Do Women Respond to Expansions in Reproductive Health Care?

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ABSTRACT

We use data from the Indonesia Family Life Survey to investigate the impact of a major expansion in access to midwifery services on use of prenatal care and delivery assistance for women of reproductive age. Between 1991 and 1998, Indonesia trained some 50,000 midwives, placing them in relatively poor communities that were relatively distant from health centers. We show that regardless of a woman's educational level, additions of village midwives to communities are associated with significant increases in receipt of iron tablets and in choices about care during delivery, which reflect a movement away from reliance on traditional birth attendants. For women with relatively low levels of education, village midwives have the additional benefits of increasing use of any prenatal care and use of prenatal care during the first trimester. The results are robust to the inclusion of fixed effects at the individual level, a strategy that addresses many of the concerns about biases because of non-random program placement.

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Many health disparities exist between developing and developed countries, but levels of maternal mortality represent one of the largest. Some 99% of the estimated 585,000 pregnancy-related deaths per year occur in developing countries (Ray & Salihu, 2004). Although the medical techniques that prevent the majority of maternal deaths exist, making them available to women in the developing world on an as-needed basis is a complex undertaking, largely because of the difficulties in responding quickly and appropriately to obstetric emergencies, which often require skilled care.

The complexity of emergency obstetric care notwithstanding, the likelihood of improvements in health outcomes of women in developing countries rises with improvements in the quality and availability of health care that women receive while pregnant and during delivery. Large-scale training programs for traditional birth attendants[1] (TBAs) and expansions of reproductive health care services are common interventions for addressing poor outcomes including maternal mortality and morbidity, neonatal mortality, and low birth weight. Such measures can only be effective, however, if women use the trained providers or new services, and it is not always the case that they do. Evaluations of a TBA training program in the Gambia, for example, found that program impact was low because those trained simply did not attend many births (Greenwood et al., 1990; Dehne, Wacker & Cowley, 1995).

In this paper we examine the relationship between access to health services and women's use of prenatal and delivery care in Indonesia, where a major expansion in midwifery services took place during the 1990s. Our goal is to assess the extent to which the expansion in

1. Traditional birth attendants are not considered skilled birth attendants because they do not have formal training and are often not part of a formal health system.

access to better quality services was accompanied by changes in use of prenatal care, in the content of that care, and in choices about site of and assistance with delivery.

We confront two key problems. First, public health investments are not likely to be located at random with respect to health outcomes. Carefully targeted programs will be placed where health outcomes are poor or utilization of services is low. Failure to take account of non-random placement will generally lead to biased estimates of the impact of the investment (Angeles, Guilkey, & Mroz, 1998). A second problem is that adequate data for addressing non-random program placement are rarely available.

In this study, we exploit data from an extremely rich longitudinal survey from Indonesia to evaluate whether government efforts to provide health care have an impact. Specifically, we consider the Village Midwife program, which was initiated in the 1990s and is estimated to have posted some 50,000 midwives throughout the country (Gani, 1996; Kosen & Gunawan, 1996; Sweet, Tickner & Maclean, 1995). To measure the effect on health service use of the introduction of a new health worker in a community, we draw on the "quasi-experiment" that occurred in Indonesia by comparing changes in health care use over sequential pregnancies among women in communities that gained a health worker with such changes for women in communities that did not.

Our main results focus on the effects of introducing a village midwife on use of health services during pregnancy and delivery. After controlling individual-level heterogeneity, we find that additions of village midwives to communities are associated with significant increases in receiving timely prenatal care, receipt of iron supplements during pregnancy, and in choices about care during delivery. Moreover, for two of the outcomes (use of any prenatal care at all during pregnancy and use of prenatal care during the first trimester) the impact of the midwife

program on is larger for women with relatively low levels of education. Program impact does not differ by educational level for receipt of iron tablets or choice of delivery care.

BACKGROUND

The Importance of Antenatal and Delivery Care

Maternal mortality is widely recognized as a leading cause of premature death and disability among women of childbearing age in developing countries (Lopez, Mathers, Ezzati, Jamison & Murray, 2006). The maternal mortality ratio exhibits the greatest disparity between developed and developing countries of all the commonly-used human development indicators (Mora & Nestel, 2000). The global maternal mortality ratio currently stands at around 400, resulting in over half a million maternal deaths each year (WHO, 2007). The Safe Motherhood Initiative, launched in 1987 by the United Nations and international maternal-child health organizations, has focused considerable policy and empirical attention on the determinants of maternal mortality. Millennium Development Goal 5 calls for reducing the maternal mortality ratio by three-quarters between 2000 and 2015.

The main proximate causes of maternal mortality include hemorrhage, infection, unsafe abortions, eclampsia/hypertension, and obstructed labor (WHO, UNFPA & UNICEF, 1999), most of which much be addressed by adequate emergency obstetric care. A systematic review of successful interventions to reduce maternal mortality (Gay et al., 2003) identifies appropriate antenatal care, including provision of iron supplementation during pregnancy and skilled attendance at delivery as important complements to a functioning emergency obstetric care delivery system.

The role that antenatal care can play in reducing maternal mortality and morbidity is controversial, as many of the complications listed above that lead to a maternal death cannot be

predicted during antenatal care and few rigorous empirical studies of antenatal care have demonstrated its effectiveness (Carroli, Rooney & Villar, 2001). However, there is still strong evidence that the timing of prenatal care and some components of its content can improve health outcomes directly (Rooney, 1992; Villar & Bergsjo, 1997; Jowett, 2000). The provision of iron tablets during pregnancy has been shown to reduce the risk of being anemic, which is an important risk factor for hemorrhage and cardiac failure during delivery (Carroli et al., 2001; Reveiz , Gyte & Cuervo, 2007).

Blood-pressure measurements and urinalysis done during antenatal care visits can screen pregnant women for hypertensive disorders of pregnancy (including preeclampsia and eclampsia) and to seek medical attention of the condition appears (Carroli et al., 2001). Identifying pregnancy-related hypertension requires at least one blood pressure reading before the 20th week of pregnancy, which provides support for at least one early or first-trimester antenatal care visit (Carroli et al., 2001).

In the course of routine antenatal care, women can be screened and treated for sexually-transmitted and urinary tract infections that may lead to preterm birth or complicate delivery, and tetanus toxoid inoculations can be administered. Both of these interventions are considered highly effective (Jowett, 2000). Several other indirect infectious causes of maternal mortality and morbidity, including HIV/AIDS, hepatitis, malaria, and tuberculosis can also be detected and treated during antenatal care visits.

If a basic obstetric history is collected during antenatal care, then women at risk for complicated deliveries can be referred to health centers and hospitals. In late pregnancy, antenatal visits can help identify women at risk for difficult deliveries (including cephalo-pelvic disproportion and a breech or transverse presentation) and direct them to appropriate delivery

care. Skilled midwives may even undertake external cephalic version to convert a breech presentation to a normal head-down presentation, preventing complications during labor (Carroli et al., 2001).

A final important function of antenatal care visits is to encourage women to choose biomedically-oriented delivery care or "skilled attendance" (Gay et al., 2003; Barber, 2006). The case for skilled attendance at delivery is quite strong. Skilled attendants include midwives, doctors, and nurses with the proficiency in managing normal deliveries and diagnosing, managing, or referring obstetric complications (WHO et al., 1999). A review of the evidence in support of skilled delivery suggests that from 16% to 33% of all maternal deaths could be avoided through prevention of the four main life-threatening obstetric complications (obstructed labor, eclampsia, sepsis, and hemorrhage) by skilled attendants (Graham, Bell & Bullough, 2001).

Factors Affecting Use of Prenatal Care and Delivery Services

Pregnant women, then, do appear to benefit from antenatal care and skilled delivery. This leads to the important question of whether the provisions of maternal care services increases actual utilization of services, and for which groups.

Several studies have considered how use of care has changed over a period during which aspects of the service environment are known, at a macro level, to have changed. Using data from rural China, for example, Short and Zhang (2004) document changes in service use between 1988 and 1997, a period during which health services moved increasingly from government to private control. Over this period, women's use of prenatal care, propensity to deliver in a hospital, and propensity to deliver with formal assistance all rose, despite privatization. In Indonesia, the percent of live births in which delivery was assisted by a health

professional increased almost two-fold between 1986 and 2002 (Hatt, Stanton, Makowiecka, Adisasmita, Achadi & Ronsmans, 2007), the period during which the Village Midwife program was implemented. The interpretation that the program succeeded in improving outcomes is consistent with the facts, although women's behaviors are not directly linked to access to program midwives.

With respect to differentials in use by characteristics of the women, correlational studies from all parts of the world consistently reveal that women with more education and higher household incomes, and women in urban areas, are more likely to access antenatal care and use skilled attendants at delivery (Abbas & Walker, 1986; Addai, 2000; Navaneetham & Dharmalingam 2000; Bloom, Wypij & Das Gupta, 2001; Barber, 2006; Bolam, Manandhar, Shrestha, Ellis, Malla & Costello, 1998; Celik & Hotchkiss, 2000; Ellencweig, Palti, Neumark & Donchin, 1993; Elo, 1992; Raghupathy, 1996; Toan, Hoa, Thach, Hojer & Persson, 1996; Anwar, Killewo, Chowdhury & Dssgupta, 2005) and that these effects remain significant when other factors such as parity, health insurance, access to care, quality of care, etc. are controlled.

In Indonesia, research shows that in the period before the economic crisis of 1998, among women who delivered at home, those from better-off households (as measured by asset ownership quartiles) were significantly more likely to have assistance from trained providers than those from economically more-deprived households (Thind & Banerjee, 2004). Other work (Hatt et al., 2007) documents a relatively greater increase over time in use of professional care during delivery for women in the poorest two quintiles of the wealth (as measured by asset ownership) distribution than for women in the middle quintile. Over the same period, however, the rise in rates of caesarean delivery (presumably, in many cases, in response to an emergency) was much higher for women from the top quintile than for less wealthy women.

In general, governments that are considering investments in new services in hopes of improving health outcomes need to know whether new services will be used. The Village Midwife program in Indonesia provides a compelling case study with which to address this question. We turn now to a more detailed description of that program.

The Village Midwife Program in Indonesia

Socioeconomic development in Indonesia has improved at a rapid pace since the 1960s. From 1967 to 1997 Indonesia's per capita gross domestic product (GDP) increased by almost 5 percent per year. At the same time, Indonesia achieved nearly universal enrollment in primary school and substantial increases in secondary-school enrollment. Since the early 1960s, several indicators of health status in Indonesia also have shown major improvements. The infant mortality rate has declined steadily, and by the mid-1990s life expectancy surpassed 60 years. By 2000, the infant mortality rate was down to 35 per 1000, from 142 per 1000 in 1965 (BPS & ORC Macro, 2003).

Gains in the area of maternal mortality have been considerably less impressive. Most estimates of maternal mortality for Indonesia in the 1990s put rates on par with those in India and Bangladesh, although *per capita* GDP in Indonesia at that point was about 50% higher than in India and about twice as high as in Bangladesh (Sarwono, Mundiharno, & Fortney, 1997). Estimated at from 390 to 650 deaths per 100,000 live births at various points during the 1980s and 1990s, Indonesia's maternal mortality rate was the highest in any of the Association of South East Asian Nations countries (Handayani, Wilujeng, Sukirno, Pranata & Daryadi, 1997; Mukti, 1996; UNICEF, 2000a; UNICEF, 2000b).

In the late 1980s, Indonesia's Ministry of Health (MOH) began to train midwives and post them to villages throughout Indonesia, in an effort to massively increase access to prenatal

care and safe delivery services (Handayani et al., 1997; Kosen & Gunawan, 1996; MOH, 1994). The government of Indonesia planned to provide a midwife in every non-metropolitan village or township between 1990 and 1996 (MOH, 1994). Midwives typically were recruited from three-year nursing academies and received one additional year of midwifery training (Sweet et al., 1995). By 1998, 54,000 midwives had been trained; between 1986 and 1996, the number of midwives per 10,000 population increased more than tenfold, from 0.2 to 2.6 (Hull, Widayatun, Raharto & Setiawan, 1998; MOH, 2000; Reproductive Health Focus, 2000).

The village midwife's duties center on providing health and family planning services, working with traditional birth attendants, and referring complicated obstetric cases to health centers and hospitals. In addition, she serves as a health resource in her community and is encouraged to seek out patients actively and visit them in their homes, as well as to develop collaborative relationships with traditional village midwives (MOH, 1994).

STATISTICAL APPROACH

One approach to pinpointing the effect of health services on outcomes is to examine the relationship between spatial variation in program availability or strength and spatial variation in health behaviors. At a point in time, however, the association between access to care and health behaviors does not identify the direction of causality. Services may be provided in a particular location in response to demand for those services or people who want services may move to places where they are provided (Rosenzweig & Wolpin, 1986; Rosenzweig & Wolpin, 1988). In either case, the relationship is governed by a common unobserved factor that yields a spurious correlation between access to services and health outcomes.

Governments may also target interventions towards communities with particular attributes or particular types of individuals. If targeting is based on characteristics that cannot

be fully controlled for in the regression and those unobserved characteristics are correlated with the outcome of interest, estimated effects of the intervention will be biased. For example, if government services are provided in communities where health status is relatively poor, the estimated impact of those services on a particular health outcome will be biased negatively unless all characteristics that underlie placement of the program are controlled. The issue of selective program placement is important in the context of health policies in Indonesia (Frankenberg, 1992; Gertler & Molyneaux, 1994; Pitt, Rosezweig, & Gibbons 1993; Frankenberg & Thomas, 2001; Frankenberg, Suriastini, & Thomas, 2005).

Following an approach we have utilized in other work on this topic, we adopt a quasi-experimental approach to evaluate the effects of an expansion in access to midwifery services and health outcomes in Indonesia (Frankenberg & Thomas, 2001; Frankenberg et al., 2005). Specifically, we take advantage of the fact that pregnancy is a repeated event and that we have longitudinal data on women's pregnancies that span the period during which midwives were introduced.

By estimating a model that includes an individual fixed effect, we sweep out factors that are fixed at the level of the woman or her community and enter the model additively, including any characteristics that are correlated with placement of midwives. This "fixed effects" model has been used extensively in the program evaluation literature (for a discussion, see Heckman and Robb [1985]). We are contrasting behaviors during pregnancy for women before and after the "treatment" (the assignment of a program to a community) with behaviors over the same period for a control group, namely women whose pregnancies took place in communities where there was no "treatment" because the program had not been introduced. Because there may be a secular trend in health-seeking behavior and because pregnancies that occurred relatively

early will be more likely to predate the arrival of the program, we also include an indicator of time.

Formally, the model that we estimate can be specified as follows:

$$Y_{ict} = \beta_0 + \beta_1 P_{ct} + \beta_2 X_{it} + \beta_3 X_{ct} + \beta_4 TIME + (\mu_c + \upsilon_i + \varepsilon_{ict})$$

where Y_{ict} is an outcome for woman i in community c at time t, P_{ct} is an indicator of whether a government program is available, X_{it} is a set of characteristics specific to that woman at time t, X_{ct} is a set of characteristics specific to the community at time t. In this model, μ_c represents fixed but unobserved factors at the community level and υ_i represents fixed but unobserved factors at the individual (woman) level. These factors are swept out of the model by the inclusion of the fixed effect. In this model, ε_{ict} is an individual- and time-specific idiosyncratic error term. The coefficient of key interest is β_1, which indicates the effect of access to a village midwife during pregnancy (i.e. program access) on outcome Y.

DATA

Our data are drawn from three rounds of the Indonesia Family Life Survey (IFLS), an ongoing panel survey of individuals, households, communities, and facilities. The first round of data (IFLS1, collected in 1993) included interviews with 7,224 households (Frankenberg & Karoly, 1995). The IFLS conducted interviews in 321 enumeration areas in 13 of Indonesia's 26 provinces, and represents about 83% of the Indonesian population.[2]

2. The 321 IFLS enumeration areas are small survey-defined clusters of households located in 312 administrative areas known as *desa* (village) or *keluruhan* (township), of which there are more than 62,000 in Indonesia. We refer to *desa* and *keluruhan* collectively as "villages." For the remainder of this paper we use the term *community* to designate both an IFLS enumeration area and the larger administrative area ("village") in which it is located.

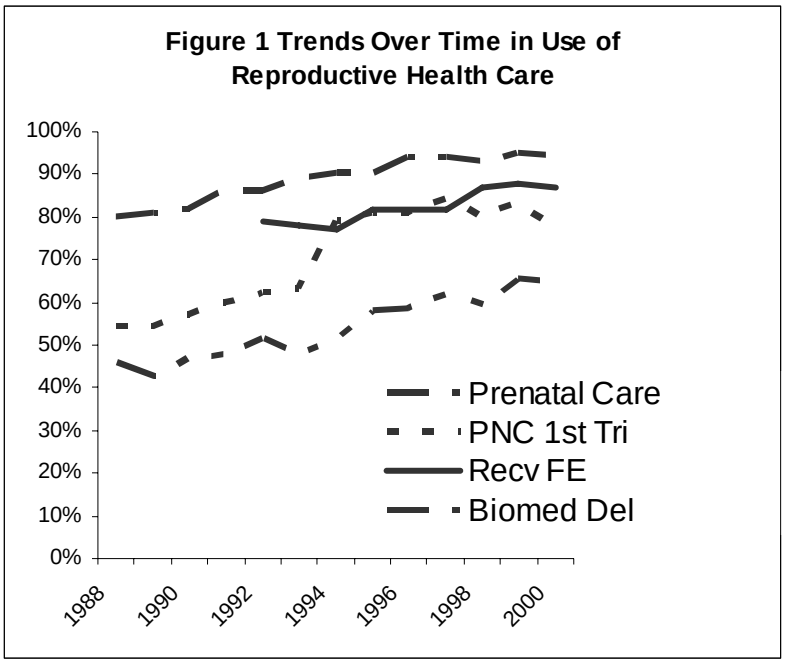
In 1997, we conducted a resurvey (IFLS2) in which we sought to re-interview all IFLS1 households (and all members of these households in 1997), as well as a set of target members of IFLS1 households in 1993 who had migrated out by 1997 (Frankenberg & Thomas, 2000). IFLS2 succeeded in re-interviewing 94.5% of IFLS1 households and 92% of the individuals who were age-eligible for this study. In 2000, we conducted another resurvey (IFLS3), using the same relocation goals and protocols. Re-contact rates were at similarly high levels.

The IFLS questionnaire covers a broad array of topics. Women of reproductive age were asked extensive questions about their pregnancies. For births occurring in the past five years, detailed questions were asked on the receipt and timing of prenatal care and on choices about use of care at the time of delivery. We combine data on live births from the 1993, 1997, and 2000 interviews to construct an analytical file with information from 4,501 women on 7,108 births that occurred between 1988 and 2000. We use these data to construct measures of prenatal care use and care during delivery.

RESULTS

Trends in Use of Prenatal Care and Delivery Assistance

Figure 1 presents trends over time in four outcomes related to use of reproductive care: whether a woman received any prenatal care during her pregnancy, whether she received prenatal care during her first trimester, whether she received iron tablets during her pregnancy (these data are available only from the 1997 and 2000 surveys), and whether her birth delivery took place either in a biomedically-oriented institution or was attended by a practitioner with biomedical training (the alternative is that the woman delivered with the assistance of family members or a TBA in a home setting).



For all the indicators, the percentage of women choosing the behavior has risen over time. For use of prenatal care, even in 1988, most women (80%) received some prenatal care during their pregnancy. By 2000 the fraction had risen to 94%. The increase is more dramatic for receipt of care during the first trimester of pregnancy. The percentage of women using prenatal care during the first trimester rose from 54% to 77% over this period. The increase over time in receipt of iron tablets (tracked from 1992 to 2000) is smaller: from 79% in 1992 to about 87% in 2000. Dramatic improvements in behaviors related to choices regarding care during delivery are observed. In 1998, only about 44% of deliveries were classified as biomedical. By 2000, the fraction was about 62%.

Expansion of the Midwife Program

In this paper, we focus on the impact of expanding the Village Midwife program. Table 1 summarizes the nature of this expansion, as measured by the IFLS1, IFLS2, and IFLS3 community-facility surveys. Access to the Village Midwife program is measured with an indicator of whether a village midwife was present in the community in each of the survey

years. The IFLS reflects the dramatic expansion of the Village Midwife program documented in the literature on the Indonesian health system. In 1993, just under 10% of IFLS communities had a village midwife; by 1997 this percentage had increased to 46%, and by 2000 it was 50%. Over the four-year period between the 1993 and 1997 survey waves, more than one-third of IFLS communities gained a village midwife. After 1997, expansion of the program slowed dramatically. By 2000, an additional 10% of communities had Village Midwives, but 6% of communities reported that the Village Midwife was no longer present.

Table 1
Expansion of Access to Village Midwives over Time

	1993	1997	2000
% of IFLS communities with a Village Midwife	9.6%	46.3	50.3
Community-level changes in access			
Gained a midwife between 1993 and 1997		36.8	
Lost a midwife between 1993 and 1997		0.0	
Gained a midwife between 1997 and 2000			10.2
Lost a midwife between 1997 and 2000			6.4
Other community characteristics			
Main road is paved	63.9	84.0	84.0
Public phone in community	42.9	51.1	64.6
Average level of monthly expenditure (Rp)	88,137	202,763	164,064

N=312 communities

The descriptive statistics indicate a substantial increase in access to village midwives between 1993 and 1997. In examining how these midwives were allocated across communities, we use the IFLS data from 1993 to explore how aspects of socioeconomic development and health status, measured at the community level in 1993, are associated with access to midwives in 1993, 1997, and 2000. Three regressions are estimated, in each the dependent variable is a dichotomous indicator of whether the community had a village midwife in each of the survey years. The results are presented in Table 2.

We include average per capita expenditure levels of households in the community (measured in 1993) to test whether gaining a village midwife varies with the community's wealth. Expenditure is specified as a spline with a knot at the 25th percentile. For communities in the lowest quartile of the expenditure distribution, higher household expenditure does not affect the probability that a village midwife will be assigned to the community in any of the three years. In 1997, however, when mean expenditure level in communities is in the top three quartiles of the distribution, the coefficient is large, negative, and statistically significant. The results provide strong evidence that, among the IFLS communities, the poorest as of 1993 were most likely to gain a village midwife by 1997. Moreover, the results reveal that the greater a community's distance from a health center in 1993, the more likely that the community had a village midwife by 1997 ($p=0.10$) or in 2000 ($p=0.06$). In 1993 and 1997, villages in which the main road is paved are significantly less likely to have a village midwife, and in all three years villages with a public telephone are significantly less likely to have a midwife. In addition, communities with a public phone in 1993 were significantly less likely to gain a village midwife by 1997.

These results suggest that village midwives are targeted to communities that are relatively poor and underserved in terms of health, transportation, and communication infrastructure. We also include a variable measuring the percentage of births delivered at home with a TBA in attendance during the period from 1988 to 1991 (before the Village Midwives program began arriving in villages). The coefficient for this variable is positive and significant in both 1997 and 2000, suggesting that midwives were disproportionately likely to be assigned to villages in which decisions regarding care during delivery were quite traditional. These results are consistent with earlier research that we have conducted on this program, and suggest

the importance of the statistical strategy that we outlined above, which sweeps out unobserved community- and individual-level characteristics associated both with use of reproductive health care and access to a village midwife.

Table 2

Community-Level Correlates of Presence of a Village Midwife in 1993, 1997, and 2000

	1993	1997	2000
1993 per capita expenditure < 25th %	0.020	0.018	-0.009
(spline)	(0.017)	(0.013)	(0.014)
1993 per capita expenditure >= 25th %	-0.008	-0.010*	-0.004
(spline)	(0.011)	(0.005)	(0.003)
Distance to nearest health center	-0.209	0.232	0.274
	(0.154)	(0.141)	(0.147)
Main road is paved	-1.487**	-0.464**	0.181
	(0.483)	(0.345)	(0.354)
Public phone in the community	-2.540*	-1.593**	-1.379**
	(1.061)	(0.324)	(0.310)
% of births delivered at home with a TBA (1988-91)	0.740	1.491**	1.703**
	(0.696)	(0.458)	(0.455)
Constant	-2.236	-0.837	0.181
R^2	0.21	0.27	0.24

Note: Logistic regressions, level of observation is IFLS enumeration area; sample size is 311. Standard errors reported in parentheses.

Program Impact on Use of Reproductive Health Care

We turn now to the main analytical task, which is to relate the reproductive health outcomes to access to a program midwife. Our analytical sample of women consists of 4501 women, who experienced 7108 pregnancies over the 13 years from 1988 through 2000. On average, the mothers in this sample have about six years of education and are almost 30 years old.

The independent variable of primary interest is whether the pregnancy took place in a village in which a program midwife was present at the time of either conception, for outcomes related to prenatal care, or at the time of birth, for care during delivery. Access to a midwife is indicated with a dichotomous variable that is set to one if the village midwife was present in the village by the time of conception (or childbirth) and zero otherwise.

We do not control for time invariant characteristics of the mother, such as her educational level, because characteristics that do not change will drop out of fixed-effects models, but we do control for monthly household per capita expenditure level (logged). We also control for resources and infrastructure at the community level: the average household per capita expenditure within the community, whether a public phone is available, and whether the main road is paved. Data on these attributes were available in 1993, 1997, and 2000, but pregnancies occur throughout the period. Each pregnancy was matched to the temporally most proximate information on household expenditure level and community infrastructure.

Table 3 presents results from both logistic regressions and from the specifications that include a mother-specific fixed effect. The question of greatest interest for this research is the sign and significance level of the coefficients associated with the availability of a village midwife, which are displayed in the first row of the table. Data columns 1-4 display the results for the logistic regressions of reproductive health outcomes as a function of midwife availability. For each of the outcomes related to prenatal care (receipt of any prenatal care, receipt of care in the first trimester, and receipt of iron tablets during pregnancy), the coefficient on availability of a midwife is positive and statistically significant. For the choice of biomedically-oriented delivery care, however, the coefficient on midwife availability is negative and statistically significant. *A priori*, it seems improbable that village midwives

simultaneously have a positive effect on choices related to prenatal care and a negative effect on choices related to delivery. Instead, these results may arise if unobserved characteristics at the individual or community-level bias all the coefficients downward.

The results from the specifications that include a mother-specific fixed effect are presented in data columns 5-8. For three of the four outcomes (all but receipt of care in the first trimester), the coefficients increase substantially in size in the fixed effects specification. The coefficients are not as precisely estimated, and so because the standard errors are larger, the effects of access to a midwife on use of prenatal care (at all or during the first trimester) are no longer statistically significant at standard levels.[3] Access to a village midwife does have a positive and statistically significant impact on receipt of iron tablets during pregnancy and choosing a biomedically oriented delivery. Moreover, the sign on the coefficient for use of biomedically oriented delivery care reverses and becomes positive. No longer is access to a midwife associated with a decreased likelihood of use of biomedical care during delivery. Instead, a woman is about 1.7 times more likely to choose a biomedically oriented delivery when a village midwife is available than when one is not. This reversal of sign is strongly suggestive of the interpretation that the coefficients in the logistic regression are negatively biased. That is, the logistic regression estimates understate the impact of access to a village midwife on choices related to reproductive health care because of unobserved features that are positively correlated with the midwife's presence and negatively correlated with service use. The fixed effects specifications sweep out these unobserved characteristics to reveal far more positive, albeit relatively more imprecisely estimated, program impacts. Indeed, the results in

3. In the fixed effects specifications, for a woman to contribute information to the coefficient estimation, she must have experienced two or more pregnancies across which her behavior on the outcome of interest varied. Many women do not change their behavior across pregnancies. The number of women and the number of pregnancies they contribute differs by outcome, ranging from 290 women with 729 pregnancies for the biomedically oriented delivery, to 106 women with 240 pregnancies for receipt of iron tablets.

Table 3
Multivariate Regressions of Access to a Village Midwife
and Use of Reproductive Health Care

	Logistic Regression[a]				Mother-specific Fixed Effects			
	Any prenatal care	Prenatal Care in First Trimester	Received iron tablets during pregnancy	Biomedically oriented delivery[b]	Any prenatal care	Prenatal Care in First Trimester	Received iron tablets during pregnancy	Biomedically oriented delivery[b]
Pregnancy-specific indicators								
Village Midwife								
available by conception	0.22*	0.47**	0.28**	-0.23**	0.49	0.20	1.14*	0.52‡
	(0.11)	(0.07)	(0.09)	(0.07)	(0.33)	(0.20)	(0.51)	(0.29)
Date of conception	-0.05**	-0.04**	0.00	-0.08**	0.17**	0.15**	0.18	0.16**
	(0.01)	(0.00)	(0.01)	(0.00)	(0.04)	(0.03)	(0.09)	(0.04)
Time-varying household characteristics								
Per capita Expenditure	0.79**	0.60**	0.24**	0.66**	0.17	0.14	0.03	0.14
	(0.08)	(0.05)	(0.07)	(0.05)	(0.23)	(0.14)	(0.28)	(0.19)
Time-varying community characteristics								
Expenditure level	0.67**	0.40**	0.09	0.92**	-0.39	0.01	-0.98‡	-0.32
	(0.13)	(0.08)	(0.10)	(0.09)	(0.38)	(0.22)	(0.59)	(0.30)
Main roads are paved	0.10	0.16*	0.29*	0.88**	-0.32	0.10	-0.29	0.14
	(0.11)	(0.07)	(0.12)	(0.08)	(0.40)	(0.26)	(0.59)	(0.36)
Public phone available	0.75**	0.40**	0.07	0.80**	0.95	0.09	-0.85	-0.12
	(0.14)	(0.08)	(0.11)	(0.08)	(0.50)	(0.27)	(0.54)	(0.38)
Observations	7105	7097	3911	6730	7105	7097	3911	6730
Hausman Statistic								

[a] Standard errors adjusted for clustering within women.
[b] Availability of village midwife measured at time of birth rather than at conception.
** p<=0.01, * p<=0.05, ‡ p<=0.10

Table 2 show that midwives were more likely to be assigned to communities in which, before the program began, reliance on TBAs for delivery was high. Therefore, the counter-intuitive result in data column 4 or Table 3 arises because of reverse causality. In the cross-sectional regression, it is the high reliance on TBAs that drives the presence of a program midwife, rather than the presence of a program midwife that is driving the choice to deliver without biomedically-oriented assistance.

In the results presented in Table 3, we necessarily do not include maternal characteristics that do not change over time, such as education. In the research reviewed above, however, women's reproductive health behaviors clearly vary by educational level. In the fixed effects framework it is possible to interact educational level with the measures of access to a midwife to explore whether program impact varies by educational level. *A priori* it is unclear whether access to a program midwife will make more of a difference for the behaviors of relatively better-educated women, who may be better equipped to understand the benefits of biomedically-oriented services, or for the behaviors of poorly educated women, for whom a change in access may put modern midwifery services in reach (geographically or psychologically) for the first time. It is also possible that the program has had the same impact for all women, regardless of the mother's educational level. The results for the interactions between maternal education and access to a program midwife are presented in Table 4. For each outcome, the main effect of access to a village midwife is statistically significant ($p=0.10$ for receipt of iron tablets during pregnancy) and positive. The interaction between access to a village midwife and level of maternal education is negative for each outcome, although it is statistically significant only for the two prenatal care outcomes.

Table 4
Interactions between Access to a Village Midwife (VMW) and Maternal Education

	Village Midwife– Maternal Education Interactions			
	Any prenatal care	Prenatal care in first trimester	Received iron tablets during pregnancy	Biomedically oriented delivery[a]
Pregnancy-specific indicators				
VMW available by conception	0.98*	0.63*	1.47‡	0.93*
	(0.45)	(0.30)	(0.90)	(0.47)
VMW* years of education	-0.12‡	-0.08*	-0.05	-0.07
	(0.07)	(0.04)	(0.11)	(0.06)
Date of conception	0.17**	0.15**	0.17‡	0.16**
	(0.04)	(0.03)	(0.09)	(0.04)
Time-varying household characteristics				
Per capita Expenditure	0.18	0.13	0.03	0.13
	(0.23)	(0.14)	(0.28)	(0.19)
Time-varying community characteristics				
Expenditure level	-0.41	0.13	-0.99‡	-0.33
	(0.38)	(0.22)	(0.59)	(0.30)
Main roads are paved	-0.42	0.05	-0.30	0.11
	(0.41)	(0.26)	(0.60)	(0.36)
Public phone available	1.01*	0.10	-0.78	-0.08
	(0.50)	(0.27)	(0.56)	(0.38)
Observations				

[a] For delivery assistance, availability of village midwife is measured at time of birth rather than at conception.

** p<=0.01, * p<=0.05, ‡ p<=0.10

The negative interaction term is consistent with the interpretation that access to village midwives has a stronger effect on use of prenatal care among women with relatively low levels of education than among their better-educated counterparts. This differential impact by level of education is not statistically significant for receipt of iron tablets or for use of biomedically-oriented delivery care. For these outcomes, access to a village midwife was important regardless of the mother's level of education.

CONCLUSION

Using statistical methods that are commonly applied in the program evaluation literature, we have shown that the addition of biomedically-trained midwives to communities in Indonesia has resulted in women changing their patterns of health care use during pregnancy and delivery relative to the patterns observed for women in communities without program midwives. In particular, women are more likely to have received iron tablets during pregnancy and more likely to deliver either in a biomedically-oriented facility or with the assistance of a biomedically-trained provider. The positive effects of a midwife's presence on these aspects of prenatal care operate for all women, regardless of their level of education. Among women with relatively low levels of education, there are additional benefits of access to a village midwife in the form of increased likelihood of receiving any prenatal care and of receiving prenatal care during the first trimester of pregnancy.

These results emerge when we use a "treatment-control" framework, comparing changes over time for the treated with changes over time for the controls (this approach is possible because our data span the period during which the program was implemented). When one ignores time-invariant but unobserved factors at the community and individual level, however, the associations between program access and use of prenatal care are different (for three of the four outcomes we consider, the benefits appear to be much smaller, in fact, for the choice to use biomedically-oriented delivery services the program appears to be detrimental).

It is important to consider our finding of positive effects of the program on choices related to prenatal care and delivery in light of other studies of Indonesia's Village Midwife program and other maternal care service initiatives in developing countries. Our results are certainly consistent with our earlier work that shows that the village midwife program had a

positive effect on health outcomes both for women of reproductive age and for children who were fully exposed to a midwife during early childhood (Frankenberg & Thomas, 2001; Frankenberg, Suriastini & Thomas, 2005). Our results are also consistent with other evaluations of the Village Midwife program that found increases in access in skilled attendance at birth and increases in the proportion of women who mentioned village midwives as an important source of information (Ronsmans et al., 2001; Koblinsky, Conroy, Kureshy, Stanton & Jessop, et al. 2000).

Other work on the Indonesian program has focused on how to make it even more effective. Ronsmans and colleagues (2001) look specifically in two districts where government-trained midwives were compared to midwives who had received additional training in communication skills and in life-saving obstetric interventions, both of which were found to be important to the effectiveness of the midwives. Another district-based initiative has increased the use of village midwife services by paying traditional birth attendants to refer pregnant women and help midwives with postpartum care (Analen, 2007).

Our results indicate that access to a village midwife led to larger increases in prenatal care use for women with low levels of education compared to higher-status women. We did not find a difference in biomedical delivery or iron tablet delivery by education status. This is an important extension of cross-sectional correlations of maternal care utilization, which universally find higher utilization among higher status women. Our results confirm that the Village Midwife program was effective in reducing socioeconomic disparities in access to antenatal care. Several other papers have found correlations between reproductive health behaviors and women's socioeconomic status. Hatt et al. (2007) observe a similar narrowing of the education (and income) gap in skilled attendance over the period during which the Village

Midwife program expanded in Indonesia. Using data from two districts in West Java province, in which both program and non-program midwives were active, Achadi and colleagues (2007) show that women's education and wealth are strong predictors of delivery with a health professional.

Achadi and colleagues also examine how characteristics of the midwives themselves are associated with use of reproductive health care. Delivery with a health professional is more likely as the duration for which a midwife has been assigned to a village increases, and is more likely for women who live in villages where the midwives are tied to a health center rather than serving as village midwives. The idea that a midwife's effectiveness depends on her own characteristics is intuitively compelling (and, indeed, Makowiecka and colleagues [Makowieka, Achadi, Izati & Ronsmans, 2007] shows that midwives' characteristics do vary considerably between remote and more urbanized areas), but it is difficult to devise a methodological strategy that corrects for potential biases for non-random placement of midwives of certain types. If the most effective and more experienced midwives are more successful at getting posted to areas where the demand for their services is higher, the correlation between experience and success at attracting clients will be upwardly biased.

It is important to underscore that our results show only that access to program midwives improves women's use of care. Antenatal care and skilled delivery are important inputs in the process of reducing maternal morbidity and mortality. Indeed, village midwives have been associated with lower maternal mortality in Malaysia, Sudan, Bangladesh, Thailand, and elsewhere (Koblinsky, Campbell & Hiechelheim, 1999; Ray & Salihu, 2004; Chowdhury, Botlero, Koblinsky, Saha, Dieltiens & Ronsmans, 2007). But substantial improvements in maternal mortality are not likely without adequate emergency obstetric care. Although village

midwives may succeed in identifying and providing referrals for cases that are high risk or in which complications have emerged, they have neither the skills nor the equipment to undertake the more complicated surgical interventions that have the potential to save so many lives.

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