), increased usage of injectable contraceptives while decreased incidence of oral contraceptive and implant use (Weaver et al., 2013). Children exposed to the program were also benefited in terms of better nutrition status (as measured by height for age) (Frankenberg et al., 2005).

The literature on effects of maternal health intervention programs on sex ratio (as measured by number of males per 100 females) is scant, especially in developing countries. In particular, we are not aware of any such study on Village Midwife Program. But in general, there is ample evidence from epidemiological studies provide which show exogenous variations of maternal conditions can impact the likelihood of a male birth. In particular, these studies have focused on the impacts of intrauterine nutrition on sex ratio (as measured by number of males per 100 females) along with other infant and adult outcomes. For instance, Song (2012) finds evidence in favor of adaptive sex ratio hypothesis for Chinese Great Leap Forward Famine. Some other studies which find positive evidence include (Fukuda et al., 1998) for earthquake in Japan, Zorn et al (2002) for war in Slovenia, Catalano et al (2006) for terrorist attack, Sanders and Stoecker (2015) for air pollution, Williams and Gloster (1992) for food availability, Shifotoka and Fogarty (2012) for prevalences of HIV and tuberculosis etc.

However, the impact of maternal health interventions on birth weight and infant mortality is somewhat, better examined. For the Village Midwife Program, Frankenberg and Thomas (2001) find birthweights are greater in communities after introduction of midwives than before. In the context of developed countries, there are a number of studies in medicine and economics which examine impacts of different kinds of interventions on birth weight and neonatal mortality. For instance, Almond et al. (2011) find pregnancies exposed to Food Stamp Program in US three months prior to birth yielded deliveries with increased birth weight, with the largest gains at the lowest birth weights. Pollution and temperature are also found to affect these outcomes. Currie et al. (2009) find a one unit change in mean carbon monoxide during the last trimester of pregnancy increases the risk of low birth weight by 8 percent, and a one unit change in mean carbon monoxide during the first two weeks after birth also increases the risk of infant mortality by 2.5 percent relative to baseline levels. Similarly, Deschênes et al. (2009) report exposure to extreme temperature *in utero* associated with lower birth weight, especially in 2nd and 3rd gestational trimesters. Both of these studies are based on the US. There is also a growing literature which find similar evidence from a number of developing countries (Burgess et al., 2013; Arceo et al., 2015).

In spirit, our study is closest to the study by Hernández-Julián et al. (2014). Using the Bangladesh famine of 1974 as a natural expeiment, they find women who were pregnant during the famine were less likely to have male children and children exposed *in utero* to the most severe period of the famine were more likely to die as a neonate. Conditional on being a live birth, the male children are also more likely to die as a neonate if exposed to famine *in utero*. We complement this study by focusing on a specific positive intervention on maternal health, viz. provision of midwives.

4 Data and Measurements

We use all four waves of the Indonesian Family Life Survey (IFLS) which were conducted in 1993, 1997, 2000 and 2007 respectively. At the time of the first survey 1993–94, the sample drawn was representative of 83% of the population residing in 13 out of 27 provinces in Indonesia. Within each of these 13 provinces, the enumeration areas (EA) were randomly selected for inclusion in the final survey. In the first wave, 7,224 households were interviewed and detailed individual level information were collected, including the age and education of the household members. The later waves sought to follow up on the same household and the re-contact rates of households from first wave were 94.4%, 95.1% and 93.6% in the second, third and fourth waves respectively.

For the purpose of this study, we use data from two sources in the survey: 1) the pregnancy histories of the women of reproductive age which include information on birth date, birth outcome, gender of the child, age of the mother, birth weight report, child alive or not, if not alive–age of death, birth weight of each of the births the women ever had 2) community level information on various community level infrastructures as well as information about midwife from the village head. The placement-time information of the midwife is only available from the second wave of the IFLS.

One limitation of the data is that the placement-time information of the midwife is only available for communities which were randomly selected in the first wave[9]. The attrition of the households due to migration could be a concern, as Thomas et al. (2012) show that the migrants could be different from non-migrants in terms of observable characteristics. However, Weaver et al. (2013) argue that conditional on select individual and community characteristics, the receipt of the mid-

[9]312 communities/enumeration areas were randomly selected for the first wave of the IFLS. However, some of the sampled households and respondents later moved to other communities.

wife of a community is not significantly related to woman's migration out of the study communities or loss to follow up over study period. We discuss more about this issue in the empirical strategy.

The main analysis of this study is based on the birth sample obtained from last five year pregnancy histories of the ever married women in the sampled households. If the follow up wave took place within five year, we restrict the pregnancy history up to the last wave year to avoid double counting. Since the fourth wave took place 7 years after the third wave, we also separately consider birth sample obtained from last seven years for continuity. Table 1 presents the summary information of the birth sample for pregnancy histories restricted up to last five years. It shows that about 51 percentage of all the live births is male. The women in the sample on an average has more than primary education, as the mean years of education is 6.64. The mean age at birth is 31 years. The mean birth weight is 3,163 grams. The birth weight information is not available for all the births, which is another limitation of the data.

5 Empirical Strategy

The empirical strategy section is divided in two subsections. The first subsection describes the empirical challenges, and the second subsection describes the empirical framework for analyzing the impact of the midwife program on probability of a male birth, and birth weights by gender.

5.1 Empirical Challenges

Endogenous Program Placement— Evaluation of health or for that matter, any intervention is often complicated, as the outcomes of interest are affected by the characteristics of individuals, households and communities. The government may target a set of population where the program is likely to be most successful, or on a set of population which is badly in need of such programs. Under these circumstances, an evaluation of a government initiated program is complex—as the programs are not randomly allocated.

As discussed earlier, the midwife program was initiated to lower the rate of maternal mortality. Therefore, the placement of the program could depend on the community level observable and unobservable characteristics. In fact, Frankenberg and Thomas (2001) show a communitys levels of poverty and remoteness influenced whether it received a village midwife. For causal identification of the effect of midwife program, we exploit the variation in timing of the midwife program and include community fixed effects in all regression equations. The application of community fixed effects absorbs the community specific observable as well as unboservable characteristics. On the other hand, the timing variation allows us to compare the outcomes of interest for the same community before and after the program.

Selective fertility, Migration and Mortality Attrition— One concern in evaluating the impact of a health intervention program on pregnancy outcomes is that the health intervention may affect fertility selection. Frankenberg and Thomas (2001) show that midwife also provided contraceptives to reproductive age women. Moreover, they may also provide suggestions regarding family size or birth timing. Therefore, it is necessary to examine whether the placement of the midwife program has changed the observed parental characteristics of the birth sample or changed the parental fertility behavior.

As far as migration is concerned, calculating program effects is difficult even in a randomized control design study if the migration pattern differs between the treatment and control groups. In our set up also, the migration pattern between areas with midwife and areas without a midwife can differ. However, Weaver et al. (2013) do not find any significant association between migration and midwife placement after controlling for individual and other community level observables.

Another important concern is that the provision of a midwife program may affect the maternal mortality rate in the program communities. Recall that the pregnancy outcomes are obtained from the pregnancy histories of women respondents of the sampled households, only if the women are alive during the survey year. If the provision of a midwife affects the mortality rates of women differently for different socio-economic characteristics (SES), the observed parental characteristics of the birth sample will change. It is important to point out that mortality is an extreme event[10].

[10]Based on several studies, Frankenberg and Thomas (2001) document that Indonesia experienced 390 to 650 maternal deaths per 100,000 live births in early '90s.

Therefore, it is unlikely that provision of a midwife program has substantially altered the composition of parental characteristics due to maternal mortality attrition. Moreover, the subsequent waves of the IFLS were conducted in short intervals. The use of short recall period of pregnancy histories reduces any concern that provision of a midwife may have affected the parental characteristics of the observed birth sample in the program areas.

To examine whether parental characteristics of the birth sample have changed due to the provision of a midwife, we analyze the following variables with the program placement: maternal years of education, mother age at birth, and number of total live births. There is a large literature which documents better educated and healthier mothers tend to have healthier children (Rosenzweig and Schultz, 1982; Thomas et al., 1990, 1991; Ahsan and Bhowmick, 2015). If such mothers are more likely to give birth after the provision of a midwife in their communities, we may observe an increase in the probability of a male birth only because of the composition of mothers while the program had no real health effect on mothers [11]. We examine this possibility by looking at mother education in this paper. Similarly, change in age at birth may capture complications regarding pregnancies at certain age, along with other unobservable dimensions of the mothers. Moreover, number of live births may reflect change in parental change in quality vs quantity trade off. It should be noted that any change in birth outcome, attributed to change in fertility behavior of certain sub-sections due to the program still counts as a program effect- we only have to be careful regarding the mechanisms of impact.

Trend difference— As in any Difference-In-Difference (DID) research design, a valid concern is that treatment and control groups may face different time trends. Often the government provides multiple facilities or "treatments" to specific communities. In that case, DID may overestimate the impact of a program if the placement of the other programs are not taken into account. The richness of the IFLS data allows us to consider various time varying community characteristics, which may correlate with the provision of a midwife in a community and may also affect the pregnancy outcomes of the mother. Following Frankenberg and Thomas (2001), we include these

[11] Ahsan and Bhowmick (2015) report a higher likelihood of male child at first birth for taller mothers in areas of India, where infant mortality rates are high.

time varying community level variables in our estimating equations: paved road status, urban status, public telephone, and distance to nearest health facility. We additionally include time varying community characteristics like distance to market, community electricity status, distance to sub-district, and number of health posts.

5.2 Empirical Framework

To examine the impact of the midwife program on likelihood of a male birth, we estimate the following linear probability model for child i who is born in month m and year t and whose mother lives in community j:

$$malec_{ijmt} = \beta_1 Treated_{jt} + \beta_2 X_{ijmt} + \beta_3 \theta_{jt} + \gamma_m \times \delta_t + \theta_j + \epsilon_{ijmt} \quad (1)$$

The dependent variable $malec$ takes a value of 1 if the child is male and 0 otherwise. β_1, the co-efficient for $Treated$ captures the impact of the midwife program on the probability of a male birth. We have considered two variants for $Treated$. In our primary regressions, this variable takes a value of 1 if the community has a midwife in the year of birth of the child, else takes a value of 0. In another variant, it is defined as years of exposure of the community to the program, so that the heterogeneous impact due to program intensity can be captured. The interaction term, $\gamma_m \times \delta_t$ represents birth month by birth year effects, which controls for seasonality, monthly prices, and different other time varying observables and unobservables. The inclusion of θ_j controls for community level fixed observables and unobservables. X_{ijmt} is a set of mother level observables such as mother education and mother age at the time of survey. These variables are defined as spline functions. θ_{jt} includes set of time varying community observables such as paved road status, urban status, public phone status, distance to market, distance to sub-district, number of health posts, community electricity status and distance to nearest health facility. The distance to nearest health facility and provision of a midwife program may highly correlate with each other, therefore we regress equation (1) by both excluding and including the distance to nearest health facility.

To examine the impact of the midwife program on birth weight, we estimate the following regression equation for child i who is born in month m and year t and whose mother lives in community j:

$$birthweight_{ijmt} = \lambda_1 Treated_{jt} + \lambda_2 X_{ijmt} + \lambda_3 \theta_{jt} + \gamma_m + \delta_t + \theta_j + \varepsilon_{ijmt} \tag{2}$$

λ_1 is the co-efficient of interest.

Recall that the birth weight information is not available for all births. One possibility is that the provision of a midwife may have changed gender-specific birth weight reporting. In that case, the mechanism of impact of the midwife program on birth weight is change in reporting and not any biological change among mothers. To explore this issue, we regress a linear probability model for child i who is born in month m and year t and whose mother lives in community j:

$$bwreport_{ijmt} = \sigma_1 Treated_{jt} + \sigma_2 Post_t \times Treated \times malec + \sigma_3 X_{ijmt} + \sigma_4 \theta_{jt} + \gamma_m + malec \times \theta_j + malec \times \delta_t + \xi_{ijmt} \tag{3}$$

bwreport is an indicator if the birth weight information for child i is available; it takes a value of 1 if the birth weight is reported and 0 otherwise. The coefficient of interest is σ_2. If σ_2 is significantly different from zero, then we should be worried that the difference in association between provision of a midwife program and birth weight, across gender could be driven by reporting bias.

6 Results

6.1 Male Births

We report the effects of Village Midwife Program on likelihood of male births in Table 2. In the first three columns, we consider all births in last 5 years from the date of interview while we consider all births between 1987 and 2007 in the remaining columns. In each of these two sets of columns, we first include birth month-by-birth year fixed effects and individual controls, then add community controls and finally add distance from nearest health facility. As expected from our discussion at the beginning, the impact is quite positive and significant. The impact is quite large- a mother residing in a community with village midwife is 4 percentage points more likely to give birth to a male child. The results are extremely stable across all the specifications and samples. We repeat the same exercise in Table 3, but for first births only. The point estimates are usually larger, while the statistical significance is lost due to smaller sample size. Similar to the findings of this paper, Sanders and Stoecker (2015) find that the Clean Air Act Amendments in 1970 in USA led to a similar increase in likelihood of a live birth being a male in the affected counties.

Next we show the results by mother education in Table 4, while only considering births from last 5 years of interview. The first three columns correspond to the mothers with education level of primary or less while the last three columns correspond to mothers with higher levels of education. We find mothers who are primary or less educated are more heavily impacted due to the program in terms of likelihood of male birth. These mothers are 5 percentage points more likely to give birth to a child due to the program. The impact is more than halved (and also insignificant) for mothers who are high educated.

We also repeat the exercises above, but for a continuous measure of treatment which in this context is the years of exposure to the program. This is defined as the number of years a community has received a midwife, till the year of birth of the child. The results are reported in the appendix, Table A1, Table A2, and Table A3 . The direction of relationship is unchanged. In fact, the results are usually statistically more significant for the continuous treatment exposure.

6.2 Birth Weight

We show in Table 5, the impacts of the program on birthweight. The first three columns contain the results for male children while the final three columns have the same for female children. For male children, we find the effect of the program on birthweight is negative. The effects vary a little across specifications, but are usually statistically significant at 10 percent levels. The results, combined with the results from earlier tables imply increase in male children have largely come about from increased likelihood of survival of marginal fetuses which are of lower quality. The program, on the other hand, does not seem to impact the birthweights for female children.

In Table A4, we show the results for continuous treatment measures. Similar to binary treatment specifications, the program effect on birth weight for male children is negative and statistically significant at 10 percentage points. There is a slightly positive effect for female children, but is statistically insignificant.

6.3 Threats to Identification

Motivated by the findings of Ahsan (2015), Brown and Thomas (2011), and Buckles and Hungerman (2013), we check for selective fertility behavior as well as self-selection of mothers to the program. If babies born to mothers during the program are born to different families than those in absence of the same, then the mechanisms identified behind the observed effects of the program would be misleading. We also check if there is any change in gender-specific reporting due to the program in a similar spirit.

6.3.1 Fertility

We check for selective fertility by using the same regression specification for Table 2 with total number of births as the dependent variable. Results are reported in Table 6. First three columns consider births in last 5 years from the date of interview while all births between 1987 and 2007 are considered in the remaining columns. The results indicate no strong evidence of selective fertility, and it remains true in most rigorous of specifications.

6.3.2 Mother Characteristics

Similar to the approach in Buckles and Hungerman (2013), we also test for parental selection into the program. For that purpose, we check if presence of midwife program can explain maternal education and mother age at birth of the sample. We report the results in Table 7 and Table 8. We don't find evidence of any effect of the program on either of the mother characteristics.

6.3.3 Gender-specific Reporting Bias

Our final check concerns any change in gender-specific reporting of births due to the program. Table 9 reports the findings. Although, there appears to be a general increase in reporting due to the program, but we don't find the increase to be gender-specific. In other words, the reporting has increased uniformly across both gender.

7 Conclusion

In this paper, we estimate the impacts of the Village Midwife Program in Indonesia on two measures of birth endowment- likelihood of a male birth and birth weight. Using four waves of Indonesian Family Life Surveys (IFLS) and employing a Difference-In-Difference empirical strategy, we show that a woman of reproductive age is 4 percentage points more likely to give a male birth due to the program which is nearly 10 percent of the mean. This is consistent with the epidemiological studies which find improved nutritional status of mothers leads to higher survival chances of male fetuses to term. It is well-documented that this program is successful in raising the body mass index of reproductive age women. The impact we estimate is largely driven by mothers with at most primary education. However, we find there is a decrease in birth weights for male children because of the program while there is such impact for female children. We conclude that increased chance of survival for marginal fetuses is the main reason for this paradoxical impact. The observed relationships could be interpreted as causal as our estimates are robust to several strategies which attempt to correct for a number of unobserved factors, driving access to midwives and birth outcomes together.

Our results have interesting implications for economic and health policy. Several studies find girls to be particularly vulnerable to fluctuations in economic and environmental conditions (Maccini and Yang, 2009; Rose, 1999), possibly due to gender bias and imperfect consumption smoothing, so that interventions like social insurance schemes, public health investments, or food security programs can act as effective shields for this subgroup with respect to health consequences. Our finding that more male children with inferior birth weights may be born due to such program brings two opposing consequences, depending on parental responses to initial birth endowments, if degree of son preference is not high (true for Indonesia). If parents try to compensate the initial inferior endowments of male children, then a simple mean comparison of parental investments between boys and girls may mistakenly come across as gender bias towards boys. On the other hand, if parents try to reinforce the birth endowments which seems to be more evident in the empirical literature (Almond and Mazumder, 2013), then a gender-reversal may ensue in human capital formation.

One key point from our results is that interventions with the potential to improve maternal health before or during pregnancy, can have serious distributional impacts for live births which may lead to erroneous conclusions. It is important to carry out investigations on dynamics of selection into live birth, in general and sex-specific live births, in particular for any line of literature, related to human capital formation, demography or early life studies. Insights from reproductive biology and epidemiology should be incorporated into the standard behavioral modeling structure of economists as well as in sampling and survey designs.

An analysis of the overall welfare impact of any such intervention should include regular economic outcomes (like consumption, income etc), along with health and nutritional status, mental health and subjective welfare (Thomas et al., 1990; Adhvaryu et al., 2014). We analyze the effect of the Village Midwife program on mainly one aspect of human capital formation which is health status at birth. Future research on the effectiveness of this program should focus on these other important outcomes to arrive at a more holistic conclusion about it's efficacy.

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8 Tables

Table 1: Summary Statistics

	Mean	S.D.	N
Male Child	0.515	0.500	8420
Mother Years of Education	6.641	3.577	8420
Mother Age at Birth	31.17	6.678	8420
Birth Weight (in kilos)	3.163	0.592	6251

Table 2: Impacts of The Village Midwife Program on Likelihood of Male Birth

	Birth Cohort:1989-99 & 2003-07			Birth Cohort: 1987-2007		
	(1)	(2)	(3)	(4)	(5)	(6)
Treated(=1)	0.040*	0.042*	0.042*	0.035*	0.039**	0.039*
	(0.022)	(0.022)	(0.023)	(0.020)	(0.020)	(0.020)
Distance from Health Facility			-0.002			-0.001
			(0.007)			(0.005)
R^2	0.065	0.066	0.066	0.056	0.058	0.058
Observations	8420	8399	8399	11003	10974	10974
Mean of dependent variable	0.515	0.514	0.514	0.517	0.517	0.517
Birth Month × Year FE	Y	Y	Y	Y	Y	Y
Individual Controls	Y	Y	Y	Y	Y	Y
Community Controls	N	Y	Y	N	Y	N
Original IFLS Community	Y	Y	Y	Y	Y	Y

Note: Standard errors are clustered at the community level (*** p<0.01, ** p<0.05, * p<0.1). The first three columns report all births from last 5 years while the last three columns consider all births from 1987 to 2007. The dependent variable $Malec$ takes a value of 1, if the child is male, and 0 otherwise. The variable $Treated$ takes a value of 1, if midwife is present during the birth year of the child, and 0 otherwise. The individual controls includes mother years of education (splines with knots at 6,9 and 12) and mother age at survey (splines with knots at 20, 25, 30, 35, 40 and 45). Community controls include time varying changes at the community level: paved road status, electricity status, number of health posts, urban status, public phone status, distance to market, distance to sub-district, and distance to nearest health facility.

Table 3: Impacts of The Village Midwife Program on Likelihood of a Male Child at First Birth

	Birth Cohort:1989-99 & 2003-07			Birth Cohort: 1987-2007		
	(1)	(2)	(3)	(4)	(5)	(6)
Treated(=1)	0.053	0.056	0.054	0.036	0.041	0.039
	(0.035)	(0.035)	(0.035)	(0.031)	(0.031)	(0.031)
Distance from Health Facility			-0.006			-0.006
			(0.015)			(0.010)
R^2	0.113	0.114	0.114	0.102	0.104	0.104
Observations	4584	4579	4579	6142	6135	6135
Mean of dependent variable	0.512	0.512	0.512	0.514	0.513	0.513
Birth Month× Birth Year FE	Y	Y	Y	Y	Y	Y
Individual Controls	Y	Y	Y	Y	Y	Y
Community Controls	N	Y	Y	N	Y	N
Original IFLS Community	Y	Y	Y	Y	Y	Y

Note: Standard errors are clustered at the community level (*** p<0.01, ** p<0.05, * p<0.1). The first three columns report all births from last 5 years while the last three columns consider all births from 1987 to 2007. The sample is based on first birth only. The dependent variable $Malec$ takes a value of 1, if the child is male, and 0 otherwise. The variable $Treated$ takes a value of 1, if a midwife is present in the community during the birth year of the child, and 0 otherwise. The individual controls mother years of education (splines with knots at 6,9 and 12) and mother age at survey (splines with knots at 20, 25, 30, 35, 40 and 45). Community controls include time varying changes at the community level: paved road status, electricity status, number of health posts, urban status, public phone status, distance to market, distance to sub-district, and distance to nearest health facility.

Table 4: Impacts of The Village Midwife Program on Likelihood of Male Birth, by Mother Education

	Primary and Below			Primary Above		
	(1)	(2)	(3)	(4)	(5)	(6)
Treated(=1)	0.052*	0.051*	0.051	0.021	0.025	0.023
	(0.031)	(0.031)	(0.031)	(0.037)	(0.038)	(0.038)
Distance from Health Facility			-0.000			-0.007
			(0.010)			(0.011)
R^2	0.119	0.121	0.121	0.130	0.130	0.130
Observations	4598	4585	4585	3822	3814	3814
Mean of dependent variable	0.513	0.513	0.513	0.516	0.517	0.517
Birth Month × Year FE	Y	Y	Y	Y	Y	Y
Individual Controls	Y	Y	Y	Y	Y	Y
Community Controls	N	Y	Y	N	Y	Y
Original IFLS Community	Y	Y	Y	Y	Y	Y

Note: Standard errors are clustered at the community level (*** p<0.01, ** p<0.05, * p<0.1). The first three columns report the results for mothers with education primary and less while the last three columns report the same for the mothers with education more than primary. The dependent variable $Malec$ takes a value of 1, if the child is male, and 0 otherwise. The variable $Treated$ takes a value of 1, if a midwife is present in the community during the birth year of the child, and 0 otherwise. The individual controls mother years of education, and mother age at survey (splines with knots at 20, 25, 30, 35, 40 and 45). Community controls include time varying changes at the community level: paved road status, electricity status, number of health posts, urban status, public phone status, distance to market, distance to sub-district, and distance to nearest health facility.

Table 5: Impacts of The Village Midwife Program on Birth Weights (in Grams), by Gender

	Male Birth Weight			Female Birth Weight		
	(1)	(2)	(3)	(4)	(5)	(6)
Treated(=1)	-68.706*	-59.937*	-55.641	-2.971	-2.157	5.563
	(35.519)	(36.086)	(36.201)	(44.254)	(45.402)	(45.368)
Distance from Health Facility			21.842			29.804
			(16.825)			(18.860)
R^2	0.166	0.169	0.169	0.160	0.164	0.164
Observations	3712	3711	3711	3466	3464	3464
Mean of dependent variable	3188.31	3188.60	3188.60	3103.17	3102.94	3102.94
Birth Month FE	Y	Y	Y	Y	Y	Y
Birth Year FE	Y	Y	Y	Y	Y	Y
Individual Controls	Y	Y	Y	Y	Y	Y
Community Controls	N	Y	Y	N	Y	Y
Original IFLS Community	Y	Y	Y	Y	Y	Y

Note: Standard errors are clustered at the community level (*** p<0.01, ** p<0.05, * p<0.1). The first three columns report the results for male children while the last three columns do the same for female children. The dependent variable *birthweight* is measured in grams. The variable *Treated* takes a value of 1, if a midwife is present in the community during the birth year of the child, and 0 otherwise. The individual controls mother years of education (splines with knots at 6,9 and 12) and mother age at survey (splines with knots at 20, 25, 30, 35, 40 and 45). Community controls include time varying changes at the community level: paved road status, electricity status, number of health posts, urban status, public phone status, distance to market, distance to sub-district, and distance to nearest health facility.

Table 6: Testing for Selective Fertility

	Birth Cohort:1989-99 & 2003-07			Birth Cohort: 1987-2007		
	(1)	(2)	(3)	(4)	(5)	(6)
Treated(=1)	-0.035	-0.048	-0.069	-0.034	-0.054	-0.065
	(0.105)	(0.105)	(0.106)	(0.101)	(0.100)	(0.100)
R^2	0.302	0.307	0.308	0.292	0.298	0.298
Observations	3592	3586	3586	4671	4662	4662
Mean of dependent variable	2.49	2.49	2.49	2.51	2.51	2.51
Birth Year FE	Y	Y	Y	Y	Y	Y
Individual Controls	Y	Y	Y	Y	Y	Y
Community Controls	N	N	N	N	N	N
Original IFLS Community						

Note: Standard errors are clustered at the level (*** p<0.01, ** p<0.05, * p<0.1). The dependent variable is total number of live births. The variable *Treated* takes a value of 1, if a midwife is present in the community during the birth year of the child, and 0 otherwise. The individual controls mother years of education (splines with knots at 6,9 and 12) and mother age at survey (splines with knots at 20, 25, 30, 35, 40 and 45). Community controls include time varying changes at the community level: paved road status, electricity status, number of health posts, urban status, public phone status, distance to market, distance to sub-district, and distance to nearest health facility.

Table 7: Testing for Selection of Mothers: Mother Education

	Birth Cohort:1989-99 & 2003-07			Birth Cohort: 1987-2007		
	(1)	(2)	(3)	(4)	(5)	(6)
Treated(=1)	0.176	0.191	0.184	0.153	0.161	0.161
	(0.122)	(0.123)	(0.122)	(0.119)	(0.120)	(0.118)
Distance from Health Facility			-0.016			-0.001
			(0.040)			(0.037)
R^2	0.454	0.454	0.454	0.438	0.439	0.439
Observations	8420	8399	8399	11003	10974	10974
Mean of dependent variable	6.64	6.64	6.64	6.60	6.61	6.61
Birth Month × Year FE	Y	Y	Y	Y	Y	Y
Individual Controls	Y	Y	Y	Y	Y	Y
Community Controls	N	Y	Y	N	Y	N
Original IFLS Community	Y	Y	Y	Y	Y	Y

Note: Standard errors are clustered at the community level (*** p<0.01, ** p<0.05, * p<0.1). The dependent variable is mother years of education. The variable *Treated* takes a value of 1, if a midwife is present in the community during the birth year of the child, and 0 otherwise. The individual controls include mother age at survey (splines with knots at 20, 25, 30, 35, 40 and 45). Community controls include time varying changes at the community level: paved road status, electricity status, number of health posts, urban status, public phone status, distance to market, distance to sub-district, and distance to nearest health facility.

Table 8: Testing for Selection of Mothers: Mother Age at Birth

	Birth Cohort:1989-99 & 2003-07			Birth Cohort: 1987-2007		
	(1)	(2)	(3)	(4)	(5)	(6)
Treated(=1)	0.021	0.027	0.024	0.014	0.019	0.022
	(0.031)	(0.031)	(0.031)	(0.031)	(0.032)	(0.031)
Distance from Health Facility			-0.007			0.007
			(0.011)			(0.015)
R^2	0.991	0.991	0.991	0.986	0.986	0.986
Observations	8420	8399	8399	11003	10974	10974
Mean of dependent variable	31.17	31.16	31.16	32.23	32.22	32.22
Birth Month × Year FE	Y	Y	Y	Y	Y	Y
Individual Controls	Y	Y	Y	Y	Y	Y
Community Controls	N	Y	Y	N	Y	N
Original IFLS Community	Y	Y	Y	Y	Y	Y

Note: Standard errors are clustered at the level (*** p<0.01, ** p<0.05, * p<0.1). The dependent variable is mother age at the time of birth of her child. The variable *Treated* takes a value of 1, if a midwife is present in the community during the birth year of the child, and 0 otherwise. The individual controls mother years of education (splines with knots at 6,9 and 12) and mother age at survey (splines with knots at 20, 25, 30, 35, 40 and 45). Community controls include time varying changes at the community level: paved road status, electricity status, number of health posts, urban status, public phone status, distance to market, distance to sub-district, and distance to nearest health facility.

Table 9: Testing for Gender-specific Reporting Bias due to the Village Midwife Program

	(1)	(2)	(3)
Treated(=1)	0.047*	0.042	0.036
	(0.028)	(0.027)	(0.027)
Male Child × Treated(=1)	-0.001	-0.003	-0.003
	(0.032)	(0.032)	(0.032)
R^2	0.448	0.448	0.449
Observations	9460	9437	9437
Mean of dependent variable	0.76	0.76	0.76
Birth Month FE	Y	Y	Y
Male Child × Birth Year FE	Y	Y	Y
Individual Controls	Y	Y	Y
Community Controls	N	Y	Y
Male Child × Original IFLS Community	Y	Y	Y

Note: Standard errors are clustered at the community level (*** p<0.01, ** p<0.05, * p<0.1). The dependent variable *bwreport* takes a value of 1, if the birth weight is reported, and 0 otherwise. The variable *Treated* takes a value of 1, if a midwife is present in the community during the birth year of the child, and 0 otherwise. The individual controls mother years of education (splines with knots at 6,9 and 12) and mother age at survey (splines with knots at 20, 25, 30, 35, 40 and 45). Community controls include time varying changes at the community level: paved road status, electricity status, number of health posts, urban status, public phone status, distance to market, distance to sub-district, and distance to nearest health facility.

9 Appendix

Table A1: Impacts of The Village Midwife Program on Likelihood of Male Birth- Continuous Treatment

	(1)	(2)	(3)	(4)	(5)	(6)
Years of Program Exposure	0.004	0.004	0.004	0.003	0.003	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Distance from Health Facility			-0.002			-0.002
			(0.008)			(0.005)
R^2	0.065	0.066	0.066	0.056	0.057	0.057
Observations	8420	8399	8399	11003	10974	10974
Mean of dependent variable	0.515	0.514	0.514	0.517	0.517	0.517
Birth Month × Birth Year FE	Y	Y	Y	Y	Y	Y
Individual Controls	Y	Y	Y	Y	Y	Y
Community Controls	N	Y	Y	N	Y	N
Original IFLS Community	Y	Y	Y	Y	Y	Y

Note: Standard errors are clustered at the community level (*** p<0.01, ** p<0.05, * p<0.1). The first three columns report all births from last 5 years while the last three columns consider all births from 1987 to 2007. The dependent variable $Malec$ takes a value of 1, if the child is male, and 0 otherwise. The variable $YearsofProgramExposure$ is number of Years midwife is present in the community in that birth year. The individual controls mother years of education (splines with knots at 6,9 and 12) and mother age at survey (splines with knots at 20, 25, 30, 35, 40 and 45). Community controls include time varying changes at the community level: paved road status, electricity status, number of health posts, urban status, public phone status, distance to market, distance to sub-district, and distance to nearest health facility.

Table A2: Impacts of The Village Midwife Program on Likelihood of Male Child at First Birth-Continuous Treatment

	(1)	(2)	(3)	(4)	(5)	(6)
Years of Program Exposure	0.006*	0.006*	0.006	0.004	0.004	0.004
	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
Distance from Health Facility			-0.006			-0.007
			(0.015)			(0.010)
R^2	0.113	0.114	0.114	0.102	0.104	0.104
Observations	4584	4579	4579	6142	6135	6135
Mean of dependent variable	0.512	0.512	0.512	0.514	0.513	0.513
Birth Month × Birth Year FE	Y	Y	Y	Y	Y	Y
Individual Controls	Y	Y	Y	Y	Y	Y
Community Controls	N	Y	Y	N	Y	N
Original IFLS Community	Y	Y	Y	Y	Y	Y

Note: Standard errors are clustered at the level (*** p<0.01, ** p<0.05, * p<0.1). The first three columns report all births from last 5 years while the last three columns consider all births from 1987 to 2007. The dependent variable $Malec$ takes a value of 1, if the child is male, and 0 otherwise. The variable $YearsofProgramExposure$ is number of Years midwife is present in the community in that birth year. The individual controls mother years of education (splines with knots at 6,9 and 12) and mother age at survey (splines with knots at 20, 25, 30, 35, 40 and 45). Community controls include time varying changes at the community level: paved road status, electricity status, number of health posts, urban status, public phone status, distance to market, distance to sub-district, and distance to nearest health facility.

Table A3: Impacts of The Village Midwife Program on Likelihood of Male Birth, by Mother Education- Continuous Treatment

	(1)	(2)	(3)	(4)	(5)	(6)
Years of Program Exposure	0.008**	0.007**	0.007**	-0.001	-0.000	-0.001
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Distance from Health Facility			-0.000			-0.008
			(0.010)			(0.011)
R^2	0.119	0.121	0.121	0.130	0.130	0.130
Observations	4598	4585	4585	3822	3814	3814
Mean of dependent variable	0.513	0.513	0.513	0.516	0.517	0.517
Birth Month × Birth Year FE	Y	Y	Y	Y	Y	Y
Individual Controls	Y	Y	Y	Y	Y	Y
Community Controls	N	Y	Y	N	Y	Y
Original IFLS Community	Y	Y	Y	Y	Y	Y

Note: Standard errors are clustered at the level (*** p<0.01, ** p<0.05, * p<0.1). The first three columns report the results for mothers with education primary and less while the last three columns report the same for the mothers with education more than primary. The dependent variable $Malec$ takes a value of 1, if the child is male, and 0 otherwise. The variable $YearsofProgramExposure$ is number of Years midwife is present in the community in that birth year. The individual controls mother years of education and mother age at survey (splines with knots at 20, 25, 30, 35, 40 and 45). Community controls include time varying changes at the community level: paved road status, electricity status, number of health posts, urban status, public phone status, distance to market, distance to sub-district, and distance to nearest health facility.

Table A4: Impacts of The Village Midwife Program on Birth Weights (in Grams), by Gender-Continuous Treatment

	(1)	(2)	(3)	(4)	(5)	(6)
Years of Program Exposure	-6.323*	-5.314	-4.853	2.382	2.844	3.534
	(3.519)	(3.597)	(3.664)	(4.175)	(4.334)	(4.387)
Distance from Health Facility			21.951			31.349
			(16.997)			(19.048)
R^2	0.166	0.169	0.169	0.160	0.164	0.165
Observations	3712	3711	3711	3466	3464	3464
Mean of dependent variable	3188.31	3188.60	3188.60	3103.17	3102.94	3102.94
Birth Month FE	Y	Y	Y	Y	Y	Y
Birth Year FE	Y	Y	Y	Y	Y	Y
Individual Controls	Y	Y	Y	Y	Y	Y
Community Controls	N	Y	Y	N	Y	Y
Original IFLS Community	Y	Y	Y	Y	Y	Y

Note: Standard errors are clustered at the level (*** p<0.01, ** p<0.05, * p<0.1). The first three columns report the results for male children while the last three columns do the same for female children. The variable $YearsofProgramExposure$ is number of Years midwife is present in the community in that birth year. The individual controls mother years of education (splines with knots at 6,9 and 12) and mother age at survey (splines with knots at 20, 25, 30, 35, 40 and 45). Community controls include time varying changes at the community level: paved road status, electricity status, number of health posts, urban status, public phone status, distance to market, distance to sub-district, and distance to nearest health facility.