Information Interventions to Reduce Maternal Mortality in Indonesia

by

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Duke University

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Dissertation submitted in partial fulfillment of
the requirements for the degree of Doctor
of Philosophy in
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ABSTRACT

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## Abstract

Indonesia consistently records higher levels of maternal mortality than other countries in Southeast Asia with its same level of socioeconomic development. I use a quasi-experimental, difference-in-differences approach to understand whether the role of information on the risk of death in childbirth can change women's reproductive behaviors. In the first two chapters, I use the Maternal Mortality Module from the Demographic and Health Survey (DHS) in Indonesia to examine fertility and reproductive behavior responses to a sister's death in childbirth. Fertility desires remain relatively unchanged but women take up behaviors in subsequent births that avert the risk of maternal death. In the last chapter, I combine population-representative data from the DHS with a village-level census (PODES) on service availability to understand how a village-level intervention to improve obstetric service use using a birth preparedness and complications readiness (BPCR) approach may improve obstetric service use. In this study, I find that the Desa Siaga intervention in Indonesia improved knowledge of the danger signs of complications among women but not among men relative to villages that did not get the program while controlling for endogenous program placement. More women got antenatal care due to the program but use of a skilled birth attendant and postpartum care did not change as a result of the intervention. Both genders report discussing a blood donor in preparation for delivery.

# Dedication

To the bright, audacious and perseverant people of Indonesia.  Semangat!

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# Acknowledgements

I wish to acknowledge the support of my dissertation supervisor Elizabeth Frankenberg., participants in the International Population Health and Development (IPHD) seminar in the Duke economics department, fellow graduate students and faculty who participated in the Sanford Graduate Student Research Workshop (SGRW) and participants in oral sessions presented at the Population Association of American (PAA), American Public Health Association (APHA) and Association for Public Policy Analysis and Management (APPAM) annual meetings. All mistakes are my own.

# 1. Dying to Give Birth: The Effect of a Sister's Death in Childbirth on Reproductive Behaviors in Indonesia

## *1.1 Introduction*

Despite nearly 30 years of focused efforts to reduce maternal deaths globally, childbearing continues to carry substantial risks for women in developing countries. Maternal causes were the fifth leading cause of death for women of reproductive age in Indonesia in 2013, causing more deaths to women in this age group than transport injuries, while women in developed countries in 2013 faced the same risk of dying in childbirth as dying from malaria or nutritional deficiencies, diseases considered to be eradicated in these countries (Institute for Health Metrics and Evaluation, 2013).

Estimates suggest that about two-thirds of maternal deaths occur during labor and in the 24 hours after delivery (the intrapartum period) or immediately post-partum, which includes the period from 24 hours to 6 weeks after delivery (Kassebaum, 2014; Ronsmans & Graham, 2006). Professional delivery care (e.g. trained rather than traditional birth attendants) at the time of delivery, when most complications occur, is the key policy instrument to address both the timing and causes of maternal deaths. For women, however, the decision-making process about where to deliver and who to seek care from is complex and improvements in service availability may or may not lead to improvements in care at the time of delivery. In fact, maternal mortality has remained stubbornly high in Indonesia despite substantial expansions in health infrastructure. Women may not fully internalize the benefit of relying on professional birth attendants or

receiving antenatal care until they experience complications at which point it may be too late for women to seek life-saving care.

I assembled data on maternal deaths in childbirth from five Demographic and Health Surveys (DHS) conducted in Indonesia between 1994 and 2012 to investigate whether signals from one's social network regarding the dangers of childbearing (specifically, a sister's death in childbirth) lead to behavior change at the time of delivery and patterns of prenatal care use that have the potential to guard against maternal death. By tracing the timing and causes of sister deaths and relating these events to reproductive behavior, I can make causal inferences about the role of risk information in changing reproductive behaviors.

## *1.2 Background and Context*

In September 2015, the United Nations declared a goal to reduce the world's maternal mortality ratio to under 70 deaths per 100,000 live births by the year 2030 (United Nations, 2015). Estimates suggest, however, that this goal is not obtainable for some countries even if their performance matches that of the countries with the most impressive gains over the last fifteen years (Verguet et al., 2014). Innovative policy solutions are critical for accelerating declines in maternal mortality and one place to look for these solutions may be in how women respond to information through their social networks.

The majority of maternal deaths occur during labor, delivery or within the first 24 hours after delivery (Kassebaum, 2014). About one-third of all deaths are directly

caused by hemorrhaging which can be addressed by access to skilled birth assistance during delivery (Campbell & Graham, 2006; Carroli et al., 2001; Khan et al., 2006; Supratikto et al., 2002). Maternal deaths can be prevented by focusing on the "three delays" (Thaddeus & Maine, 1994). Women may delay in seeking care for a complication because they underestimate their risk of negative consequences. When risks are known, delay in reaching a facility may hinder receipt of care and delay in receiving adequate care at facilities may exacerbate complications. Studies of admissions to hospitals in Indonesia point to delays in care-seeking at the time of delivery that result in "near misses" - women arriving at a facility already in a state of life-threatening obstetric morbidity at which point death may be imminent (Adisasmita, Asri et al., 2008; Adisasmita, A. et al., 2015; Ronsmans et al., 2009). "Near misses" can be reduced by addressing the first of the three delays – ensuring that women are aware of the dangers of not seeking care before it is too late. Most studies that track the information women know about complications in childbirth come from studying institutional sources rather than information from social networks which obscures one important channel for delivering behavior change information.

### 1.2.1 Theories of Health Behavior Change

Reducing delays in care-seeking at the time of delivery is a classic individual behavior change problem. Social scientists have long sought to understand how to stimulate positive behavior change at the individual level (Ajzen, 1991; Fishbein, 2000;

Fishbein & Ajzen, 1975; Hochbaum, 1958; Lewin, 1935; Rosenstock, 1990). A 2014 review of behavior change interventions turned up 82 health behavior change theories (Davis et al., 2014). The most widely-cited of these theories have developed similar constructs: perceived susceptibility or vulnerability to a health risk or threat, the process of weighing costs and benefits of behavior change, and the relevance of the broader environmental and social context in which individuals make decisions (Noar & Zimmerman, 2005). Operationalizing "perceived vulnerability" and measuring the causal pathways to behavior change (whether this is reported intentions or observed actions) prospectively has been an empirical challenge in research employing health behavior change theories.

The Health Belief Model (HBM) is the most prominently applied theory of behavior change. The HBM was originally developed by the U.S. Health Department to understand why individuals did not take up preventive behaviors to guard against tuberculosis (Hochbaum, 1958; Rosenstock, 1974). The HBM asserts that individual behavior change depends on a sense of vulnerability to a severe health threat and for the individual the benefits of taking up a new behavior (or abandoning a harmful one) must outweigh the costs. Individuals take into account three dimensions of perceived risk when considering a behavior change: perceived likelihood that a particular harm will befall them, perceived vulnerability or susceptibility to a particular harm, and the severity of the consequences of not changing behavior (Brewer et al., 2007). In the case

of susceptibility to maternal death, women may consider the likelihood that giving birth at home without a skilled birth attendant (or not receiving antenatal care, not taking iron supplements and so on) might lead to maternal death, whether death in childbirth is something likely to happen to them given what they know about risks to other women like them, and the severity of consequences of not adopting health promoting behaviors (the most severe being death in childbirth).

Correlational and descriptive studies in psychology and public health have demonstrated the usefulness of health behavior change theories (Glanz et al., 2008; Noar & Zimmerman, 2005; Painter et al., 2008) although few studies in these disciplines have considered whether experimental manipulation of information about risks can motivate behavior change. A review of previous studies of the role of perceived susceptibility indicated that most studies have been cross-sectional, relying on retrospective self-reports of behavior rather than assessing risk and behavior prospectively (Brewer et al., 2007; Carpenter, 2010). Among retrospective and prospective studies, prospective studies considered in Brewer (2007) showed a stronger predictive relationship for perceived susceptibility in changing behavior while other meta-analyses have found perceived susceptibility to be the weakest mechanism (Carpenter, 2010). The results of these meta-analyses should be viewed in light of the fact that the constructs of the HBM have not been uniformly implemented across studies.

Despite the lack of prospective studies in the psychology and public health literature, there have been several experimental studies in the economics literature taking place in developing countries that manipulate how information on health risk is disseminated. Providing information on the quality of drinking water through randomized controlled trials (RCTs) causes individuals to change their behavior, whether it is switching to a different, uncontaminated source of drinking water or purifying water in the home (Jalan & Somanathan, 2008; Madajewicz et al., 2007). Similar results have been found for providing information on nutritious food options for children (Fitzsimons et al., 2012) and providing specific risk information on susceptibility to HIV infection (Duflo et al., 2006; Dupas, 2011). Oster (2012) has used observational data to examine how behaviors that reduce the risk of contracting HIV differ across environments with varying levels of mortality. Oster (2012) finds that in areas where the competing risks of mortality are high, the magnitude of behavior change to protect against HIV is lower, suggesting that context is a key component in predicting whether and how much behaviors will change in response to risk information.

One compelling line of inquiry in the public health literature has used natural experiments and interrupted time series models to examine how individuals respond to health crises that occur suddenly in the lives of celebrities. For example, this research finds that when American actress Angelina Jolie announced she had a prophylactic

double mastectomy due to her genetic predisposition to breast cancer Google searches for genetic testing sky-rocketed, though they returned to prior levels within a week after the announcement (Noar et al., 2015). Studies have also tracked behavior as opposed to merely intent to change behavior as measured through information-seeking via online search engines. One study found that when Nancy Reagan announced in 1987 that she had breast cancer and would undergo a mastectomy rather than breast conserving surgery, the rate of breast conserving surgery among women in Reagan's demographic decreased sharply but returned to its prior pace of increase just a few months after Reagan's announcement (Du et al., 2000; Nattinger et al., 1998). This phenomenon extends beyond the United States. Cervical cancer and breast screening in the UK and Australia soared after celebrity announcements of bouts with cancer and these increases were among women in the same demographic as the celebrities afflicted; again rates of screening returned to prior levels within a few weeks after the announcements (Chapman et al., 2005; Kelaher et al., 2008; Marlow et al., 2012; Twine et al., 2006). Only one study I am aware of has looked at behavior change intentions as a result of a celebrity crisis in a low-income country. That study showed that internet searches for advice on how to quit smoking increased markedly among Brazilians after former Brazilian President Lula da Silva announced he developed a type of cancer attributed to smoking (Ayers et al., 2014). A general picture of the evidence on health behavior change emerges from this literature. Quasi-experimental studies have been able to

detect population level responses to announcements about celebrity health crises, responses have been stronger among the same demographic group as the celebrity but rates of screening, etc., return to prior levels fairly quickly.

This study aims to solve some of the ongoing methodological concerns in the HBM literature. I use a measure of tangible behavior rather than intention both before and after a woman gets more precise information on her susceptibility to risk of maternal mortality, thereby providing a more rigorous approach to measuring reactions to risk than asking women to recall their perceptions of risk and how this contributed to their behavior change. I also use quasi-experimental methods that are more rigorous than observational and correlational designs.

### 1.2.2 Empirical Challenges to Measuring Behavior Change Regarding Maternal Mortality

While the level of maternal mortality in economically developing countries has fallen over time, large gaps in maternal mortality rates persist between countries stratified by income (Hill et al., 2007; Hogan et al., 2010; Kassebaum, 2014; World Health Organization, 2010, 2014). In the absence of vital statistics at the national level, maternal mortality is measured through population-representative household surveys like the Demographic and Health Surveys (DHS) by asking female (and sometimes male) respondents to recall all the siblings born to their natural mother and causes of death for sisters as they relate to pregnancy and childbirth (Graham et al., 1989; Merdad et al., 2013).

Debates about the level of maternal mortality and global trends have rightly focused on the shortcomings of indirect estimation of demographic rates from household surveys to track trends over time due to large confidence intervals around estimates and under and misreporting on siblings (Graham et al., 1989; Helleringer et al., 2014a). However, a recent review of the sisterhood mortality data from the DHS shows that while under-reporting is a perennial concern, women are generally able to remember the vital status of their male and female siblings. The results of Ahmed et al. (2014) demonstrate that the sisterhood mortality data does not suffer from any more reporting bias than other recall-based measures collected in the DHS and they echo what earlier reports on the completeness of reports of maternal death in the DHS have found (Graham et al., 1989; Stanton et al., 1997, 2000) – the sisterhood mortality data is remarkably complete. If anything, estimates from household surveys of maternal mortality are underreported because of forgotten siblings and unknown timing of a sibling's death related to childbirth (Ahmed et al., 2014; Helleringer et al., 2013; Helleringer et al., 2014a; Helleringer et al., 2014b). Of course, reporting of vital status varies by country and researchers should remain aware of the shortcomings of data collected through this survey method. Until now, however, the data has not been used to understand how a sister's death in childbirth can impact reproductive behaviors of the respondent herself at the time of delivery and during pregnancy.

Several features of Indonesian religious culture mitigate the critiques of the sisterhood method in terms of recall about events happening to siblings. In Javanese variants of Islam, it is customary to pray for someone in time increments of several days and weeks after their death and on the anniversary of the person's death thereafter (Beatty, 1999; Daniels, 2012). Followers of Islam in Indonesia also observe a practice that obligates them to visit the graves of their loved ones every year before Ramadan and for all siblings to return to the homes of their parents during the week following Ramadan (Daniels, 2012; Woodward, 2010). In Indonesia, where 87.2% of the population identified as Muslim in 2010 (Pew Resource Centre's Forum on Religion and Public Life, 2012) remembering deaths, even those occurring long ago, seems likely.

## *1.3 Reproductive Health in the Indonesian Context*

Over the last three decades in Indonesia, socioeconomic well-being, both in terms of income per capita and average levels of education, has improved dramatically. Typically, improvements in health outcomes accompany improvements in these markers of socioeconomic status. Indeed, infant and child mortality in Indonesia has improved considerably while the maternal mortality ratio has remained stubbornly high, even increasing from 228 maternal deaths per 100,000 live births in 2007 to 359 maternal deaths per 100,000 live births in 2012 as estimated by the 2012 Indonesia Demographic and Health Survey (IDHS) – with the caveat that confidence bands around these estimates overlap (Statistics Indonesia (Badan Pusat Statistik - BPS) et al., 2013).

Indonesia has long been focused on reducing both geographic and financial barriers to use of high quality obstetric care like skilled birth attendants (midwives, doctors and nurses) for delivery and encouraging facility deliveries rather than home births. Table 1 illustrates the rapid increase in facility deliveries and use of skilled birth attendants between 1994 and 2012.

**Table 1. Obstetric service use in Indonesia over time; percentage of births in the five years before each Demographic and Health Survey (DHS)**

| | DHS Survey Wave | | | | |
|---|---|---|---|---|---|
| | 1994 | 1997 | 2002 | 2007 | 2012 |
| Percent (%) of births delivered in a facility[a] | 18 | 21 | 41 | 46 | 63 |
| Percent (%) of births delivered by a skilled birth attendant[b] | 37 | 43 | 66 | 73 | 83 |
| Percent (%) of births with any antenatal care by a skilled provider | 82 | 89 | 92 | 93 | 96 |

[a]A facility could be one of hospital (public or private), health center, delivery post, or clinic.
[b]Skilled birth attendants/providers in this context are doctors, midwives, obstetricians and nurses.

During this period, facility deliveries have more than tripled and births attended by skilled birth attendants have more than doubled. Strengthening the skills and availability of providers characterized the first efforts in Indonesia to reduce access barriers – midwives have been highly effective service providers in remote villages since the early 1990s when Indonesia undertook to provide a midwife in each of 50,000 villages across the island archipelago (Frankenberg et al., 2008; Frankenberg & Thomas, 2001). Midwives, however, may not be trained to provide more complicated procedures

that women might require in an obstetric emergency including blood transfusions and c-sections. Recently, the rigor of midwifery training in Indonesia has been called into question given the proliferation of many schools without proper credentialing (Rokx et al., 2010). Between 1992 and 1997, a program that required physicians to serve in remote areas was scaled back leading to many public health centers in remote areas without a general practitioner on staff, though midwives trained to provide obstetric care were still rapidly expanding to these areas between 1996 and 2006 (Diana et al., 2014; Rokx et al., 2010). Financial subsidy programs targeting use of obstetric care for poor women were developed in the early 2000s (Kruse et al., 2012) and have continued to evolve rapidly over the period of this study leading to a scheme for poor families developed in 2005 (ASKESKIN, now known as Jamkesmas) to alleviate health service fees for the poor, which can be used to cover the services of a skilled birth attendant (Ronsmans et al., 2009). There are also recent moves towards universal health coverage (Anderson et al., 2014) that would give more women the opportunity to access skilled delivery care.

Despite these efforts, patterns of access to more sophisticated obstetric care tend to favor the more populous and economically advantaged islands of Java and Bali (Barber et al., 2007a; Diana et al., 2014). Typically it is women with fewer human capital resources who underutilize pregnancy-related services such as antenatal care (Titaley et al., 2010). Even when the same quality of obstetric services are available for women in communities, poorer women report receiving lower quality care than women at the

higher end of the income distribution (Barber & Gertler, 2008). Patterns of health care quality also favor the urban, more populous areas of Indonesia and quality of prenatal care provided tends to lag behind curative care for adults and children (Barber et al., 2007a, 2007b; Diana et al., 2014). Despite rapid expansions in access to care, gaps remain in the adequacy of prenatal and delivery care provided to poor, rural women in Indonesia. The rapid evolution of obstetric services in Indonesia has created two relatively distinct periods with respect to service access, quality and health care financing. Accordingly, I consider two periods: 1989 to 2000 and 2001 to 2012 in my analysis.

Though the ratio of maternal deaths to live births is high in Indonesia relative to other countries at the same level of human development, maternal death in Indonesia is still a rare event, and the risks of childbirth may seem very low to women whose only experience with labor and delivery involves instances without complications. Women who underestimate the potential risks inherent in childbearing (e.g. excessive bleeding, fever, convulsions, long labor, etc.) may be less likely to choose delivery care that could intervene effectively if such complications arise and less likely to choose inputs that increase the likelihood that complications will be detected before they become an emergency. This study examines pathways outside the health system through which women learn about the risks of childbearing and how they may change their behavior in response.

Social networks are one channel through which women may learn information about the dangers of childbearing which may heighten their perceived vulnerability to complications during delivery and lead to behavior change. It is this process that works through social networks rather than institutional channels that provides the framework for my empirical task. I first operationalize the construct of perceived susceptibility and severity by considering a group of women whose sisters die in childbirth and whom I observe before and after their sisters have died. I hypothesize that deaths in childbirth have information embedded within them on risk of dying in a similar way. Sisters who die in childbirth are not distant strangers, but members of one's family, thus leading to a heightened sense of susceptibility to maternal death for the women who have lost a sister. Maternal deaths, while not random, are rare events that are likely unanticipated and thus provide an event that may suddenly heighten perceived susceptibility, severity about the likelihood of death and may cause positive behavior change during pregnancy and at the time of delivery. In order to understand how information about the riskiness of childbearing is transmitted through a sister's death in childbirth in the most empirically rigorous way, I need to construct a comparison group from the population of women in the Demographic and Health Survey (DHS) who have similar characteristics to women whose sisters die in childbirth. Because the sisterhood mortality module collects data on deaths of sisters from all causes, I can construct a comparison group of women who were at risk of having a sister die in childbirth but

whose sister died from a cause other than childbirth. My empirical strategy examines differences over time between women whose sisters die in childbirth and statistically similar women whose sisters die from some other cause, controlling for observable factors that vary across women.

## *1.4 Data and Methods*

This study utilizes data from five waves of the Indonesia Demographic and Health Survey (IDHS) (1994, 1997, 2002, 2007, and 2012). Respondents to the IDHS are women of reproductive age (ages 15-49) who report on their socio-economic characteristics, pregnancy histories, and an array of health behaviors regarding their own health and that of their children. This study makes extensive use of the sisterhood mortality module (Graham et al., 1989; Stanton et al., 1997, 2000) which was developed to measure maternal mortality when official vital statistics are lacking. In the sisterhood mortality module, respondents are asked to report the number of siblings (both male and female) born to their natural mother and the survival status of each of these siblings, including the dates of their death. For sisters who were older than 10 years of age when they died, women are asked whether their sister's death was related to childbirth. IDHS

surveys are representative of both urban and rural populations in each province of Indonesia.[1]

The dataset I use in this study is constructed from information on all live-births during the five year period before each survey using retrospective accounts from the IDHS. Each observation represents a woman-birth-year. The timing of sister deaths is reconstructed using retrospective reports from the IDHS sisterhood mortality module linked to the births data so that for each woman-birth-year the vital status of all the respondent's sisters is known. The five waves of the IDHS provide observations for 164,963 women, of whom 1% (1,727) of these women report experiencing the death of a sister in childbirth and 18% (29,556 women) report having a sister die at any age from a cause that is not related to childbirth. The women whose sisters have died in childbirth are the individuals who received information on the dangers of childbearing through the personal experience of losing a sister in childbirth.[2] I would like to compare these women to a group of women who are similar to them, i.e. women who were at risk of having a sister die in childbirth. I make two restrictions of the sample to select a group of at-risk women. First I select all births that occurred while a woman had a sister of reproductive age (between the ages of 15 and 49). Then, I select women whose sisters

[1] Due to civil unrest, prior to 2007 the DHS did not sample households in the provinces of Aceh, Papua and West Papua. Therefore observations from these provinces do not appear in my sample until the 2007 and 2012 survey waves.

[2] For some of these women, their sisters are not of reproductive age when they die. 5.5% of women (9,144) have sisters who die of causes other than childbirth when the sister is between ages 10 and 49.

have died in childbirth or from another cause when they were between the ages of 10 and 49 to mimic the maternal mortality question asked in the IDHS. After restricting the data in this way, there are 651 women whose sisters die in childbirth and 3,179 women whose sisters die from some other cause. In my main focal group of women who gave birth between 2001 to 2012 (in the later period when the obstetric service environment was much richer), there are 291 women whose sisters die in childbirth and 1,572 women whose sisters die from some other cause. Women whose sisters die in childbirth during this period contribute 367 births and women whose sisters die from some other cause contribute 1,911 births.

While sister deaths in childbirth may be both rare and unanticipated, women who experience a sister's death in childbirth likely differ in observable and unobservable ways from women whose sisters die of a cause other than childbirth and are likely to differ from the larger population of women giving birth in the five years before the survey. Table 2 presents descriptive statistics for women in the IDHS who are at-risk of losing a sister in childbirth as defined earlier. The first column pools all women who meet the criteria for being at-risk of maternal death and the remaining columns disaggregate women into those who experience childbirth (CB) deaths and those who experience deaths from another cause (NCB). Between 2001 and 2012, 47% of births in Indonesia were delivered at home and of those births delivered at home 52% were delivered with a skilled birth attendant present. Almost three-quarters of women took

iron supplements during pregnancy. For women whose sisters died in childbirth compared to women at-risk whose sisters do not die, women who experience a sister's death in childbirth were more likely to give birth at home, less likely to use skilled birth attendants at home births and less likely to take iron supplements during pregnancy. For demographic variables measured for each birth such as woman's age, parity and year of each birth, and those constant over time for each woman such as primary education or more, location in the wealth spectrum and rural residence, I find that while differences between women whose sisters die in childbirth and women at-risk of a sister death are large, the gap diminishes when comparing women whose sisters die in childbirth to those whose sisters die from some other cause (column 4 of Table 2). The last column of Table 2 shows that when I use both birth and woman-specific variables to predict whether a woman will experience a death in childbirth (I do not include variables measuring birth-specific dependent variables), only being in the top two of five wealth quintiles and lower parity is protective against experiencing a sister's death in childbirth.[3] It is important to control for demographic and socio-economic differences between the two groups of women whose sisters die in childbirth or who die from some other cause.

[3] Analysis of the period 1989-2000 shows broadly similar results. Table available from the author upon request.

**Table 2. Descriptive statistics for dependent and independent variables used in the main analysis (years 2001-2012). Variables disaggregated by birth-specific variables and time invariant variables measured at the woman-level.**

| | | Differences (relative to at-risk sample) | | | |
|---|---|---|---|---|---|
| | All women with sisters of reproductive age (at-risk) | Women whose sisters died in childbirth (CB) | Women whose sisters died from some other cause (NCB) | Difference (CB relative to NCB) | Partial correlation of variable with sister death in CB |
| | mean (sd) | difference (se) | difference (se) | difference (se) | direction, p-value |
| | (1) | (2) | (3) | (4) | (5) |
| *Dependent Variables (birth-specific)* [a] | | | | | |
| Delivery at home (ref: delivery in a hospital, delivery post, health center, etc.) | 0.47 | 0.18 | 0.05 | 0.13 | |
| | (0.50) | (0.04) | (0.02) | (0.04) | |
| Delivery with a skilled birth attendant during home birth (ref: home birth without a skilled birth attendant) | 0.52 | -0.17 | 0.01 | -0.18 | |
| | (0.50) | (0.05) | (0.03) | (0.05) | |
| Took iron supplements during pregnancy | 0.72 | -0.09 | -0.03 | -0.06 | |
| | (0.45) | (0.04) | (0.02) | (0.04) | |

| | | | | | |
|---|---|---|---|---|---|
| *Birth-specific Control Variables* | | | | | |
| Woman's age in years at index birth | 27.95 | 2.10 | 2.19 | -0.01 | + |
| | (6.18) | (0.54) | (0.27) | (0.60) | 0.44 |
| Parity at index birth | 1.44 | 0.85 | 0.49 | 0.36 | + |
| | (1.63) | (0.15) | (0.07) | (0.16) | 0.01 |
| Year at index birth | 2006 | -0.24 | -0.06 | 0.19 | - |
| | (3.29) | (0.26) | (0.13) | (0.28) | 0.67 |
| Number of observations | 33,939 | 367 | 1,911 | 2,278 | |
| *Time Invariant Woman-level Control Variables* | | | | | |
| 7+ years of education | 0.58 | -0.18 | -0.08 | -0.10 | - |
| (ref: primary education or less) | (0.49) | (0.04) | (0.02) | (0.05) | 0.26 |
| Top 2 wealth quintiles | 0.40 | -0.19 | -0.04 | -0.15 | - |
| (ref: bottom 3 wealth quintiles) | (0.49) | (0.04) | (0.02) | (0.04) | 0.01 |
| Rural residence | 0.53 | 0.09 | 0.04 | 0.05 | - |
| (ref: urban residence) | (0.50) | (0.04) | (0.02) | (0.05) | 0.76 |
| Number of observations | 28,532 | 291 | 1,572 | 1,863 | 33,939 |

Note: Table reports weighted values for the analytical sample. The analytical sample includes women who have given birth in the five years before the survey and had a sister of reproductive age at the time a sister between the ages of 10 and 49 died. In the main analysis, a woman-birth-year is the level of observation with some variables birth-specific and some variables time-invariant for each woman. The final column reports the direction of the relationship and p-value for the partial correlation of each control variable with having a sister die in childbirth among all at-risk women.

[a] Number of observations for birth-specific outcomes varies between at home and taking iron supplements because the at home outcome is measured for all births in the five years before the survey and iron is only measured for the last birth. For at-home, there are 33,725 observations from at-risk women. 363 observations from women whose sisters have died in childbirth (CB) and 1,898 observations from women whose sisters have died from some other

cause (NCB). For using a skilled birth attendant, conditional on giving birth at home there are 18,268 at risk women, 255 CB and 1,113 NCB. For taking iron supplements, there are 28,511 at risk women, 295 CB and 1,547 NCB.

### 1.4.1 Outcome Variables

The empirical question is whether the death of a sister encourages a woman to take up behaviors that can reduce her own risk of dying in childbirth. Risk reduction is operationalized through the selection of three outcomes that were chosen for their proximity to behaviors that can avert maternal death during the intrapartum period, when most deaths occur.

The first outcome is a zero one indicator variable that is equal to one when a birth occurs at home, zero otherwise. Home births in Indonesia carry more risks than births that occur in health centers and hospitals where emergency obstetric care is more likely to be available should complications arise. As of 2012, a little more than 35% of births in Indonesia took place at home (National Statistical Service Indonesia, 2012). One way to limit risk while delivering at home is to have a skilled birth attendant, typically a midwife, attend the birth.

The second outcome examines whether conditional on giving birth at home, the birth had a skilled birth attendant present. Skilled birth attendants in this context can be doctors, nurses, midwives or obstetricians while non-skilled birth attendants include "dukun" (traditional birth attendants with limited or no medical training), relatives, friends or no assistant. Nearly all non-home births are attended by skilled providers, however, 44% of home births delivered between 2007 and 2012 had no skilled birth attendant present.

The last outcome I examine is taking iron supplements during pregnancy which captures an important aspect of risk reduction behavior that women can adopt during their pregnancy. Nearly one-third of deaths in childbirth are caused by hemorrhaging during delivery which can be aggravated by anemia. Anemia is a particular concern in Indonesia where diets consist mainly of rice and other low iron food sources. One recent study estimated that as many as 20% of women of reproductive age in Indonesia were anemic (MoH Indonesia, 2013).

### 1.4.2 Analytical Strategy

The effect of a sister's death in childbirth is estimated using a difference-in-difference strategy (Bertrand et al., 2004). This strategy takes into account observable differences between women whose sisters have died in childbirth and those who have died from some other cause and makes use of the fact that women can be observed both before and after their sisters have died.

This study uses an ordinary least squares (OLS) linear probability model to estimate the following equation:

$$\theta_{it} = \beta_1 (sisterdeathCB)_i + \beta_2 (after)_{it} + \beta_3 (sisterdeathCB_i * after_{it}) + year + \boldsymbol{X}\beta + \varepsilon_{it} \quad (1)$$

$\theta$ refers to a dichotomous indicator for any of three behaviors (giving birth at home, using a skilled birth attendant conditional on giving birth at home, or taking iron supplements during pregnancy). *sisterdeathCB* is an indicator that is equal to one if a respondent's sister has died in childbirth, zero if a respondent's sister has died from a cause other than childbirth. *after* is an indicator that is equal to zero for all births that occurred for woman $i$ at time $t$ before a sister death of any type; after a sister death has occurred this variable is equal to 1. The difference-in-difference estimate is represented by the coefficient $\beta_3$. This can be interpreted as the differential change in behavior for women whose sisters have died in childbirth, over and above the change for those who have died from some other cause. In addition, year fixed effects are included to pick up any variation that is coming from secular trends in service use and availability. $\mathbf{X}\beta$ is a vector of control variables that include respondent's age at the index birth, age squared, a fixed effect for parity at the time of the index birth, and dummy variables indicating whether a respondent has seven or more years of education (which equates to more than primary school in Indonesia), is in the top two of five wealth quintiles or the wealth quintile is missing (as it is in the 1994 IDHS), and whether the respondent resides in a rural area at the time of the IDHS. For delivery care outcomes the period after a sister's death is delineated by the year the sister died. Each observation is weighted using the individual sampling weights provided by IDHS. Robust standard errors are clustered at the level of the sampling cluster.

Because of rapid changes in the service environment in Indonesia over the study period, I divide the sample into two periods that correspond to the service roll-outs described earlier in the background section. The first period includes births that occurred between 1989 and 2000. Some of these births occurred during a time when Indonesia was facing an economic collapse on the order of magnitude of the Great Depression, which began in late 1997. Moreover, a program that required physicians to serve at public health centers in rural and remote areas as civil servants was phased out between 1992 and 1997, which led to an increase in the percentage of public health centers without general practitioners (Diana et al., 2014; Rokx et al., 2010). Later in the period, beginning in 2001, insurance schemes to help defray the costs of obstetric care were developed and targeted towards poor households (Kruse et al., 2012) and there was an extremely rapid scaling up of midwives posted to provinces outside Java and Bali between 1996 and 2006 (Rokx et al., 2010). The difference between these two service environments sheds light on the service environment facing women in Indonesia over time and plays a critical role in explaining contextual factors that can influence behavior change as described in the Health Belief Model (HBM) (Glanz et al., 2008).

Possibly the effects of information vary by women's socio-economic and demographic characteristics. To examine this I stratify by: parity (first and second births vs. third births and higher), education (having 7 years of schooling or more or 6 or fewer

years, which is the cut-off for primary school in Indonesia), and living in an urban or a rural area.

Lastly, I examine whether results differ by time since a sister's death to test the claim that health seeking behaviors change quickly and then rapidly return to prior levels as time since a health threat lengthens. I also test for the possibility that after a sister has died, her children enter the household of the living sister thus making it more difficult for the respondent to access care after her sister's death relative to before.

## *1.5 Results*

This section presents the results of estimating the difference-in-difference models for all outcomes. The main results are presented first, followed by results disaggregated by various subsets (parity at the index birth, education level, and rural or urban residence).

### 1.5.1 Main Results for the Full Sample

Table 3 presents the main results of estimating the difference-in-difference equation. In the earlier period (births occurring between 1989 and 2000), a sister's death in childbirth has no statistically significant effect on behaviors related to delivery location, choice of a skilled birth attendant or taking iron during pregnancy. However, in the later period, between 2001 and 2012 when physical availability of delivery services had improved substantially, interesting patterns of service use emerge. After their sister has died in childbirth, women are 22% points less likely ($p< 0.01$) to

give birth at home relative to before their sister has died. This gap is net of time trends, socioeconomic characteristics and differencing out behavior change for women whose adult sisters die of a cause other than childbirth. 52% of women whose sisters die from some other cause gave birth at home during the period of the study. A 22% point decrease for women whose sisters die in childbirth is almost half of the level of home-birth use in the comparison group. The result for using a skilled birth attendant conditional on having a home birth is not statistically significant. The result for iron supplementation is imprecisely estimated, though it moves in a direction suggesting positive behavior change.

Columns 7-9 of Table 3 present the results of limiting the sample further to only women whose sisters die during delivery (this excludes sister deaths while pregnant or within 24 hours to 42 days after delivery). The results for women whose sisters die in delivery are stronger than when all types of maternal death are pooled together. Women are now 32% points less likely to give birth at home ($p<0.001$). Moreover, the result for taking iron supplements is positive and significant at the 10% level indicating women are 28% points more likely to take iron supplements after a sister has died in childbirth. For both giving birth at home and taking iron supplements, an F-test rejects that the coefficient representing the differential change in behavior is the same for both the full sample (deaths at any point in pregnancy) and the sample of women whose

**Table 3. Regression results comparing partition of data by service environment and timing of death in childbirth**

| | Early Service Delivery Environment: 1989-2000 | | | Late Service Delivery Environment: 2001-2012 | | | Late Service Delivery Environment: During Delivery Only | | |
|---|---|---|---|---|---|---|---|---|---|
| | Gave birth at home | Used a skilled birth attendant during home birth | Took iron during pregnancy | Gave birth at home | Used a skilled birth attenda-nt during home birth | Took iron during pregnancy | Gave birth at home | Used a skilled birth attenda-nt during home birth | Took iron during pregnancy |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Sister death in childbirth x After sister death | 0.04 | 0.02 | 0.31 | -0.22** | -0.02 | 0.14 | -0.32*** | 0.02 | 0.28† |
| | (0.05) | (0.07) | (0.22) | (0.07) | (0.12) | (0.13) | (0.09) | (0.14) | (0.15) |
| Sister death in childbirth | 0.02 | -0.07 | -0.35* | 0.25*** | -0.13 | -0.15 | 0.34*** | -0.17 | -0.29* |
| | (0.04) | (0.06) | (0.16) | (0.07) | (0.11) | (0.13) | (0.09) | (0.12) | (0.14) |
| After sister death | -0.02 | -0.04 | -0.17+ | 0.04 | -0.07 | -0.00 | 0.04 | -0.07 | -0.00 |
| | (0.04) | (0.04) | (0.10) | (0.04) | (0.05) | (0.04) | (0.04) | (0.05) | (0.04) |
| Age of woman in years | -0.04* | 0.03 | -0.02 | -0.05** | 0.02 | -0.00 | -0.05** | 0.03 | -0.00 |
| | (0.02) | (0.02) | (0.08) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) |
| Age of woman in years squared | 0.00* | -0.00 | 0.00 | 0.00* | -0.00 | 0.00 | 0.00* | -0.00 | 0.00 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| 7 or more years of | -0.18*** | 0.31*** | 0.07 | -0.12*** | 0.27** | 0.14*** | -0.11*** | 0.27*** | 0.13*** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| education | (0.03) | (0.04) | (0.09) | (0.03) | (0.05) | (0.04) | (0.03) | (0.05) | (0.04) |
| Top 2 wealth quintiles | -0.06 | 0.04 | 0.22* | -0.12** | 0.12+ | -0.02 | -0.12** | 0.12+ | -0.02 |
| | (0.05) | (0.07) | (0.09) | (0.04) | (0.06) | (0.04) | (0.04) | (0.06) | (0.04) |
| Wealth quintile missing | -0.01 | -0.10+ | | | | | | | |
| | (0.03) | (0.05) | | | | | | | |
| Rural residence | 0.28** | -0.14** | 0.01 | 0.30*** | -0.08 | -0.03 | 0.30*** | -0.08 | -0.03 |
| | (0.04) | (0.05) | (0.09) | (0.04) | (0.06) | (0.04) | (0.04) | (0.06) | (0.04) |
| Constant | 1.28*** | 0.06 | 1.56 | 1.38*** | 0.15 | 0.73* | 1.38*** | 0.14 | 0.72* |
| | (0.25) | (0.26) | (1.19) | (0.27) | (0.36) | (0.35) | (0.27) | (0.36) | (0.35) |
| Parity controls? | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| Year controls? | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| F-test: full sample = during delivery sample | | | | | | | | | |
| chi2 | | | | | | | 4.07 | 0.98 | 4.85 |
| p > chi2 | | | | | | | 0.04 | 0.32 | 0.03 |
| Observations | 2,549 | 2,030 | 323 | 2,261 | 1,368 | 1,842 | 2,242 | 1,356 | 1,827 |
| R-squared | 0.27 | 0.19 | 0.15 | 0.33 | 0.17 | 0.06 | 0.33 | 0.18 | 0.07 |

Note: Skilled birth attendant in this context is a doctor, nurse, midwife, or obstetrician. Home births are relative to births in public and private health facilities including hospitals, delivery posts and midwife's practice, etc. Sampling weights are used. Robust standard errors are clustered at the level of the sampling cluster.

+p < .10; *p < .05; **p < .01; ***p < .001

sisters have died during delivery suggesting that the information embedded in a death during delivery carries a strong message about risk of death in childbirth.[4]

An interesting phenomenon arises from the results in Table 3. The coefficient on the interaction term (which indicates the effect of a sister's death in childbirth net of changes in the comparison group, represented by $\beta_3$ in Eq. 1) tends to be of similar magnitude and significance level as the coefficient on the baseline differences between the two subsets of women I examine (represented by $\beta_1$ in Eq. 1). For example, women whose sisters die in childbirth are 25% points more likely to give birth at home ($p < 0.001$) than women whose sisters die from some other cause. After a sister's death in childbirth, women are 22% points less likely to give birth at home ($p < 0.01$). On average, women whose sister's die in childbirth are 13% more likely to give birth at home than women whose sisters die from another cause (Table 2, column 4). A sister's death in childbirth seems to work to narrow the gap between these women. Similar results emerge for taking iron supplements. Women whose sisters die in childbirth are 6% points[5] less likely to use iron supplements during pregnancy than women whose sisters die from another cause. After a sister's death in childbirth, the gap between these

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[4] I also test the following indicators of antenatal care: antenatal care use in the first semester, at least four antenatal care visits during pregnancy or none at all. Results for these outcomes are not statistically significant but generally suggest that, as with delivery care use, effects are more favorable for births that occur between 2001 and 2012 than births occurring in the earlier period, 1989-2000. Results available from the author upon request.

[5] See Table 1.

women is closer to 1% point (15-14). Recall from Table 2 that women who lose sisters to deaths in childbirth are poorer and less-educated than women whose sisters die from other causes; taken together these results suggest that a sister's death in childbirth helps usher women of lower socio-economic status into the formal healthcare system – a system other women are already accessing despite never having a sister die in childbirth.

### 1.5.2 Subgroup Analysis

It is possible that the impact of a sister's death varies by characteristics of the respondents. Table 4 reports the results of stratifying by parity, years of education, and rural residence. An interesting pattern emerges with regards to parity and socioeconomic status. The impact of a sister's death in childbirth on reduced chances of delivering at home are driven primarily by behavior change among women at low parities, low levels of education and living in rural households. An F-test of whether, for each subset, the coefficients are significantly different from each other fails to reject that the coefficients are the same.

Conditional on giving birth at home, women who are of lower parity and who have fewer years of education are more likely to use skilled birth attendants, the coefficients are imprecisely estimated but the results are in a direction that suggests less risky behavior. Urban women are more likely to use skilled birth attendants conditional

on giving birth at home which suggests they reside in a richer service environment where this kind of care is possible. An F-test rejects that this outcome for urban and rural women is the same. However, women with more than a primary education are less likely to use skilled birth attendants when giving birth at home. This seems counterintuitive, possibly women in this demographic who give birth at home are a very select group for whom religious or other social factors preclude them from both giving birth outside the home and using skilled birth attendance during home births.

Women of lower parity, women with more than a primary education and urban women are more likely to take iron supplements when they are pregnant than women of higher parity, women with primary education or less and women living in rural areas. An F-test fails to reject that the coefficient for each subset is the same.

**Table 4. Results of stratifying the sample by demographic characteristics**

| | Gave birth at home | Used a skilled birth attendant during home birth | Took iron during pregnancy |
|---|---|---|---|
| *Parity subsets* | | | |
| First or second births | -0.24* | 0.01 | 0.23 |
| | (0.11) | (0.18) | (0.16) |
| Third or higher births | -0.10 | -0.04 | -0.19 |
| | (0.09) | (0.16) | (0.14) |

| | | | |
|---|---|---|---|
| F-test: first or second vs. third or more births | | | |
| chi2 | 0.90 | 0.04 | 3.92 |
| prob > chi2 | 0.34 | 0.85 | 0.85 |
| *Education subsets* | | | |
| Fewer than 7 years of education | -0.32*** | 0.18 | 0.08 |
| | (0.09) | (0.15) | (0.19) |
| 7 or more years of education | -0.11 | -0.34+ | 0.27 |
| | (0.12) | (0.19) | (0.20) |
| F-test: fewer than 7 vs. 7 or more | | | |
| chi2 | 1.91 | 5.07 | 0.51 |
| prob > chi2 | 0.17 | 0.02 | 0.48 |
| *Place of residence subsets* | | | |
| Rural | -0.23** | -0.13 | 0.01 |
| | (0.09) | (0.12) | (0.15) |
| Urban | -0.17 | 0.50 | 0.31 |
| | (0.12) | (0.29) | (0.24) |
| F-test: rural vs. urban | | | |
| chi2 | 0.19 | 3.10 | 1.01 |
| prob > chi2 | 0.66 | 0.08 | 0.32 |

Note: Coefficients are from the interaction term in the difference-in-difference regression as in other tables. Sampling weights are used and robust standard errors are clustered at the level of the sampling cluster. Sample includes observations from 2001-2012 for both delivery and non-delivery childbirth deaths.
+p < .10; *p < .05; **p < .01; ***p < .001

### 1.5.3 Time Since Death Analysis

The quasi-experimental literature on behavior change as a result of celebrity health crises suggests that behavior change related to smoking and cancer screenings is usually sudden and tends to trail off quickly within a few weeks to months after the celebrity's announcement. I examine evidence for whether the impact of a sister's death

varies as a function of elapsed time since the death occurred. Table 5 compares all women before their sister has died from any cause to women who give birth in the first three years after a sister death, those who give birth within 4-7 years after a sister's death and those who give birth within 8 or more years after a sister's death. For all but women whose sisters have died within the last 3 years, the coefficients are of the same magnitude and significance level as those when time is not disaggregated. For using a skilled birth attendant conditional on giving birth at home, an F-test fails to reject that the coefficient is the same for women who are in the first three years since a sister has died compared to the full set of women. Smaller effects in the first three years after a sister's death could suggest some selection into childbearing in this period as a response to a sister's death. For instance, one reaction to a sister's death in childbirth could be to prolong the time to next birth, which could lead to women who are less likely to change their delivery behavior also more likely to give birth in this window. (I explore this hypothesis in other work.)

**Table 5. Regression results analyzing responses to a sister's death by time since death.**

| | Gave birth at home | | | Used a skilled birth attendant during home birth | | | Took iron during pregnancy | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1-3 years ago | 4-7 years ago | 8+ years ago | 1-3 years ago | 4-7 years ago | 8+ years ago | 1-3 years ago | 4-7 years ago | 8+ years ago |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Sister death in childbirth x After sister death | -0.17$^{+}$ | -0.28$^{**}$ | -0.23$^{**}$ | -0.23$^{+}$ | -0.09 | 0.06 | 0.00 | 0.15 | 0.17 |
| | (0.10) | (0.10) | (0.08) | (0.13) | (0.15) | (0.13) | (0.16) | (0.15) | (0.14) |
| Sister death in childbirth | 0.26$^{***}$ | 0.27$^{***}$ | 0.25$^{***}$ | -0.14 | -0.16 | -0.11 | -0.12 | -0.15 | -0.15 |
| | (0.07) | (0.07) | (0.07) | (0.12) | (0.10) | (0.11) | (0.14) | (0.13) | (0.13) |
| After sister death | 0.07 | 0.03 | 0.04 | 0.00 | -0.06 | -0.11$^{†}$ | 0.05 | -0.03 | -0.00 |
| | (0.05) | (0.05) | (0.04) | (0.07) | (0.06) | (0.06) | (0.05) | (0.05) | (0.05) |
| Age of woman in years | -0.11$^{***}$ | -0.05 | -0.05$^{+}$ | -0.01 | -0.03 | 0.06$^{*}$ | 0.03 | -0.01 | -0.02 |
| | (0.03) | (0.03) | (0.02) | (0.04) | (0.04) | (0.03) | (0.04) | (0.04) | (0.03) |
| Age of woman in years squared | 0.00$^{***}$ | 0.00 | 0.00 | 0.00 | 0.00 | -0.00† | -0.00 | 0.00 | 0.00 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| 7 or more years of education | -0.06 | -0.12$^{*}$ | -0.15$^{***}$ | 0.22$^{***}$ | 0.24$^{***}$ | 0.24$^{***}$ | 0.08 | 0.14$^{*}$ | 0.18$^{***}$ |
| | (0.05) | (0.05) | (0.04) | (0.06) | (0.06) | (0.06) | (0.06) | (0.06) | (0.05) |
| Top 2 wealth quintiles | -0.13$^{+}$ | -0.09 | -0.10$^{+}$ | 0.26$^{**}$ | 0.33$^{***}$ | 0.11 | 0.05 | 0.06 | -0.06 |
| | (0.06) | (0.06) | (0.05) | (0.08) | (0.08) | (0.07) | (0.07) | (0.07) | (0.05) |
| Rural residence | 0.29$^{***}$ | 0.31$^{***}$ | 0.32$^{***}$ | -0.16$^{*}$ | -0.04 | -0.05 | 0.05 | -0.06 | -0.02 |
| | (0.05) | (0.06) | (0.04) | (0.08) | (0.07) | (0.06) | (0.07) | (0.06) | (0.05) |
| Constant | 2.12$^{***}$ | 0.93$^{+}$ | 0.92$^{**}$ | 0.51 | 0.84 | -0.34 | 0.16 | 0.98 | 0.78 |
| | (0.38) | (0.49) | (0.31) | (0.60) | (0.52) | (0.42) | (0.58) | (0.54) | (0.43) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Parity controls? | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| Year controls? | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| F-test: full sample = timing subset | | | | | | | | | |
| chi2 | | | | | | | | | |
| p > chi2 | 0.67 | 0.6 | 0.02 | 5.13 | 0.42 | 2.5 | 2.2 | 0.02 | 0.46 |
| | 0.41 | 0.44 | 0.89 | 0.02 | 0.51 | 0.11 | 0.14 | 0.89 | 0.50 |
| Observations | 756 | 806 | 1,533 | 450 | 478 | 928 | 586 | 625 | 1,253 |
| R-squared | 0.38 | 0.36 | 0.33 | 0.29 | 0.31 | 0.18 | 0.11 | 0.17 | 0.07 |

Note: Skilled birth attendant in this context is a doctor, nurse, midwife, or obstetrician. Home births are relative to births in public and private health facilities including hospitals, delivery posts and midwife's practice, etc. Sampling weights are used. Robust standard errors are clustered at the level of the sampling cluster. Sample includes observations from 2001-2012 for both delivery and non-delivery childbirth deaths.

$^{+}p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

### 1.5.4 Additional Burden in the Household Analysis

Is it possible that the results arise because of a factor that is correlated with losing a sister rather than the death itself? Perhaps a sister's death results in the deceased sister's children entering the household of the living sister. Additional children in the home at the time of subsequent births might affect women's delivery choices. Young children might inhibit plans to deliver in facilities, making the woman more likely give birth at home. Alternatively, the presence of an adolescent could mean that there is a caretaker for young children while the mother goes to a facility to deliver. If it is the case that women have additional children in their care which prevent them from delivering away from home, the coefficient I estimate would be too small; many women would want to change their behavior but be unable to. Additionally, women whose sisters die from some other cause may also take a sister's children into their home and so women in the comparison group may also need to contend with additional children to

**Table 6. Results for excluding individuals who report adopted, foster, stepchildren or other relative children under age 13 in the household.**

| | Gave birth at home | | Used a skilled birth attendant during home birth | | Took iron during pregnancy | |
|---|---|---|---|---|---|---|
| | Excluding households with adopted, foster or stepchildren | Excluding households with other relative children under age 13 who are usual residents | Excluding households with adopted, foster or stepchildren | Excluding households with other relative children under age 13 who are usual residents | Excluding households with adopted, foster or stepchildren | Excluding households with other relative children under age 13 who are usual residents |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Sister death in childbirth x After sister death | -0.24** | -0.21** | -0.04 | 0.01 | 0.16 | 0.18 |
| | (0.08) | (0.08) | (0.13) | (0.13) | (0.13) | (0.14) |
| Sister death in childbirth | 0.26*** | 0.23*** | -0.11 | -0.15 | -0.17 | -0.18 |
| | (0.07) | (0.07) | (0.11) | (0.12) | (0.13) | (0.13) |
| After sister death | 0.05 | 0.03 | -0.06 | -0.11+ | 0.00 | -0.01 |
| | (0.04) | (0.04) | (0.05) | (0.06) | (0.04) | (0.05) |
| Age of woman in years | -0.05** | -0.06** | 0.03 | 0.03 | 0.00 | -0.00 |
| | (0.02) | (0.02) | (0.02) | (0.03) | (0.02) | (0.03) |
| Age of woman in years squared | 0.00+ | 0.00* | -0.00 | -0.00 | 0.00 | 0.00 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| 7 or more years of | -0.11*** | -0.09** | 0.27*** | 0.27*** | 0.14*** | 0.14*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| education | | | | | | |
| | (0.03) | (0.04) | (0.05) | (0.05) | (0.04) | (0.04) |
| Top 2 wealth quintiles | -0.13*** | -0.12** | 0.13* | 0.11+ | -0.03 | -0.03 |
| | (0.04) | (0.04) | (0.06) | (0.06) | (0.04) | (0.04) |
| Rural residence | 0.31*** | 0.31*** | -0.08 | -0.07 | -0.03 | -0.02 |
| | (0.04) | (0.04) | (0.06) | (0.06) | (0.04) | (0.04) |
| Constant | 0.96*** | 1.52*** | 0.21 | -0.02 | 0.54 | 0.75+ |
| | (0.29) | (0.29) | (0.36) | (0.40) | (0.36) | (0.40) |
| Parity controls? | yes | yes | yes | yes | yes | yes |
| Year controls? | yes | yes | yes | yes | yes | yes |
| F-test: full sample = sample with exclusions | | | | | | |
| chi2 | 1.65 | 0.35 | 0.88 | 1.89 | 0.39 | 1.53 |
| p > chi2 | 0.20 | 0.56 | 0.35 | 0.17 | 0.53 | 0.22 |
| Observations | 2,224 | 1,969 | 1,346 | 1,221 | 1,813 | 1,615 |
| R-squared | 0.34 | 0.33 | 0.18 | 0.18 | 0.06 | 0.07 |

Note: Skilled birth attendant in this context is a doctor, nurse, midwife, or obstetrician. Home births are relative to births in public and private health facilities including hospitals, delivery posts and midwife's practice, etc. Sampling weights are used. Robust standard errors are clustered at the level of the sampling cluster. Sample includes observations from 2001-2012 for both delivery and non-delivery childbirth deaths.

+p < .10; *p < .05; **p < .01; ***p < .001

care for at the time of their next birth. I test this claim by using reports of household composition from the IDHS household roster. Very few of the births I consider (only 1.9% of births where a childbirth death has occurred and 1.6% of births with a death from another cause) report any adopted/foster or stepchildren in their homes. A larger percentage (10.6% of childbirth death observations and 13.2% of observations with a death from another cause) report any "other relatives" under age 13 as usual residents in the household. Table 6 shows the result of excluding these cases and an F-test for whether the coefficients differ when these cases are excluded. My results do not appear to be sensitive to excluding these cases.

## *1.6 Discussion*

This study investigates whether women are less likely to engage in behaviors that put them at risk of maternal death and more likely to adopt risk averting behaviors after their sisters die in childbirth relative to women whose sisters have died from some other cause. The underlying construct of risk of maternal death is operationalized in several ways. Women can chose to give birth at home or in a facility. Conditional on giving birth at home women can deliver with or without a skilled birth attendant (e.g. doctor, nurse, midwife or obstetrician) present – this is a behavior that puts a woman in danger if there is a life-threatening complication (Ronsmans et al., 2009). Women can also reduce their risk of complications at the time of delivery by taking iron supplements

– this is especially important in Indonesia where roughly 20% of women of reproductive age were anemic in a 2013 study (Indonesia MOH, 2013).

The results of this study show that, in comparison to women whose sisters have died from some other cause, women whose sisters die in childbirth are less likely to give birth at home after their sisters have died relative to before their sisters have died. In the sample based on births between 2001-2012, women are 22% points ($p < 0.01$) less likely to engage in risky, home births after a sister's death in childbirth; when sister deaths are restricted to those occurring during delivery the effect rises to 32% points ($p < 0.001$). Behavior change on this dimension appears to be driven by lower parity women, women who have a primary education or less and those who live in rural areas and is robust to socio-economic and demographic controls and time trends. Iron supplementation emerges as a second result that is suggestive of behavior change that has the potential to guard against maternal death. In the full sample of women from 2001-2012 and across a range of socioeconomic stratifications, women whose sisters die in childbirth are more likely to report that they were given or bought iron supplements and took any of these pills during pregnancy after their sister had died in childbirth compared to before. While this result is imprecisely estimated in all but the sample restricted to deaths that occur during delivery, where it only reaches significance at the 10% level, its sign and consistency suggest that with more power this study may have found a statistically significant effect. Comparing baseline differences between women

who experience a sister's death to the change in behavior over time as a result of a sister's death in childbirth suggests that a sister's death in childbirth persuades women who had not been part of the formal healthcare system to obtain delivery care services that are of higher quality than what they had used prior to a sister's death.

I am limited in this study to using variation in behaviors across women rather than intra-individual changes in reproductive behaviors. While the DHS asks about all siblings no matter when they have died, only reproductive behaviors for births that have occurred within the five years before each survey are included. In order to use an individual fixed-effect and look at changes across births for the same woman, a sister would need to die between two births within a five-year window. There are not enough observations on such women to produce reliable estimates at the intra-individual level.

The results from this study provide evidence that information about the dangers of childbearing that is transmitted outside antenatal care visits through a sister's death does produce behavior change that can guard against maternal death.[6] This study focuses on the effect of a sister's death, but women may also learn from friends and other relatives about what to expect in pregnancy and what kind of protective behaviors to take up. Public health campaigns that draw on women's experiences as an example may have the potential to influence delivery care behaviors and accelerate declines in

[6] Fletcher et al. (2013) provide some evidence that sibling deaths that occur during childhood have long-lasting negative impacts on the human capital of surviving siblings using data from U.S. samples.

maternal mortality in Indonesia. Indonesia is a country that relies on volunteer health workers, called cadres, to assist with spreading health information in remote villages. Recruiting women whose sisters have died to share their stories and the potential benefits of delivery in proximity to modern obstetric care may be one way to spread knowledge about the potential dangers of childbearing without adequate assistance to women who remain outside the formal obstetric care system.

The practice of using spokespeople to share information on health risks has a precedent in public health. The main policy recommendation from the literature on behavior change resulting from celebrity crises suggests that more purposeful communication should accompany announcements of celebrity crises, using these events as an opportunity to infuse publish health information into groups that feel a heighted susceptibility to risk (Borzekowski et al., 2013; Chapman et al., 2005; Gellert et al., 1992; Kamenova et al., 2013; Metcalfe et al., 2010). Public health campaigns targeting maternal mortality might be able to extend their scope to educate a broader audience of stakeholders by including women who have been touched by a maternal death "close to home" – a sister, mother, cousin or aunt; these women may be sources of advice for currently pregnant women, to ensure that they are aware of the importance of adequate care during childbearing. Such an effort might be particularly important in places where the service environment is modernizing rapidly as it is in much of the developing world.

The literature on how reproductive behaviors change when women feel a heightened sense of vulnerability to complications could also be informed by in-depth qualitative analysis of the non-institutional channels influencing choice of delivery location and inputs into health during pregnancy. Low levels of knowledge of the potential risks of inadequate delivery care in Indonesia is a particularly urgent public health issue. Descriptive statistics based on recall by women who had received antenatal care in the five years before the survey show that while more than 97% of women in Indonesia received antenatal care during pregnancy between 2007 and 2012, women with no education were half as likely to say they received information on the dangers of childbearing during these visits as women with secondary education or higher (30 vs. 60%) (National Statistical Service Indonesia, 2012). Two studies in Africa found that education about pregnancy, delivery and post-partum complications delivered to women during antenatal care visits did not correlate well with information recalled during exit interviews conducted with pregnant women just after antenatal care visits (Duysburgh et al., 2013; Pembe et al., 2010). Doctor, et al. (2013) found that knowledge of complications was not correlated with antenatal care but was correlated with accessing skilled birth attendants for delivery in Nigeria which begs the question of where women are learning about delivery complications and how those networks can be supplied with accurate information and leveraged to reach more vulnerable women.

This study is one of the first attempts to examine how factors outside of the formal health system can have an impact on a woman's reproductive behaviors. This study contributes to the literature on health behavior change by showing that even in low income environments, women who have heightened perceived susceptibility of a severe consequence from failing to change their behavior are influenced by information provided to them through their own personal experiences. More research is needed in countries with higher and lower maternal mortality ratios than Indonesia to understand how context matters for behavior change related to the risk of maternal death.

# 2. Better Wait Than Never: Do Fertility Desires Respond to Sibling Mortality in Childbirth in Indonesia?

## *2.1 Introduction*

Social scientists have long been interested in measuring fertility intentions, for example intended family size, and using these measures to predict fertility patterns (Bongaarts, 1992; Günther & Harttgen, 2016; Westoff, 1991). The prevailing view in economics is that couples negotiate their fertility intentions at marriage and then attempt to execute a strategy to attain those desires (Willis, 1974). Demographers, however, have argued that fertility intentions are not static but rather dynamic, changing along with life circumstances and this hypothesis has found support in several studies. Changes in desire for children have been associated with changes in work status, relationship status (marriages, divorces and separations), and financial status to name a few (Bongaarts, 1992; Debpuur et al., 2002; Freedman et al., 1965; Udry, 1983; Yeatman et al., 2013). One underexplored area of inquiry is whether a woman's fertility desires can be attributed to perceived risk of death in childbirth. For instance, would firsthand knowledge of death in childbirth elicit a change in a woman's own desires regarding childbearing? And would this change be enough to alter a woman's fertility trajectory?

This study attempts to shed light on the unanswered question of whether women's fertility desires respond to information on the risks of childbearing from their social networks. I hypothesize that the death of a woman's sister in childbirth may lead

a woman to become more apprehensive about childbearing herself. She may be unsure about whether to have another child or desire to halt her own fertility. Conditional on wanting more children she may want to wait longer to bear children herself than other women at the same parity whose sisters have not died. Further, I hypothesize that these differences in behavior will be more pronounced for women who have two children, which has been the prevailing family size norm in Indonesia for several decades. To investigate this question, I have assembled data from five waves of the Indonesia Demographic and Health Survey (IDHS) between 1994 and 2012. I utilize contemporaneously reported fertility desires and retrospectively reported pregnancies and sister deaths to ask whether the death of a sister in childbirth affects fertility among women in Indonesia.

## *2.2 Background*

Fertility intentions and expectations have special meaning for demographers. Intentions refer to future actions that women and families will take regarding their fertility whereas expectations include more abstract projections of completed fertility that take into account spacing desires and fecundity (Thomson, 1997; Yeatman et al., 2013).

Fundamental to understanding fertility intentions is how well household surveys are able to measure them. While some survey questions are better at eliciting intentions than others, the consensus tends to be that fertility intentions elicited through household

surveys are meaningful measures of future fertility achievements (Bongaarts, 1992; Debpuur et al., 2002; Günther & Harttgen, 2016; Westoff, 1991). Fertility intentions are seen not as a set of stable preferences of future achieved fertility agreed upon by couples at the outset of a marital union (Willis, 1974) but as more of a "moving target" (Lee, 1980) that responds to a number of demographic changes. Intentions can be revised both upward and downward in response to changes in life circumstances (marriages, divorces, financial success or strain). The dynamic nature of fertility preferences has been documented in western countries such as the U.S. (Hayford, 2009; Udry, 1983), Britain (Iacovou & Tavares, 2011), West Germany (Heiland et al., 2008) and in developing, high-fertility contexts such as Ghana (Debpuur et al., 2002) and Malawi (Yeatman et al., 2013). The main findings from this literature are that relationship dissolution and negative changes in work and financial status are associated with a downward revision of family size intentions while pregnancies tend to increase desired family size due to women's ex-post rationalization of mistimed and/or unwanted births as unwanted (Casterline & El-Zeini, 2007). Typically, when intentions are revised, they often change by one child, either upward or downward.

In this paper, I consider fertility "intentions" which maps onto desires for a/nother child conditional on the number of living children a woman already has. Intentions are distinct from "expectations" which may include beliefs about future fecundity and are often elicited in surveys as "ideal" family size (Casterline & El-Zeini,

2007; Thomson, 1997; Yeatman et al., 2013). In order to distinguish empirically whether unanticipated events are associated with changes in fertility desires the researcher needs measurement of fertility intentions at two points in time and a measure of an unanticipated shock that occurs in the interval between the two measurements of fertility intentions (Udry, 1983). In the current study, the unanticipated event in question is the death of a woman's sister in childbirth. I hypothesize that this death carries with it information on the potential dangers of childbearing and may lead women to revise their own desires for children downward in order to avoid their own risk of death. While I cannot observe women at two time-periods (both before and after a sister's death in childbirth) for contemporaneously reported fertility desires, I can construct a comparison group of women whose desires should not differ in expectation from women who experience a sister's death in childbirth. I construct this comparison group from women whose sisters are of reproductive age and therefore eligible to die in childbirth but who die from some other cause. In the second part of my analysis, I consider retrospectively reported interbirth intervals (defined as the time in months from the birth of the index child and the prior birth) where I am able to identify which births have occurred before and after a sister's death in childbirth which provides me with the longitudinal data required to evaluate changes in fertility in response to unexpected shocks. In the retrospective sample, women report on all their prior births and I relate that information to the timing of their sister's deaths. These women are not

reporting their fertility desires at one point in time, rather, I am observing how their observed behavior has responded to the quasi-exogenous shock of their sister dying in childbirth.

## *2.3 Reproductive Norms and Behavior in Indonesia*

Indonesia's rapid decline in infant death rates, near replacement level fertility and high contraceptive prevalence marks it as a country that has undergone the demographic transition (Van de Walle, 1992) and as a country where fertility desires and intentions reported in household surveys can be taken seriously as predictive of actual childbearing outcomes.

Indonesia's family planning program has long been considered an example for other countries seeking to reduce their own fertility rates. Facilitated by a strong national government, the Family Planning Board (BKKBN) was established in 1970 with the goal of promoting a two-child norm enabled by access to modern methods of contraception for married women (Angeles et al., 2005; Gertler & Molyneaux, 1994; Molyneaux & Gertler, 2000). During the 1970s, Indonesia also undertook a large and successful project to expand access to primary education which led to improvements in human capital across the island archipelago – a key driver in fertility reductions (Duflo, 2001). These programs, in combination with expanding economic prosperity, reduced the total fertility rate in Indonesia from 5.7 in the period 1965-1970 to 2.3 in the period 1995-2000 (UN, 2015) where it has stayed to present day.

Voluntary childlessness is uncommon in Indonesia among married women. Figure 1 and Table 2 indicate that among a group of married, fecund, childless women in Indonesia who have sisters of reproductive age, 97% would like to have at least one birth and if they already have one birth, 90% would like to have second birth. Illustrative of the two-child norm in Indonesia, only 37% of women who have already had two births would like to have a third birth and the portion wanting more than three births dwindles still to 14% (Statistics Indonesia (Badan Pusat Statistik - BPS) et al., 1994, 1997, 2003, 2007, 2013) (author's calculations). Despite the diversity in inheritance customs across Indonesia, the dominant pattern of family formation strategies is motivated by sex balance (Guilmoto, 2015), in other words, son preference is not a defining characteristic of childbearing among families in Indonesia.

For countries like Indonesia which have undergone the demographic transition, maintaining a low level of births necessitates access to contraceptives for managing desired family size and achieving the desired spacing between births. Both short and long birth intervals are associated with negative health implications for pregnant women (Conde-Agudelo & Belizán, 2000; Conde-Agudelo et al., 2007; Razzaque et al., 2005) and especially for children (Cleland et al., 2012; Rutstein, Shea O, 2005). Birth intervals (measured as the time from one birth to the next birth) in Indonesia tend to fall in the "healthy" range recommended by WHO standards of at least 33 months but not longer than 56 months (Rutstein, Shea O., 2011; WHO, 2005). Actual birth intervals vary

across birth order, with later births (order 4 and higher) having shorter birth intervals than lower order births (Rutstein, Shea O., 2011). In addition, nearly 100% of women in Indonesia know of a modern method of contraception and more than 60% of married, fecund women are currently using modern methods of contraception for limiting or spacing births (Statistics Indonesia (Badan Pusat Statistik - BPS) et al., 1994, 1997, 2003, 2007, 2013) (author's calculation).

Despite declines in infant mortality and improvements in socioeconomic status, maternal mortality remains a persistent risk for women in Indonesia. By some estimates, the maternal mortality ratio has increased from 228 maternal deaths per 100,000 live births in 2007 to 359 maternal deaths per 100,000 live births in 2012 (Statistics Indonesia (Badan Pusat Statistik - BPS) et al., 2013). Skepticism over the measurement of maternal mortality through household surveys has received considerable attention from demographers though the conclusion has been that while reporting errors are inevitable, the data on sibling deaths is no less reliable than other retrospective reports in the Demographic and Health Surveys (DHS) (Ahmed et al., 2014; Helleringer et al., 2014; Stanton et al., 2000). Data on sibling mortality in Indonesia in particular may be more trustworthy than data from other countries. Indonesia's blend of Javanese Islam, practiced by over 85% of the population (Pew Resource Centre's Forum on Religion and Public Life, 2012), includes a custom of making annual pilgrimages to the gravesites of family members and praying for family members on the

anniversary of each death, making it likely that deaths in childbirth will be reported accurately by this population (Daniels, 2012; Woodward, 2010).

## *2.4 Data and Methods*

I use reports of births and sister deaths collected in fives waves of the Indonesia Demographic and Health Surveys (IDHS) between 1994 and 2012. The IDHS is a population-based cross-sectional survey of women of reproductive age (aged 15-49) conducted at approximately five year intervals in Indonesia. In order to answer the question of whether a woman's fertility behavior responds to the death of a sister in childbirth, I proceed in two parts. First I examine contemporaneous fertility desires: desire for another birth and desired waiting time until the next birth conditional on wanting a/nother birth. Then I use retrospective reports of interbirth intervals (the time from one birth to the next) combined with reports on the timing of sister deaths to look at changes in the length of interbirth intervals before and after a sister's death separated by whether the death was in childbirth or from some other cause.

In the IDHS, women are asked to report contemporaneous measures of their fertility intentions. For instance, does the respondent want a/nother child, no more children or is undecided or ambivalent about another birth. Conditional on wanting children, women are asked how long they would like to wait for the birth of the next child. Women respond in either months, years or give a non-numeric response, for example, "it's up to God." These measures of fertility intentions are less vulnerable to

ex-post rationalization than reports of intended family size and wantedness of births (Casterline & El-Zeini, 2007; Günther & Harttgen, 2016) and are typically regarded as predictive of fertility outcomes (Bongaarts, 1992; Westoff, 1991; Yeatman et al., 2013).

The IDHS includes retrospective reports of births including birth dates for each live birth. The IDHS uses a contraceptive history calendar to collect detailed information on pregnancy outcomes and contraceptive use in the five years before the survey but data on miscarriages, abortions and contraceptive use outside this window are somewhat ambiguous. Women are asked whether they have ever had a terminated pregnancy but are not asked to give detailed timing for these birth outcomes if they occurred more than five years ago. This makes the computation of interbirth intervals (the months between live births) straightforward but there is no way to distinguish from volitional changes in interbirth intervals and birth intervals that have been lengthened by a pregnancy termination in the interval. Thus, I limit my sample when considering interbirth intervals to women who report no terminated pregnancies.

The IDHS also collects contemporaneous reports of fecundity and sociodemographic factors like age, education, a measure of wealth, and urban or rural residence. Women report their marital status at the time of the survey and the date that their first union began. For women who have been in more than one union, about 8% of the IDHS respondents pooled across five waves, the date of the most recent union is unknown. I therefore exclude women who have been in more than one union because,

as with pregnancy terminations in the interbirth interval, it is not possible to distinguish birth intervals that are lengthened by a marital disruption from those that are lengthened through any other mechanism. It is also necessary to exclude women who have been in more than one union from the fertility desires analysis because I wish to control for time since marriage for childless women and I cannot determine when the most recent union began for women who have been in more than one union.

The main focus of this study is to determine whether an unanticipated information shock about the dangers of childbearing is associated with woman's fertility desires and or with reproductive behavior. In the Sisterhood Mortality Module (Graham et al., 1989) of the IDHS, women report on the timing (month and year) of deaths of their siblings and for sisters aged 10 or older at the time of death, whether or not the death was related to childbearing. Maternal deaths are characterized according to the ICD-10 International Classification of Diseases where childbirth deaths are defined as death of a woman while pregnant, during delivery or within 42 days after delivery (World Health Organization, 2014). Using these reports of sibling age and date of death, I can identify years in which a respondent was "at-risk" of having a sister die in childbirth. I define an at-risk woman as one who has a sister of reproductive age (between 15 and 49, inclusive). For some of these women, their sister aged 10-49 has

either died in childbirth or from some other cause.[1] Other causes are not identified in the IDHS; they could be natural, accidental or under devious circumstances. Table 7 reports descriptive statistics for the samples used in the fertility desires analysis (Panel A) and the birth intervals analysis (Panel B). Typically, women whose sisters have died in childbirth have lower socioeconomic status, as measured by the percent with a primary education or more, location on a five quintile wealth spectrum and living in a rural area, than women whose sisters are at-risk of dying but do not die and those whose sisters die from a cause other than childbirth. However, these socioeconomic indicators seem to be correlated with each other and are not all predictive of a sister's death in childbirth when considered together. When I use a logistic regression to analyze the probability of losing a sister in childbirth based on age, parity, education, wealth, years since last birth or marriage, whether a woman is working at the time of the survey and whether or not a non-biological family member lives in the household, only parity and rural residence are predictive of losing a sister in childbirth. In the sample used to analyze birth intervals a few characteristics of women are protective against having a sister die in childbirth; younger, wealthier women having children in more recent periods are less likely to experience a sister's death in childbirth. I exclude working status from this analysis because the IDHS only provides contemporaneous measures of work status and I need a measure of whether the respondent is working

[1] I set the age range to 10-49 to coincide with the parameters in the IDHS Sisterhood Mortality Module.

before a sister's death. Notably, whether or not a household contains non-biological children (defined as foster children, step children, adopted children or relatives under the age of 13) does not vary by whether a woman has experienced a sister's death in childbirth suggesting that children orphaned by their mothers during childbirth are not more likely to enter the household of their maternal aunt conditional on their mother's death. Overall, while some differences remain between women whose sisters have died in childbirth and those who have died from some other cause, very few factors actually predict a sister's death in childbirth. In the empirical analysis, I control for the socioeconomic factors listed in the table.

In the fertility desires analysis, I focus on women who are married (and have only been in one union), fecund and whose last child did not die as an infant. Women who have lost their last child as infants are excluded from my analysis because it is not clear whether the fertility desires of these women are responding to a sister's death or the death of their own child. In the analysis of interbirth intervals, I focus on women who have intact unions throughout the analysis period (e.g. married only once), and report no terminated pregnancies or child deaths because these changes are indistinguishable from volitional changes in interbirth intervals (Preston, 1978; WHO, 2005).

**Table 7. Descriptive statistics for analytical sample. Panel A is women who contribute to the fertility desires equations and Panel B is women who contribute to the birth interval equations.**

| | Panel A | | | Panel B | | |
|---|---|---|---|---|---|---|
| | Fertility Desires Sample | | | Birth Interval Sample | | |
| | At-risk | Child-birth (CB) | Non child-birth (NCB) | At-risk | Child-birth (CB) | Non childbirth (NCB) |
| Woman's age[a] | 32.55 | 35.26 | 35.82 | 27.21 | 28.41 | 28.55 |
| | (7.63) | (7.56) | (7.65) | (5.84) | (5.88) | (6.06) |
| Number of children | 2.54 | 3.48 | 3.09 | 1.76 | 2.41 | 2.27 |
| | (1.76) | (2.19) | (1.98) | (1.78) | (2.03) | (2.02) |
| Primary school or more | 0.47 | 0.34 | 0.42 | 0.41 | 0.28 | 0.36 |
| (ref: less than primary) | (0.50) | (0.48) | (0.49) | (0.49) | (0.45) | (0.48) |
| Wealth | 3.17 | 2.75 | 3.18 | 3.05 | 2.61 | 3.03 |
| (scale: 1=poorest, 5=richest) | (1.42) | (1.48) | (1.41) | (1.41) | (1.41) | (1.43) |
| Wealth data is missing | 0.19 | 0.23 | 0.20 | 0.18 | 0.24 | 0.19 |
| | (0.39) | (0.42) | (0.40) | (0.38) | (0.43) | (0.39) |
| Rural residence | 0.57 | 0.69 | 0.57 | 0.59 | 0.70 | 0.59 |
| | (0.50) | (0.47) | (0.50) | (0.49) | (0.46) | (0.49) |
| Years since marriage or last birth | 5.31 | 6.42 | 6.89 | | | |
| | (4.98) | (5.59) | (5.83) | | | |
| Respondent is working | 0.56 | 0.63 | 0.60 | | | |
| (ref: not working) | (0.50) | (0.48) | (0.50) | | | |
| Adopted, step, or foster child or other relative under age 13 living in household | 0.09 | 0.10 | 0.10 | 0.09 | 0.10 | 0.11 |
| | (0.29) | (0.30) | (0.30) | (0.29) | (0.29) | (0.31) |
| Sister died within last 3 years | n/a | 0.17 | 0.20 | | | |
| | (n/a) | (0.38) | (0.40) | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Number of observations | 62,554 | 721 | 3,821 | 88,336 | 1,182 | 5,908 |

Note: Wealth is not available for the 1994 wave which accounts for about 20% of the data. Sampling weights used. Only parity and rural residence are predictive of having a sister die in childbirth in the fertility desires sample. Wealth, age and year are protective against a sister's death in childbirth in the birth interval sample.
[a]Woman's age in the birth interval sample is the minimum age for each woman.

### 2.4.1 Empirical Analysis

I use two sources of quasi-experimental variation to examine differences in reported fertility desires and interbirth intervals. The first is differences between women whose sisters die in childbirth and those whose sisters die from some other cause; in expectation, these groups should not differ in reported fertility desires and any differences that emerge may be attributable to information gained through experiencing a sister's death in childbirth. Then, I look at how much time has elapsed since the death of a sister. I create a dichotomous variable for whether a sister's death occurred within the last three years or four or more years ago. The IDHS is comprised of a sample of women, picked at random within sampling clusters that are representative of the urban and rural population in Indonesia. This sampling strategy ensures that the timing of deaths is not related to the way the sample was constructed and provides a second source of quasi-experimental variation in experience of a sister's death in childbirth.

In the analysis of contemporaneous fertility desires, I consider whether three outcomes differ by whether or not a sister has died in childbirth compared to women whose sisters have died from some other cause. The first outcome is a dichotomous

measure of whether or not a woman reports that she would like no more children or is undecided about a/nother birth compared to women who answer they would like an additional birth. This captures desires to halt childbearing conditional on the death of a sister. For women who report they would like more children, they are asked how long they would like to wait until the birth of the next child. I use this measure as a continuous dependent variable in months. Lastly, I use an indicator for whether a woman is currently using any method of contraception (modern, traditional or folkloric). This captures the seriousness of spacing and limiting intentions and is particularly salient in Indonesia where married women have access to an array of contraceptive methods (Angeles et al., 2005; Gertler & Molyneaux, 1994; Molyneaux & Gertler, 2000). For dichotomous outcomes (desire to limit childbearing and use of contraceptives), I use logistic regression. Logistic regression has the advantage of allowing me to interpret the coefficients as relative risk ratios that vary as a function of the independent variables.

The logistic equation can be written as:

$$ln\left(\frac{\theta_i}{(1-\theta_i)}\right) = \alpha + \beta_1 \left(sister\ has\ died\ in\ childbirth\right)_i + \boldsymbol{X}_i + \varepsilon_i \qquad (2.1)$$

where the dependent variable is the log odds of an outcome, $\theta_i$, that depends on whether a woman's sister has died in childbirth rather than some other cause indicated

by $\beta_1$ and a vector of socioeconomic factors measured for each woman indicated by $\mathbf{X}_i$, which includes years since the last birth for women who already have children or years since marriage for childless women, woman's age, whether the respondent is currently working, education, wealth quintile, rural residence, survey wave and province fixed effects, and an idiosyncratic error term clustered at the level of the IDHS sampling cluster denoted by $\varepsilon_i$.

I proceed by adding interactions between a sister's death in childbirth and indictors for the number of children a woman currently has, as in:

$$ln\left(\frac{\theta_i}{(1-\theta_i)}\right) = \alpha + \beta_1 \left(sister\ has\ died\ in\ childbirth\right)_i + \beta_2 \left(\begin{matrix} sister\ has\ died\ in\ childbirth \\ *\ n\ children \end{matrix}\right)_i + \boldsymbol{X}_i + \varepsilon_i \quad (2.2)$$

Finally, I add interactions between whether or not a sister has died in childbirth, the number of children she currently has and whether the death of her sister occurred recently, defined as within the last 3 years, which can be written as:

$$ln\left(\frac{\theta_i}{(1-\theta_i)}\right) = \alpha + \beta_1 \left(sister\ has\ died\ in\ childbirth\right)_i + \beta_2 \begin{pmatrix} sister\ has\ died\ in\ childbirth \\ * \ n\ children \end{pmatrix}_i + \beta_3 \begin{pmatrix} sister\ has\ died\ in\ childbirth \\ * \ n\ children \\ * \ recent\ death \end{pmatrix}_i + \boldsymbol{X}_i + \varepsilon_i \quad (2.3)$$

For continuous outcomes (desired waiting time to next birth in months), I use ordinary least squares (OLS). I proceed sequentially as before only now the coefficients are interpreted in months rather than as relative risk ratios.

The sample on fertility desires is limited to women who are married, fecund and whose last child did not die as an infant. Limiting the sample to women whose last child is living is necessary because of the physiological and behavioral pathways through which infant death may work to shorten birth intervals (Nobles et al., 2015; Preston, 1978).

I next consider retrospective birth histories which are manifestations of desires and negotiation between couples in response to life circumstances (Freedman et al., 1965; Udry, 1983). In this analysis, I use ordinary least squares (OLS) to examine

whether the length of the interbirth interval (time from one birth to the next) changes before and after a sister's death in childbirth net of changes for women whose sisters die from some other cause and controlling for socioeconomic status, parity at each birth, woman's age, year of each birth and province fixed effects. These models are estimated using retrospectively reported data.

The equation can be written as:

$$\theta_b = \alpha + \beta_1 \begin{pmatrix} sister\ has\ died\ in\ childbirth \\ *\ after\ a\ sister's\ death \end{pmatrix}_i + \mathbf{X}_b + \mathbf{X}_i + \varepsilon_i \qquad (2.4)$$

Birth specific interbirth intervals are indicated by $\theta_b$. The main independent variable of interest is the interaction between whether a sister has died in childbirth and the time period after a sister's death indicated by $\beta_1$, Factors that vary for each birth such as woman's age and parity and year of the index child's birth are included in $\mathbf{X}_b$ and socioeconomic factors that remain constant for each woman including education, wealth quintile, rural residence and province are included in $\mathbf{X}_i$. Individual sampling weights are used and errors are clustered at the level of the sampling cluster in the IDHS denoted by $\varepsilon_i$. I first consider all birth intervals and then consider separately the interval between marriage and first birth, intervals for second order births and intervals for third or higher order births. There is some indication that median birth intervals for higher order births in Indonesia (second and third births are contrasted with births of fourth order and higher) are shorter than lower order births (Rutstein, Shea O., 2011) which

biases estimates with an individual fixed effect downward. Thus, I rely on across rather than within woman comparisons in my analysis.

If birth intervals do change, we might want to know whether birth intervals are healthier after a sister's death in childbirth. I explore this possibility using the same difference-in-difference set up as in the birth intervals equations (Eq. 2.4); however, because I now explore a dichotomous dependent variable I return to using logistic regression. In Eq. 2.5, the dependent variable is coded as one if the interbirth interval was between 33 and 59 months (indicating a birth to conception interval of at least 24 months as recommended by WHO (2005)). Coefficients in this analyses are interpreted as relative risk ratios and the equation can be written as:

$$ln\left(\frac{\theta_b}{(1-\theta_b)}\right) = \alpha + \beta_1 \begin{pmatrix} sister\ has\ died\ in\ childbirth \\ *\ after\ a\ sister's\ death \end{pmatrix}_i + \boldsymbol{X}_b + \boldsymbol{X}_i + \varepsilon_i \quad (2.5)$$

where, as in Eq. 2.4, $\mathbf{X}_b$ is a vector of socioeconomic controls measured at the time of each birth and $\mathbf{X}_i$ is a set of socioeconomic characteristics that remain constant for each woman. In all of the models that consider reported interbirth intervals, I limit my sample to women who have only been in one union, have no terminated pregnancies and have only singleton births because I want to reduce the possibility that birth intervals could be shortened or lengthened for reasons unrelated to a sister's death during the interbirth interval.

All specifications use individual survey weights provided by the IDHS. All standard errors are estimated based on clustering at the level of the IDHS sampling cluster. Results are robust to bootstrapped standard errors with 50 replications and so I report non-bootstrapped standard errors and confidence intervals in the tables.

## *2.5 Results*

### 2.5.1 Fertility Desires

Figure 1 and Panel A of Table 7 indicate that almost all (97%) married, fecund women of reproductive age in Indonesia desire to have at least one child and most want to have a second (90%); desire for more children decreases consistently with parity with only 37% of women desiring to have 3 or more children. The sharp decline in fertility for women who have two children is a hallmark of the two-child norm encouraged by the Indonesia government since the 1970s. On average, married, childless women want their first child to come as soon as possible leading this group of women to report an average desired waiting time of 4.22 months (this is an average of those who report wanting their child to come as soon as possible which is coded as zero and those who report waiting times of several years). After the first child, women desire at least three years (36 months) of spacing after each subsequent birth which comports with the WHO recommendation (2005) for a birth interval that is healthy for both mother and baby. Typically, between 1-5% of women are undecided about having an additional birth at any given number of children. Women who lose a sister due to a cause other than

childbirth (Panel C of Table 8) look very similar in desires and timing to the population at large who is at risk of losing a sister.

**Table 8. Percent distribution of fertility preferences and contraceptive use for married, fecund women whose last child is living.**

| | Number of Children | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3+ | Total |
| **Panel A. Women at risk of having a sister die in childbirth** | | | | | |
| Have another (%) | 97 | 90 | 37 | 14 | 44 |
| No more (%) | 2 | 8 | 57 | 82 | 52 |
| Undecided (%) | 1 | 3 | 5 | 4 | 4 |
| Total (%) | 100 | 100 | 100 | 100 | 100 |
| Desired wait time for next child if a/nother is wanted (months) | 4.22 | 37.25 | 37.38 | 36.60 | 32.76 |
| Using method of contraception (%) | 13 | 74 | 85 | 82 | 77 |
| N women | 3,445 | 13,896 | 17,326 | 27,887 | 62,554 |
| **Panel B. Women who have a sister who has died in childbirth** | | | | | |
| Have another (%) | 100 | 87 | 28 | 16 | 30 |
| No more (%) | 0 | 6 | 69 | 82 | 67 |
| Undecided (%) | 0 | 7 | 3 | 2 | 3 |
| Total (%) | 100 | 100 | 100 | 100 | 100 |
| Desired wait time for next child if a/nother is wanted (months) | 0.66 | 30.25 | 43.46 | 40.87 | 32.46 |
| Using method of contraception (%) | 37 | 73 | 87 | 81 | 80 |
| N women | 27 | 86 | 153 | 455 | 721 |
| **Panel C. Women who have a sister has died from a cause other than childbirth** | | | | | |
| Have another (%) | 99 | 84 | 32 | 13 | 32 |
| No more (%) | 0 | 14 | 64 | 83 | 65 |
| Undecided (%) | 1 | 2 | 5 | 4 | 4 |
| Total (%) | 100 | 100 | 100 | 100 | 100 |
| Desired wait time for next child if a/nother is wanted (months) | 3.27 | 35.14 | 32.45 | 35.88 | 30.60 |
| Using method of contraception (%) | 11 | 70 | 86 | 82 | 79 |
| N women | 123 | 498 | 935 | 2,265 | 3,821 |

Note: Sample of women are all married, fecund and their last child is living at the time of the survey. Sampling weights used.

For women whose sisters die in childbirth, striking differences appear in fertility desires. Women whose sisters have died in childbirth all want to have at least one birth (Table 8, Panel B). However, when they are asked how long they would like to wait for the next birth, women whose sisters have died in childbirth report wait times that are longer than women with the same number of children whose sisters have died from some other cause. When time since a sister's death (either three or fewer or four or more years ago) is considered (Figure 2), the magnitude of the difference between women whose sisters die in childbirth and those who die from some other cause widens to about 35 months for women who already have two children and stays elevated for women who have four or more children. Table 8 also indicates that 7% of women who have had one birth and whose sisters have died in childbirth are undecided about whether they would like to have another child; the proportion of women whose sisters have died in childbirth is 2% which is much closer to the average for all at-risk women. When use of contraceptives is considered, just over one-third (37%) of childless women

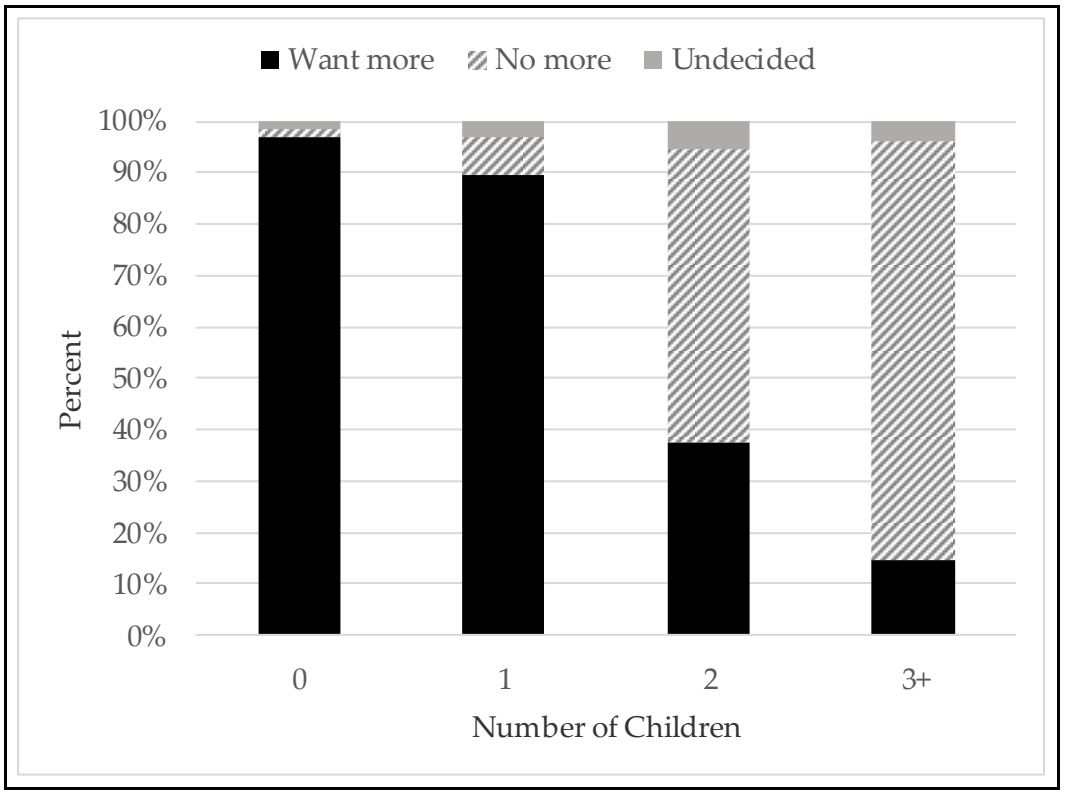


**Figure 1. Desire for more children among women who are married, fecund and are at-risk of having a sister die in childbirth.**

who have lost sisters in childbirth report using contraception compared to only 13% of all at-risk women and 11% of women who have lost sisters from some other cause.

I turn now to regression adjusted differences for women who have lost sisters in childbirth or some other cause. Table 9 displays relative risk ratios and 95% confidence intervals from three logistic regressions predicting whether women would like to stop childbearing conditional on a sister's death in childbirth or some other cause and controlling for various socioeconomic factors.[2] Column 1 reports results of estimating Eq. 1.1. There is no significant difference in desire to halt childbearing for women whose sisters have died in childbirth compared to women who have lost sisters from some other cause. Columns 2 and 3 report results of estimating Eq.'s 2.2 and 2.3 respectively. No significant results emerge after adding interactions between number of children a woman has and whether her sister has died in childbirth or from some other cause in column 2 and interacting time since a sister's death with the number of children a woman has and whether her sister has died in childbirth or from some other cause in Column 3. Column 4 considers the possibility that events associated with the death of a sister, such as the children of the deceased sister coming to live in her household, may confound estimates of the effect of a sister's death on desire for more children. In column 4, I present results of excluding households that include non-biological children

[2] Because women whose sisters have died in childbirth all want to have another birth, this category perfectly predicts failure in the logistic regressions. I therefore excluded childless women from equations in Table 3 and women with one child are the omitted category in interactions involving the number of children a woman has.

(defined as children listed as step children, foster children, adopted children or other relatives under the age of 13 listed in the household roster) and the interpretation remains the same – losing a sister in childbirth does not appear to be associated with desire to limit childbearing.

Table 10 considers desired waiting time in months until the next birth for women who report they would like to have a/nother child. Each regression uses ordinary least squares (OLS) and controls for years since the last birth or marriage (for childless women), woman's age, education, wealth quintile, rural residence, whether a woman is working, survey wave and province fixed effects. Column 1 reports results of estimating Eq. 2.1 using OLS. No differences in desired waiting time until the next birth emerge between women who have lost sisters in childbirth compared to women who have lost sisters from some other cause. Column 2 reports results of estimating Eq. 2.2 using OLS, adding interactions between whether or not a sister has died in childbirth and her current number of children does not produce any significant results. Column 3 adds in interactions between whether a woman has lost a sister in childbirth or from some other cause, the number of children a woman currently has and whether the death has occurred within the last three years. In this model, a significant difference emerges for women who already have two children and have lost sisters in childbirth recently compared to four or more years ago. Compared to childless women, these women report wanting to wait 44.11 months longer for another birth ($p<0.10$). This amounts to a

**Table 9. Results from logistic regression predicting desire to stop childbearing**

| | Wants No More Children or Is Undecided[a] | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Sister has died in childbirth** | 1.21 | 1.15 | 1.67 | 1.94 |
| (ref: sister has died from another cause) | [0.86, 1.69] | [0.34,3.94] | [0.39,7.02] | [0.44,8.56] |
| **Sister's death x n children interactions** | | | | |
| Sister has died in childbirth x two children | | 1.35 | 1.09 | 0.84 |
| | | [0.34,5.33] | [0.22,5.43] | [0.16,4.43] |
| Sister has died in childbirth x three or more children | | 0.92 | 0.66 | 0.59 |
| | | [0.25,3.38] | [0.15,3.03] | [0.12,2.87] |
| **Time since sister's death x n children interactions** | | | | |
| Sister has died three or fewer years ago x two children | | | 0.52 | 0.56 |
| | | | [0.17,1.58] | [0.15,2.05] |
| Sister has died three or fewer years ago x three or more children | | | 0.56 | 0.60 |
| | | | [0.19,1.64] | [0.18,2.06] |
| **Sister's death x time since death x n children interactions** | | | | |
| Sister has died in childbirth x sister has died three or fewer years ago x two children | | | 2.41 | 2.85 |
| | | | [0.14,42.51] | [0.14,59.15] |

| | | | | |
|---|---|---|---|---|
| Sister has died in childbirth x sister has died three or fewer years ago x three or more children | | | 4.04 [0.28,58.03] | 4.55 [0.27,75.95] |
| *N* | 4,392 | 4,392 | 4,392 | 3,850 |
| *Pseudo R-squared* | 0.39 | 0.39 | 0.39 | 0.38 |

Note: Table displays exponentiated coefficients. 95% confidence intervals based on standard errors clustered at the level of the sampling cluster in brackets. Sampling weights are used. All models include controls for number of children, years since the last birth or marriage for women with no children, woman's age, whether the respondent is currently working, education, wealth quintile, rural residence, survey wave and province fixed effects.

a. Column 4 excludes households that list non-biological children in the household roster (adopted, step, foster children or non-biological children under age 13).

$^{+}$ $p < 0.10$, $^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

**Table 10. Results from ordinary least squares regression predicting waiting time to next birth in months for women who would like to continue childbearing**

| | Months Until Next Birth[a] | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Sister has died in childbirth** | 0.08 | -1.84 | 0.22 | -2.90 |
| (ref: sister has died from another cause) | (3.53) | (4.15) | (5.24) | (4.88) |
| **Sister's death x n children interactions** | | | | |
| Sister has died in childbirth x one child | | -3.32 | -7.34 | -9.04 |
| | | (6.21) | (7.72) | (6.79) |
| Sister has died in childbirth x two children | | 14.20 | 1.85 | 5.55 |
| | | (10.91) | (7.90) | (7.70) |
| Sister has died in childbirth x three or more children | | 0.66 | -6.99 | -3.91 |
| | | (8.46) | (7.90) | (7.36) |
| **Time since sister's death x n children interactions** | | | | |
| Sister has died three or fewer years ago x one child | | | -8.56 | -8.14 |
| | | | (5.94) | (6.55) |
| Sister has died three or fewer years ago x two children | | | -10.74* | -10.77+ |
| | | | (5.33) | (5.74) |
| Sister has died three or fewer years ago x three or more children | | | -8.09 | -8.46 |
| | | | (6.88) | (7.57) |
| **Sister's death x time since death x n children interactions** | | | | |
| Sister has died in childbirth x sister has died three or fewer years | | | 15.28 | 19.47 |
| | | | (12.26) | (12.83) |

| | | | | |
|---|---|---|---|---|
| ago x one child | | | | |
| Sister has died in childbirth x sister has died three or fewer years ago x two children | | | 44.11+ (26.35) | 41.98 (26.32) |
| Sister has died in childbirth x sister has died three or fewer years ago x three or more children | | | 30.02 (19.92) | 27.06 (20.65) |
| Constant | 15.67* (6.49) | 16.91** (6.29) | 15.42* (6.62) | 12.78+ (7.17) |
| *N* | 1,318 | 1,318 | 1,318 | 1,125 |
| *R-squared* | 0.36 | 0.37 | 0.38 | 0.40 |

Note: Table displays ordinary least squares coefficients where the dependent variable is measured in months. Standard errors clustered at the level of the sampling cluster in parentheses. Sampling weights are used. All models include controls for number of children, years since the last birth or marriage for women with no children, woman's age, education, wealth quintile, rural residence and survey wave.

a. Column 4 excludes households that list non-biological children in the household roster (adopted, step, foster children or non-biological children under age 13).

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

difference of about 38 months between women who already have two children who differ only in the cause of their sister's death and how long it has been since the death occurred. Figure 2 displays average waiting times produced form estimating Eq. 2.3 using OLS and holding all other variables at their means and indicates that differences emerge for women with two children whose sisters have died in childbirth recently but not for women whose sisters have died from some other cause or for women whose sisters have died in childbirth more than 4 years ago. One reasonable alternative explanation for these results could be that when a sister dies in childbirth, her children come to live with their mother's sister and these women would like to wait longer for the birth of their next biological child. I test this possibility in Column 4 by excluding households that include non-biological children in the household roster, as defined previously, and the qualitative conclusion remains the same. Another concern may be that women who report longer desired waiting time until the next birth desire their next birth to come when they are older than 35 and at risk for problems during pregnancy and delivery (Blanc et al., 2013). I explore this possibility by excluding women whose reported desires would make them age 36 or older at their next birth and the results do not change the qualitative conclusion (results not shown).

Results to this point suggest that a sister's death in childbirth does not change whether a woman would like to have another birth but conditional on wanting another birth women whose sisters have died in childbirth recently may want to put more space

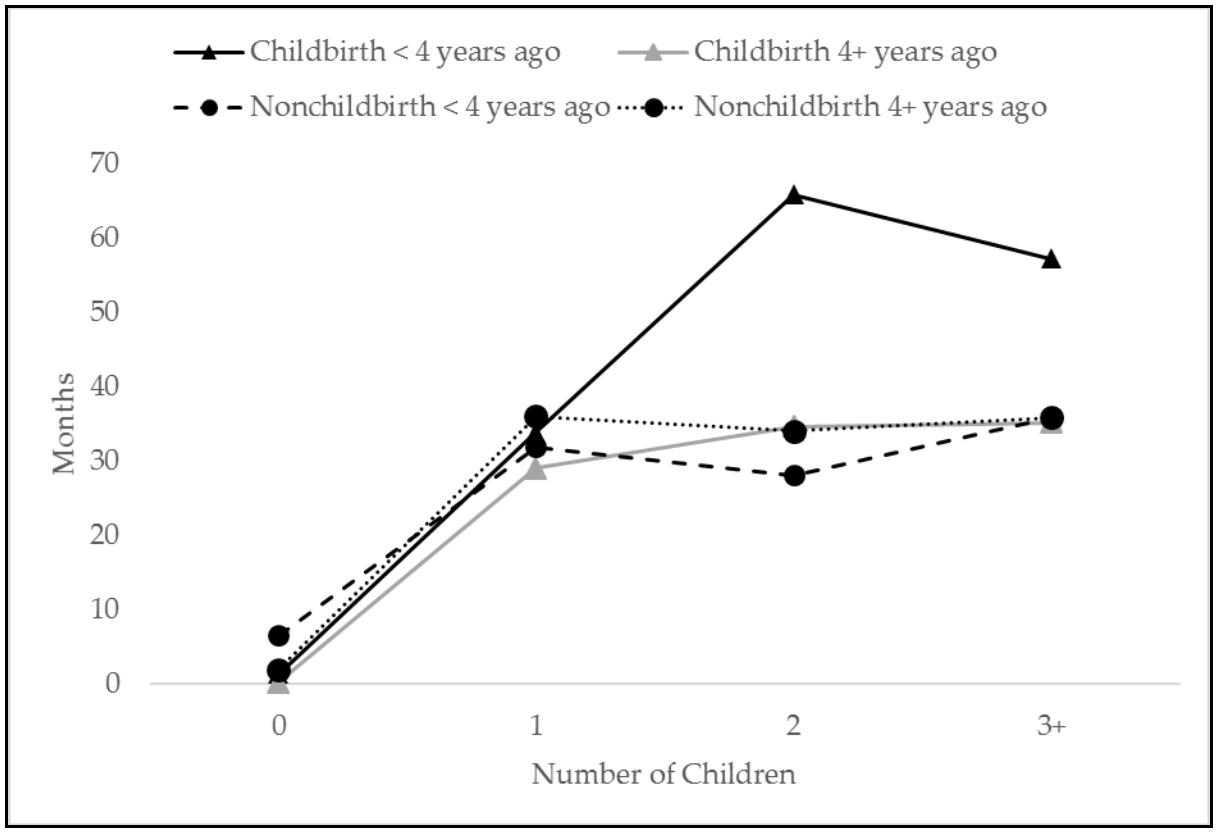


**Figure 2. Desired waiting time until next birth (months)**

between current and future births. One way to test the seriousness of these desires is to examine contraceptive use among women who have experienced the death of a sister. Table 11 displays relative risk ratios from logistic regressions predicting current use of any method of contraception (modern, traditional or folkloric). In Column 1, women who have lost sisters in childbirth are more likely to report using contraception than women who have lost sisters from some other cause (insignificant). However, in Column 2, the main effect of losing a sister in childbirth on using contraception is positive and significant at the 10% level. Women who have lost sisters in childbirth are 4.52 ($p<0.10$) times more likely to use contraception than women whose sisters have died for some other cause when controlling for socioeconomic factors and the number of children a woman currently has. Interactions between the number of children a woman has and whether or not her sister has died in childbirth are only significant for women who have three or more children. These women are less likely to use contraception than childless women which suggests that it is possible women whose sisters die in childbirth and have no children are actively trying to avoid conception more than women whose sisters have died from another cause. In Column 3, I consider whether time since a sister's death in childbirth may make a difference in whether or not a woman uses contraception. The relative risk ratios for this set of indicators are insignificant and close to 1 suggesting that recent deaths do not affect women differently than deaths that occurred four or more years ago. The main effect for women who have lost sisters in

**Table 11. Results from logistic regression predicting use of any method of contraceptive (modern, traditional or folkloric)**

| | Using Any Method of Contraception[a] | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Sister has died in childbirth** | 1.16 | 4.52+ | 6.31+ | 1.44 |
| (ref: sister has died from another cause) | [0.83,1.64] | [0.83,24.57] | [0.72,55.56] | [0.64,3.23] |
| **Sister's death x n children interactions** | | | | |
| Sister has died in childbirth x one child | | 0.31 | 0.27 | |
| | | [0.05,1.96] | [0.03,2.73] | |
| Sister has died in childbirth x two children | | 0.25 | 0.20 | 0.78 |
| | | [0.04,1.71] | [0.02,2.34] | [0.19,3.28] |
| Sister has died in childbirth x three or more children | | 0.23+ | 0.18 | 0.74 |
| | | [0.04,1.26] | [0.02,1.59] | [0.30,1.85] |
| **Time since sister's death x n children interactions** | | | | |
| Sister has died three or fewer years ago x one child | | | 0.15+ | |
| | | | [0.02,1.03] | |
| Sister has died three or fewer years ago x two children | | | 0.22 | 1.61 |
| | | | [0.04,1.37] | [0.56,4.64] |
| Sister has died three or fewer years ago x three or more | | | 0.19+ | 1.55 |
| | | | [0.04,1.04] | [0.64,3.72] |
| Children | | | | |

| | | | | |
|---|---|---|---|---|
| **Sister's death x time since death x n children interactions** | | | | |
| Sister has died in childbirth x sister has died three or fewer years ago x one child | | | 1.39 [0.04,54.75] | |
| Sister has died in childbirth x sister has died three or fewer years ago x two children | | | 1.65 [0.04,68.49] | 1.10 [0.09,13.30] |
| Sister has died in childbirth x sister has died three or fewer years ago x three or more children | | | 1.50 [0.05,43.93] | 0.95 [0.13,6.93] |
| *N* | 4,542 | 4,542 | 4,542 | 3,850 |
| *Pseudo R-squared* | 0.12 | 0.12 | 0.13 | 0.06 |

Note: Table displays exponentiated coefficients. 95% confidence intervals based on standard errors clustered at the level of the sampling cluster in brackets. Sampling weights are used. All models include controls for number of children, years since the last birth or marriage for women with no children, woman's age, whether the respondent is currently working, education, wealth quintile, rural residence, survey wave and province fixed effects.

a. Column 4 excludes households that list non-biological children in the household roster (adopted, step, foster children or non-biological children under age 13).

$^{+}$ $p < 0.10$, $^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

childbirth becomes larger in this specification and is still only significant at the 10% level. Excluding households with non-biological children (Column 4) does not change the qualitative interpretation of these results. Across all three specifications, it is interesting to note that losing a sister in childbirth relative to losing a sister from some other cause is associated with contraceptive use ($p<0.10$) and it does not vary when interactions between the number of children a woman has and time since a death has occurred are controlled.

### 2.5.2 Interbirth Intervals

I proceed next to consider whether losing a sister in childbirth is associated with longer birth intervals, defined as the length of time in months from one birth to the next, among a group of women who report birth intervals retrospectively in the IDHS. Observed birth intervals are not directly comparable to the contemporaneously reported desires I consider in earlier analysis; however, women in this set of analyses are losing their sisters in childbirth when they have varying numbers of children so if we observe longer interbirth intervals after a sister's death in childbirth relative to before this may be indicative of a desire to wait longer for an additional birth. Table 12 reports results from these analyses. The focus is on the difference-in-difference estimator, $\beta_1$ in Eq. 2.4, which is whether or not a sister has died in childbirth (rather than some other cause) interacted with an indicator for the time period after a sister's death. The length of time between each birth could be lengthened by miscarriages or other pregnancy

**Table 12. Regression results for analyzing interbirth interval length**

| | Interbirth Interval (months) | | | | Interbirth Interval between 33 and 59 months | | |
|---|---|---|---|---|---|---|---|
| | All Births | Marriage to First Birth | Second Births | Third or higher order births | All Births | Second Births | Third or higher order births |
| | OLS | OLS | OLS | OLS | Logit | Logit | Logit |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Sister has died in childbirth x after sister death | 0.86 | -1.50 | 2.20 | -0.31 | 0.88 | 0.85 | 0.89 |
| | (1.60) | (2.16) | (2.90) | (2.22) | [0.68,1.15] | [0.53,1.37] | [0.64,1.25] |
| Sister has died in childbirth | 1.18 | 1.43 | 0.84 | 2.00 | 1.02 | 1.02 | 1.03 |
| | (1.12) | (1.38) | (1.76) | (1.43) | [0.84,1.24] | [0.74,1.40] | [0.81,1.31] |
| After a sister's death | -0.75 | -0.58 | -2.10$^{+}$ | -0.24 | 1.05 | 1.03 | 1.05 |
| | (0.78) | (1.02) | (1.09) | (1.22) | [0.92,1.19] | [0.85,1.26] | [0.90,1.23] |
| *N* | 17,532 | 7,090 | 6,007 | 11,525 | 17,532 | 6,007 | 11,525 |
| *R-squared or pseudo R-squared* | 0.37 | 0.12 | 0.40 | 0.26 | 0.01 | 0.03 | 0.01 |

Note: OLS models display point estimates in months; standard errors in parentheses. Logit models display exponentiated coefficients and 95% confidence intervals in brackets. All modes control for woman's age at each birth, education, wealth quintile, rural residence year of each birth and province fixed effects. Standard errors clustered at the level of the sampling cluster in parentheses. Sampling weights are used. $^{+}$ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

terminations in the interval between births and by marital dissolution (Razzaque et al., 2005; Udry, 1983; WHO, 2005). Therefore, I exclude from the analysis women who have had any infant deaths or pregnancy terminations and who have been in more than one union. All results are net of controlling for woman's age and parity at each birth, education, wealth quintile, year of each birth and province fixed effects. Column 1 shows that in the full sample of births, interbirth intervals are 0.86 months (not significant) longer after a sister's death in childbirth compared to before and net of the difference for sister deaths from some other cause. This estimate is likely biased downward because higher order births tend to have shorter median birth intervals than lower order births (Rutstein, Shea O., 2011). In fact, using an individual fixed effect produces a small, negative and insignificant coefficient (results not shown). Column 2 considers the interval between marriage and first births which could reflect differing desire in childbearing upon marriage for women whose sisters have died in childbirth – though in Indonesia, conditional on being married and fecund women want their first child to come as soon as possible suggesting that women may enter into marriage with childbearing as the prerogative. This analyses produces a small negative and insignificant coefficient yielding little evidence of an effect of a sister's death on choice of childbearing conditional on marriage. Column 3 of Table 12 shifts the focus to second births which may be a critical period in women's desires to continue childbearing given the two-child norm in Indonesia. Second births occurring after a sister's death in

childbirth compared to before and net of changes for loss of a sister from some other cause have interbirth intervals that are 2.20 months longer (not significant) than births occurring before a sister has died. I move on to consider third or higher order births in Column 3 where the result is again small and insignificant. Interbirth intervals do not seem to reflect the large differences reported by women with two children in the contemporaneous reports though these are two different sets of women who are not fully comparable.

It is possible that while interbirth intervals are not significantly longer, changes in the timing of births shifts some births that would have been unhealthy into healthier birth intervals. Healthy birth intervals are those that occur between 36 and 59 months from a prior birth (WHO 2005). Columns 4 to 6 of Table 12 examine this possibility. There seems to be no evidence to support the claim that birth intervals become healthier after a sister's death in childbirth. No results are significant and relative risk ratios are close to one. Results do not change when households with additional children in them are excluded from the analysis (results not shown).

## *2.6 Discussion*

This analysis illustrates that reported fertility desires of women in Indonesia do seem to respond to a sister's death in childbirth. When women are asked how long they would like to wait until a/nother birth when their sister has died in childbirth three or fewer years ago, they report wanting to wait approximately three years longer (38

months) if they already have two or more children than women whose sisters have died from some other cause and women whose sisters have died in childbirth four or more years ago (Table 10 and Figure 2). This result is significant at the 10% level and robust to excluding households that include adopted, foster children, step children or relatives under the age of thirteen in the household – potential correlates of a sister's death and desired waiting time until a/nother birth. Turning to mechanisms through which women might achieve their desired spacing indicates that women whose sisters have died in childbirth are significantly more likely to use any method of contraception ($p<0.10$) than women whose sisters have died from some other cause; no significant differences emerge by time since sister's death or number of children each woman has. These results do not appear to be driven by households taking on additional children as a result of a sister's death.

Turning the focus to observed interbirth intervals reveals that intervals before and after a sister's death in childbirth are no different on average by whether or not a sister has died in childbirth or from some other cause. Stratifying by parity suggests no difference for the interval from marriage to first birth, second births or for third or higher order births. Women are also no more likely to report a healthy birth interval – between 33 and 59 months – though median birth intervals for all women in Indonesia are already typically in this healthy range (Rutstein, Shea O., 2011).

Taken together these results provide weak evidence for the role of a sister's death in childbirth in changing a woman's own fertility desires. Conditional on having two children and experiencing a sister's death within the last three years, women report wanting to wait longer for a next birth and women whose sisters die in childbirth are more likely to use contraception than women who have lost sisters from some other cause controlling for a set of socioeconomic indicators including rural or urban residence and province. Both of these results are only weakly significant at the 10% level. Other studies that have considered the role of changes in life circumstance (relationship status, financial success or hardship) (Debpuur et al., 2002; Freedman et al., 1965; Hayford, 2009; Heiland et al., 2008; Udry, 1983; Yeatman et al., 2013) report revisions in fertility preferences up or down by only one birth. In this study, I did not find evidence that experiencing a sister's death in childbirth should be included in the list of demographic events that can affect a woman's fertility behavior. Future research that includes larger samples or qualitative interviews with women who have lost their sisters in childbirth may reveal a richer picture of the role of experiencing a sister's death in childbirth in influencing a woman's own fertility desires.

# 3. Desa Siaga: Evaluation of a Village-Level Information Intervention to Promote Safe Deliveries in Indonesia

## *3.1 Introduction*

WHO recommends that antenatal care include a component of education on birth preparedness and complication readiness (BPCR) which includes education of pregnant women about the dangers signs of complications during pregnancy, delivery and the postpartum period and encouraging women to make plans in advance of delivery including who will assist, where the delivery will take place, transportation, payment and finding a blood donor; despite this strong recommendation, WHO indicates that the quality of evidence for these programs is low or very low but that any undesirable effects are outweighed by potential benefits[1] (WHO, 2015). Which type of intervention is the most effective - delivery of information to pregnant women and/or husbands through facility-based antenatal care, home visits, or community-based programs - remains an open question. A set of papers evaluating a BPCR intervention in Indonesia called Desa Siaga ("Alert Village") (Sood, et al., 2009; Sood, Suruchi et al., 2004) that was scaled up in 2006 as part of a community-based program to address obstetric emergencies rely on weak evidence for causal inference and this paper

[1] Interventions rated as "low" require future research and there is a high likelihood that future research may change the interpretation of current studies. Interventions rated as "very low" report estimates that are very uncertain due to weak empirical designs.

attempts to answer the call by the international community for more rigorous evidence on BPCR interventions (Miller et al., 2003; Stanton, 2004; WHO, 2015).

In this paper, I link together a village-level census of service availability (*Potensi Desa* or PODES) with reproductive service use, knowledge of complications and preparedness for delivery reported by reproductive age women and a subset of their husbands in the Demographic and Health Surveys (DHS). I am able to compare reproductive service use for births in villages before and after the village becomes a Desa Siaga by using village-fixed effects. I also examine level of knowledge and reported preparedness measured in the post-period, as in other studies, but I add controls for the endogenous placement of the Desa Siaga program which helps reduce the bias in post-only estimates.

## *3.2 Background and Context*

Indonesia has one of the highest maternal mortality ratios among its neighbors in Southeast Asia. Despite increases in educational attainment and rising incomes across the last four decades, the maternal mortality ratio has remained stubbornly high and by some accounts has increased from 228 maternal deaths per 100,000 live births in 2007 to 359 maternal deaths per 100,000 live births in 2012 (Statistics Indonesia (Badan Pusat Statistik - BPS) et al., 2013). Roughly 30% of maternal deaths in Indonesia result from complications in the intra-partum period (the time including delivery and the 24 hours after delivery) which include bleeding and hypertensive disorders of pregnancy

(Kassebaum, 2014). Maternal deaths are in many cases preventable by addressing the "three delays" – delay in knowing there is a problem, delay in reaching a facility when care is needed and delay in receiving adequate care once a facility is reached (Thaddeus et al., 1994). The Indonesian government has undertaken several strategies to reduce the three delays and I discuss those in the next paragraph.

The government of Indonesia has been proactive in addressing geographic barriers to services that reduce the risks of maternal death from the second and third delays. In the mid-1990s, the government of Indonesia undertook a very successful program to train midwives and appoint them to remote villages across the island archipelago – which spans more than 5,000 kilometers from east to west across a territory that includes more than 17,000 islands (Frankenberg et al., 2005; Frankenberg et al., 2001). Midwives have training in uncomplicated deliveries but may lack the training to perform services that may be needed during complicated deliveries such as c-sections or blood transfusions. To support midwives, Indonesia has concentrated on building referral networks that match women in need with life-saving services in emergencies but relies on midwives for antenatal risk screening and normal deliveries. Recent efforts to implement health insurance for poor families (ASKESKIN) have been targeted at reducing financial barriers to the use of skilled obstetric services (Rokx et al., 2010). Since 2006, Indonesia has had a national program that focuses on reducing the first delay which by relying on community health surveillance and promotion of healthy

behaviors during pregnancy and childbirth, among other goals. This program in its current form is known as *Desa Siaga Aktif* which translates to "Alert Villages." This paper evaluates the effect of this community-based empowerment program on knowledge, preparedness among women and men and service use during pregnancy and at the time of delivery for women and their husbands who have been exposed to program activities in their villages compared to a set of villages that were not part of the program.

### 3.2.1 The Siaga Concept in Indonesia

The Maternal and Neonatal Health (MNH) program funded by USAID and coordinated by JHPIEGO and the Johns Hopkins University School of Public Health Center for Communication Programs (JHUCCP) (JHPIEGO, 2004) developed the Siaga concept in Indonesia in 1999 and carried out the initial program activities that would become a model for national level expansion. The MNH program, with input from Indonesian partners, developed a communication strategy to address birth preparedness and complications readiness (BPCR) among husbands of pregnant women in Indonesia. The campaign was known as Suami Siaga (loosely "watchful husbands") and included a media campaign that was national in scope with targeted program activities concentrated in areas of West Java, South Sulawesi and South Sumatra. The focus of Suami Siaga was to increase awareness of pregnancy and delivery complications and encourage planning for delivery by husbands, who may be the key decision-makers on

providing permission or funds to seek services in some cases (Shefner-Rogers et al., 2004). By the time the program ended in 2004, it had progressed from merely focusing on husbands to coordinating whole villages to become "alert villages" or Desa Siaga. From 2006-2009, the German development agency (GIZ) and AusAID coordinated activities to establish alert villages in two remote provinces in eastern Indonesia (East Nusa Tenggara and West Nusa Tenggara).

In 2006, based on positive evaluations of the MNH program, the government of Indonesia issued a decree establishing the Desa Siaga program nationally as part of its Healthy Indonesia 2010 strategy (MoH Indonesia, 2005, 2006). At the time of the 2006 expansion, Siaga programs were expanded to include not just preparedness for obstetric emergencies but community readiness for disaster management reflecting the government's response to recent disasters including the 2006 volcanic explosion of Mount Merapi and the 2004 Indian Ocean earthquake and tsunami; this paper focuses on the impact of the Desa Siaga program on obstetric services. The Desa Siaga program would have as its central nervous system the Poskesdes (a new facility created for this purpose, though villages were encouraged to convert existing village delivery posts to Poskesdes). The Poskesdes should be staffed by one midwife and two village health volunteers (cadres in Indonesian). The stated goal of the Desa Siaga program was to increase life expectancy, reduce infant and maternal mortality and reduce the prevalence of malnutrition among children under the age of five as well as. These goals would be

achieved through a combination of surveillance and health promotion in the village by the midwife and village health volunteers. The key components distinguishing alert villages from other villages include: monthly meetings of the Desa Siaga committee, listing of pregnant women, designation of a community ambulance, setting up funds to help women pay for delivery services, and identifying blood donors. Midwives working in Alert Villages were also required to faithfully implement the components of the P4K program (MoH Indonesia, 2009) which is a communication strategy for midwives that includes counseling women and husbands on the potential dangers signs during pregnancy, delivery and the postpartum period and encouraging women to make preparations for delivery in advance including where the delivery will take place, who will provide assistance (skilled assistance was encouraged), transportation, payment and finding a blood donor. The centerpiece of this program was a sticker designed to be posted on the outside of a pregnant woman's house so that the community could identify pregnant women and help them in an emergency. Incumbent on midwives in the Desa Siaga villages was the responsibility for working with government officials to ensure the villages attainment of Desa Siaga status.

The government of Indonesia reinforced its commitment to the Desa Siaga program in 2008 when it declared a goal to have an active Poskesdes in 80% of villages by 2015 (MoH Indonesia, 2008). In 2010, the program was further expanded to include as *Desa Siaga Aktif* villages without physical infrastructure for a Poskesdes but where

citizens had easy access to services from midwives and at public health centers (MoH Indonesia, 2010). According to the strategic plan from the Indonesian Ministry of Health 2015-2019 (MoH Indonesia, 2015), Desa Siaga remains a key policy goal. The Poskesdes is still a center for Siaga activities and midwives in villages with Poskesdes are required to implement the components of the P4K program (correspondence with Ministry of Health Official, January 2016).

Evaluations of the initial MNH program implemented between 1999 and 2004 have found positive results; however, no studies include controls for the endogenous placement of the program and only one (unpublished) study (Sood, et al. 2004) has measures of pre-program characteristics of respondents but it ignores the endogeneity of program placement and village characteristics at baseline. Shefner-Rogers and Sood (2004) focuses on Suami Siaga in West Java, South Sulawesi and South Sumatra and relies on self-reports of exposure from men in program areas and lacks pre-data on the level of knowledge among men in their sample. Sood, et al. (2009) uses a community-level definition of exposure based on intensity of program activities but has no data from the time period before the program. Village-level characteristics in Sood, et al. (2009) differ across levels of exposure suggesting that exposure of the program may have depended on village-level characteristics such as obstetric service use at baseline, personality of village leader, acceptability of the program by midwives and education level of program participants.

To improve on prior evaluations, the researcher needs measures of the outcome of interest before and after the program begins, ideally within the same villages or for the same women. The researcher should also be mindful of program placement when evaluating public health programs that may be targeted to certain areas based on observable characteristics as the study of the midwife program and family planning programs in Indonesia make clear (Frankenberg & Thomas, 2001; Molyneaux et al., 2000). When program placement is not carefully controlled, the most empirically rigorous strategy employs village-fixed effects so that outcomes at two points in time – before and after the program – in the same village can be compared across villages that do and do not receive the program. This study aims to fill this empirical gap in the evaluation of the Siaga program in Indonesia. I combine information on the presence or absence of a Poskesdes at the village level from the 2005, 2008 and 2011 Village Potential Census (*Potensi Desa* or PODES) with data on obstetric service use, planning for delivery and knowledge of the danger signs of complications during pregnancy collected in the 2012 Indonesia Demographic and Health Survey (IDHS). I now have data on births in villages before and after the program begins and I can use a village-fixed effect to rid the estimates of any endogeneity associated with factors that contributed to program placement.

## *3.3 Data and Methods*

I make use of two datasets in this paper that when linked together allow me to analyze how population-level health outcomes are associated with village-level provision of health services. Data on the availability of a Poskesdes comes from a village-level census in Indonesia called *Potensi Desa* or PODES. Data on reproductive behaviors, knowledge and planning come from the Indonesia Demographic and Health Survey (IDHS), a cross-sectional, population representative survey of reproductive age women. The next section details the two datasets, the process I used to combine the two files and an analysis of characteristics that predict match success.

The first set of data is a village-level census carried out by the government of Indonesia in approximately three year intervals; I focus on the 2005, 2008 and 2011 waves because the Desa Siaga/Poskesdes program was established nationally in 2006. In the PODES, village leaders report on the village population, availability of services (health, education and religious facilities), and other physical and economic characteristics of the village. Villages are considered to have a service (poskesdes, midwife, physician, and/or village delivery posts) if the service is either located in the village or the village leader reports that it is very easy to obtain services from one of

these facilities. Each village in Indonesia is identified by a ten-digit code and village name.[2]

The second dataset I use is the 2012 Indonesia Demographic and Health Survey (IDHS). The IDHS is a cross-sectional survey of 45,607 reproductive age women who report on their education, age, location in a five quintile wealth spectrum (calculated from a list of assets owned by the household) and other socioeconomic characteristics and birth outcomes for all children born in the five years before the survey which encompasses 17,886 births between January 2007 and July 2012. Every third woman's husband is eligible to be interviewed in the men's questionnaire comprising a final sample of 8,198 men. The IDHS is constructed to be representative of the urban and rural populations of each of Indonesia's 33 provinces. Importantly for merging the IDHS and PODES, the IDHS includes ten-digit village codes but lacks names.

Because villages can change codes and names frequently over time, I first merge the IDHS village codes to a crosswalk of village code and name changes from the Indonesian Statistical Agency (*Badan Pusat Statistik*). I then match each IDHS village to its village-level service characteristics in the PODES using ten-digit village code and name. 1,827 unique villages were surveyed in the 2012 DHS. I am able to match 99% of these villages to the 2008 and 2011 PODES. Fewer (90%) match to the 2005 PODES but

[2] I use the term village to refer to both villages (desa) and urban wards (kelurahan). Both urban wards and villages are uniquely identified by ten-digit codes and names.

when villages that were part of newly established provinces in the early part of the 2000s are excluded, the match rate increases to 96%. In my analysis, I exclude Jakarta because the Desa Siaga program is primarily targeted to areas outside the capital, in fact no areas of Jakarta report having a Poskesdes in any year and my match rate is the same for the whole sample and when Jakarta is excluded. Few demographic and population factors predict whether a village will be unmatched from the IDHS to the 2008 and 2011 PODES (results available upon request), the only exception is whether a village is in an Eastern province which includes Nusa Tenggara, Kalimantan, Sulawesi, Gorontalo, Maluku and Papua. Areas that were more well off and had lower fertility were more likely to match to the 2005 PODES but I do not find this too concerning because the focus of this evaluation is obstetric service use that happened after the 2008 and 2011 PODES surveys. Furthermore, villages that became Desa Siaga between 2005 and 2008 are no less likely to match to the 2005 PODES, results not shown.

### 3.3.1 Endogeneity of Program Placement

Table 13 displays rate of expansion of the Poskesdes program among IDHS villages and in the PODES at large and confirms that I am picking up the population-level transitions with the villages sampled in the IDHS. In Table 13, it is clear that the Poskesdes program was experiencing the most active expansion over the period I study compared to other services that women could employ to assist with pregnancy and delivery. Among IDHS villages, 24% had gained a Poskesdes between the initiation of

**Table 13. Changes in service availability at the village level (2005-2011)**

| | PODES | | | DHS | | |
|---|---|---|---|---|---|---|
| | 2005 | 2008 | 2011 | 2005 | 2008 | 2011 |
| Has Poskesdes (%) | 0 | 22 | 44 | 0 | 24 | 47 |
| Gains Poskesdes (%) | | 22 | 22 | | 24 | 23 |
| Has village delivery post (%) | 45 | 41 | 27 | 42 | 36 | 22 |
| Gains village delivery post (%) | | -4 | -14 | | -6 | -14 |
| Has midwife (%) | 74 | 75 | 77 | 86 | 88 | 90 |
| Gains midwife (%) | | 1 | 2 | | 2 | 2 |
| Has doctor (%) | 28 | 30 | 31 | 53 | 57 | 60 |
| Gains doctor (%) | | 2 | 1 | | 4 | 2 |
| N villages | 69,957 | 75,410 | 78,609 | 1,642 | 1,803 | 1,800 |

Note. Source: PODES 2005, 2008, 2011 and DHS 2012. Villages are considered to have a Poskesdes, midwife, doctor or delivery post if there is one reported in the village or the village head reports that it is very easy to gain access to one considering geographic distance.

the program in 2006 and the 2008 PODES (which was enumerated between April 24 and May 24 of 2008). By the 2011 PODES in April 2011, an additional 23% of villages had gained a Poskesdes and nearly half of all villages in Indonesia could be considered Desa Siaga. The increase in villages with a Poskesdes was accompanied by a decrease in villages with a village delivery post, though of a smaller magnitude. This is explained by the wording of the policy in the 2006 declaration that encouraged villages to transition their village delivery post to a Poskesdes (MoH Indonesia, 2006). The rate of expansion for midwives and doctors was considerably slower than that of Poskesdes.

Close to 90% of IDHS villages had midwives in all PODES waves I consider and the rate of increase was only 2% across this period. Similarly, the rate of increase for doctors was only between 2 and 4% across the same time period. Fewer villages in the full sample of villages from the PODES report the presence of a midwife or doctor which likely speaks to my low match rate among remote provinces where it is difficult to entice health workers to practice.

Table 14 explores the community level correlates of whether a village will have a Poskesdes in 2008 and 2011 compared to lagged measures of service availability from the prior survey. Column 1 shows that villages that were the first to become Desa Siaga after 2006 (i.e. had a Poskesdes by 2008) were more likely to already have a midwife, doctor and a village delivery post and were less likely to be in Indonesia's remote, eastern provinces. They were also more likely to have an elementary school which could contribute to higher levels of education among residents and perhaps condition acceptability of the program. Column 2 shows that having a midwife, village delivery post and elementary school are predictive of gaining a Poskesdes. Eastern, rural provinces where roads are not passable year-round are less likely to gain a Poskesdes between 2008 and 2011 suggesting that, over time, the program has targeted villages that have the necessary infrastructure already to implement the program – a Poskesdes must be staffed by a midwife and two volunteers and villages that already had village delivery posts were encouraged to convert these facilities to a Poskesdes. Column 3

**Table 14. Community level correlates of gaining a Poskesdes**

| | Village has Poskesdes in 2008 | Village has Poskesdes in 2011 | Village has Poskesdes in 2011 | Village has Poskesdes in 2011 |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Easy access to a midwife in 2005 | 2.21*** | | | |
| | [1.41,3.46] | | | |
| Easy access to a doctor in 2005 | 1.40* | | | |
| | [1.03,1.89] | | | |
| Traditional Birth Attendant in 2005 | 1.01 | | | |
| | [0.78,1.29] | | | |
| Easy access to a village delivery post in 2005 | 1.25** | | | |
| | [1.07,1.47] | | | |
| Pharmacy in 2005 | 0.98 | | | |
| | [0.89,1.07] | | | |
| Dentist in 2005 | 1.08 | | | |
| | [0.85,1.39] | | | |
| Elementary school in 2005 | 2.24+ | | | |
| | [0.94,5.33] | | | |
| Widest road paved in 2005 | 1.2 | | | |
| | [0.86,1.69] | | | |
| Widest road passable year-round in 2005 | 1.32 | | | |

| | | | | |
|---|---|---|---|---|
| | [0.75,2.33] | | | |
| Rural (measured in 2012) | 1.12 | 0.73+ | | 0.70+ |
| | [0.83,1.52] | [0.53,1.00] | | [0.46,1.06] |
| Eastern Province | 0.78+ | 0.59*** | | 0.61** |
| | [0.61,1.01] | [0.47,0.75] | | [0.45,0.83] |
| Easy access to a midwife in 2008 | | 1.44+ | | 1.44 |
| | | [0.99,2.10] | | [0.91,2.26] |
| Easy access to a doctor in 2008 | | 0.89 | | 0.89 |
| | | [0.65,1.22] | | [0.60,1.34] |
| Traditional Birth Attendant in 2008 | | 0.81 | | 0.83 |
| | | [0.62,1.05] | | [0.60,1.16] |
| Easy access to a delivery post in 2008 | | 1.64*** | | 1.59** |
| | | [1.25,2.14] | | [1.15,2.21] |
| Pharmacy in 2008 | | 0.85 | | 0.8 |
| | | [0.60,1.21] | | [0.52,1.25] |
| Dentist in 2008 | | 0.8 | | 0.83 |
| | | [0.57,1.12] | | [0.54,1.27] |
| Elementary school in 2008 | | 1.88* | | 1.66 |
| | | [1.04,3.40] | | [0.79,3.47] |
| Widest road passable in 2008 | | 1.1 | | 1.1 |
| | | [0.81,1.50] | | [0.75,1.60] |
| Widest road passable year-round in 2008 | | 1.57+ | | 1.53 |
| | | [0.98,2.52] | | [0.85,2.73] |
| Proportion of births delivered at home in 2007/2008 | | | 0.73 | 0.77 |

| | | | | |
|---|---|---|---|---|
| | | | [0.50,1.07] | [0.50,1.19] |
| Births assisted by a skilled birth attendant 2007/2008 | | | 0.89 | 0.78 |
| | | | [0.55,1.45] | [0.46,1.31] |
| Births receiving 4 or more antenatal care visits 2007/2008 | | | 1.02 | 0.97 |
| | | | [0.64,1.61] | [0.60,1.58] |
| Percent of reproductive age women with primary education or more | | | | 0.52* |
| | | | | [0.28,0.97] |
| N | 1,550 | 1,283 | 839 | 839 |
| pseudo R2 | 0.04 | 0.04 | 0 | 0.04 |

Notes. Source: Facility information comes from the Village Potential Surveys (Potensi Desa or PODES) and obstetric service use comes from the 2012 Demographic and Health Survey (DHS). Table displays exponentiated coefficients; 95% confidence intervals in brackets. Column 1 displays a model predicting whether a village will have a Poskesdes in 2008 based on characteristics measured at the village level in 2005. Columns 2-4 present results of predicting whether a village that does not have a Poskesdes in 2008 will receive one in 2011 based on village-level service availability, obstetric service use and women's education at the village level measured before the 2008 survey from 2007 until May 2008 at the time of the 2008 facility survey. Models exclude Jakarta.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

examines whether village-level obstetric service use between July 2007 and just prior to the 2008 PODES, in May 2008, predicts program placement. These results indicate that the level of births delivered by a skilled birth attendant, at home or those with four or more antenatal care visits do not predict whether a village will be targeted by the Desa Siaga program. Column 4, combines services in 2008 and obstetric service use and finds broadly similar results though now the association of gaining a Poskesdes with having an elementary school is subsumed by the coefficient for percent of women with a primary education or more. It is evident that the Poskesdes/Desa Siaga program in Indonesia was not rolled out randomly but has focused on areas that already have infrastructure for implementation; while this can ensure that the program is implemented successfully, it is also necessary to take the endogeneity of program placement into any empirical analysis of the program's effect.

### 3.3.2 Outcome Variables

The outcomes I consider come from the 2012 IDHS. The stated goal of the Desa Siaga program is to reduce infant and maternal mortality, raise life expectancy and reduce malnutrition among children under age five. Though these variables cannot be measured directly from the IDHS, I chose a set of process indicators (Stanton, 2004) that may influence the rate of maternal deaths and indicate improvement in care for infants. I focus on three service use variables measured for births occurring before and after the program was implemented. These include use of a skilled birth attendant at delivery

(SBA) (in this context a SBA is a midwife, doctor, nurse, or paramedic), whether a woman has not received antenatal care for her most recent pregnancy, and whether or not a woman has received a postpartum check-up.

One of the main goals of the program was to reduce the first delay (delay in knowing there is a problem and having a strategy to address it), I consider a set of knowledge indicators that are only measured at the time of the survey for women and a subset of their husbands. All women are asked if they can spontaneously name any complication during pregnancy, delivery or the postpartum period. I create three dichotomous variables to measure women's knowledge. First, does a woman name any complication (e.g. a complication in either the pregnancy, delivery or postpartum period), second, does a woman spontaneously name bleeding as a complication in any period and lastly whether a woman name any complication other than bleeding. Because the focus of the Desa Siaga program was not entirely on bleeding, we might expect that villages where the program was more successful would increase both knowledge of bleeding and knowledge of other complications. A subset of husbands are asked about their knowledge of complications during that can occur in pregnancy (not delivery or postpartum) and I categorize their knowledge similarly to women. For at least some of the women in my sample an additional pregnancy is relatively unlikely because they have completed childbearing and want no more children. In order to focus the spotlight on women most likely to conceive, I stratify women into two groups and

include an interaction term in the knowledge equations to separate women who are likely and not likely to become pregnant. I define as "likely to become pregnant" women who are under 35 years old or are currently pregnant or are older than 35 but have declared that they would like to have more children. I consider women unlikely to become pregnant if they are over 35 and do not want more children; are widowed, divorced, infecund, or sterilized; or are under 35 but do not want more children. I subdivide men on the basis of their wife's classification.

To examine preparedness for delivery, I consider women's reports of preparedness for their most recent delivery if it happened in the five years before the survey. Women report whether during the last pregnancy they discussed any of five issues with anyone (this could be spouse, midwife, relatives, friends, etc.). Women are asked whether they discussed where they planned to deliver their pregnancy, plans for transportation, who would assist the delivery, how the payment would occur and whether they had identified a blood donor. A subset of men are also asked about plans they made for the delivery of their most recent child's birth if the birth occurred in the five years before the survey.

Observations from Indonesia's urban metropolis capital, Jakarta, are excluded from my analysis because service use is already high in these areas and no areas of Jakarta sampled in the IDHS ever report having a Poskesdes. I use the individual sampling weights provided by the IDHS.

### 3.3.3 Analytical Strategy

I begin by classifying villages by their Desa Siaga status. Villages with a Poskesdes in 2011 but not 2008 are considered to have gained the program between the two surveys; villages that have a Poskesdes in both years are considered to always have the program; villages that never report a Poskesdes are considered to never have the program and villages that had the program in 2008 but not in 2011 are classified as losing the program.[3]

Analysis for the set of outcomes that are only measured contemporaneously in the 2012 DHS can be written as in Eq. 3.1. Below

$$\ln\left(\frac{\theta_p}{1-\theta_p}\right) = \alpha + \beta_1(Gains\ Poskesdes\ by\ 2011)_v + \beta_2(Has\ Poskesdes\ in\ 2008\ and\ 2011)_v + \beta_3(Has\ Poskesdes\ in\ 2008\ Only)_v + \boldsymbol{X}_v + \boldsymbol{X}_i + \varepsilon_i \quad (3.1)$$

Outcomes are denoted by $\theta_p$. These include knowledge of the danger signs during pregnancy, delivery and the postpartum period and five plans made for delivery

[3] Loss of the program does not necessarily mean the village has downgraded its Desa Siaga status. The 2010 Desa Siaga Aktif declaration indicates that villages can still be called Desa Siaga if residents have easy access to midwives and public health centers for obstetric services. Conversations with a Ministry of Health official suggest that the Poskesdes is still the main vehicle for distributing the P4K program on education about BPCR and since BPCR is a major focus of this evaluation I wish to create a separate category for villages that "lose" the program.

(location, assistance, transportation, payment and identifying a blood donor). $\mathbf{X}_v$ contains a vector of characteristics that predict program placement which include a set of variables measured at the village living in 2008 including whether the village had very easy access to midwives, traditional birth attendants, and village delivery posts and whether the main road was passable year-round as of 2008; it also includes controls for access to a midwife constructed as three categories: those that continuously have a midwife, those who gain a midwife in 2011 and those that lose a midwife between 2008 and 2011. The reference group is villages that never have a midwife. Finally, $\mathbf{X}_i$ is a set of socioeconomic characteristics that remain constant for each woman across births including whether she has a primary education or higher versus a primary education or less, rural residence, dummies for location in a five quintile wealth spectrum and province fixed effects. Estimates for women are weighted by the woman's individual sampling weight provided by the IDHS and estimates for men are weighted by the men's individual sampling weight provided by the IDHS. Standard errors are clustered at the village level.

For outcomes that are measured before and after a Poskesdes arrives in a village, I use the same four group classification of villages as in Eq. 3.1. Since I do not know the exact date that the program began in the village, I consider two periods after each PODES (of 15 months in length), when it is reasonably certain that the program exists when those births occur. The first period corresponds to the 15 months after the 2008

PODES (June 2008 to August 2009). The second period is the 15 months after the 2011 PODES (May 2011 to July 2012). With this set-up, I compare time-trends among four types of villages across two time periods. The reference category is villages that do not report having a Poskesdes in 2008 or in 2011. The logistic regression equation can be written as:

$$\ln\left(\frac{\theta_b}{1-\theta_b}\right) = \alpha + \beta_1(Gains\ Poskesdes\ by\ 2011\ x\ Post)_v + \beta_2(Has\ Poskesdes\ in\ 2008\ and\ 2011\ x\ Post)_v + \beta_3(Has\ Poskesdes\ in\ 2008\ Only\ x\ Post)_v + \boldsymbol{X}_{mv} + \boldsymbol{X}_b + \boldsymbol{X}_i + \lambda_v + \varepsilon_v \quad (3.2)$$

where $\theta_b$ indicates a birth specific outcome and the indicators for each type of village are interacted with "Post" which delineates the two periods described above. $\mathbf{X}_{mv}$ includes indicators for whether or not a village gains, loses or maintains a midwife compared to never having a midwife interacted with "post". $\mathbf{X}_b$ includes birth-specific variables measured at each birth such as woman's age and number of prior births and $\mathbf{X}_i$ is a set of socioeconomic characteristics that remain constant for each woman across births including whether she has a primary education or higher versus a primary education or less, rural residence, dummies for location in a five quintile wealth spectrum and province fixed effects. $\lambda_v$ is an indicator for village-fixed effects which allows the comparison of birth outcomes in villages by whether or not they had the program and before and after the program begins. In Eq. 3.2, factors measured in 2008 that predict

program placement in 2011 drop out of the equation with village fixed-effects. Standard errors are clustered at the village-level.

## *3.4 Results*

Table 15 displays descriptive statistics for the sample of women and men interviewed in the 2012 IDHS, Jakarta is excluded. Women and men are equally distributed across urban and rural areas. The age profile for reproductive age women is younger than that of husbands interviewed. Husbands tend to be over 35 while women are more likely to be in the 20 to 34 age range. The group of women who are likely to become pregnant is slightly larger among women than among men, who are classified by their wife's likelihood of becoming pregnant. About 62% of women and 59% of men have a primary education or more which is comparable to the population of Indonesia. Interestingly, the sample of women report fewer children ever born (1.80) than men (2.3). This could be a reflection of the younger age of the sample of women which includes all women rather than the sample of men which is restricted to men currently married to IDHS respondents. In this sample of women, 83% deliver with a skilled birth attendant present, 3 percent have no antenatal care and 90% of deliveries had postpartum check-ups. The averages do vary by education status and rural residence in the typical pattern of high socioeconomic women being more likely to engage in positive health behaviors (results not shown).

**Table 15. Descriptive statistics for the analytical sample weighted by sampling probability**

| | Women | | Men | |
|---|---|---|---|---|
| Variable | N | % | N | % |
| **Place of residence** | | | | |
| Rural | 22,300 | 50 | 4,263 | 51 |
| Urban | 20,174 | 50 | 3,403 | 49 |
| **Age** | | | | |
| < 20 | 6,762 | 15 | 30 | 0 |
| 20 to 34 | 19,255 | 44 | 2,809 | 35 |
| 35 + | 15,457 | 41 | 4,827 | 65 |
| **Likelihood of becoming pregnant** | | | | |
| Likely | 24,972 | 57 | 3,940 | 49 |
| Unlikely | 17,502 | 43 | 3,726 | 51 |
| **Education** | | | | |
| Primary education or more | 27,498 | 62 | 4,709 | 59 |
| Primary education or less | 14,976 | 38 | 2,957 | 41 |
| **Children ever born** | 1.80 | | 2.3 | |
| **Outcomes** | | | | |
| Skilled birth attendance (n=16,778) | | 83 | | |
| No antenatal care (n=14,180) | | 3 | | |
| Postpartum check-up for mother (n=14,210) | | 90 | | |
| **Total** | 42,474 | 100 | 7,666 | 100 |

Note. Sample is comprised of 42,474 women who report on 16,778 births in the five years before the survey. All women answer questions about knowledge of complications; women answer whether all births in the five years before the survey had a skilled birth attendant (SBA); planning questions are only asked about the most recent birth if it occurred within the last 5 years. Women are considered likely to become pregnant if they are less than 36 years old, would like to have another child or are pregnant and are not widowed, divorced or sterilized. Individual sampling weights are used, Jakarta is excluded.

Table 16 shows the distribution of knowledge and planning across five indicators of risk for poor obstetric outcomes: residence, age, likelihood of becoming pregnant, education and parity. In the full sample, women are much more likely to name danger signs during childbearing than men. However, men and women are equally likely to report discussing the location of the delivery, assistance, transportation and payment. Men, on the other hand, are more likely to report that they discussed finding a blood donor than women – 25% of men report this behavior compared to only 14% of women. Several factors emerge as predictive of knowledge of complications: both men and women living in urban areas, with primary education higher and who have already had a child are more likely to spontaneously report knowing a sign a pregnancy is in danger than their lower educated, childless counterparts living in rural areas. Women aged between 20 and 34 are more likely to report knowledge of complications than younger and older women, whereas for men, those aged 35 or older are much less likely to report knowledge of complications. Women who are likely to become pregnant are equally likely to know about complications, however, men whose wives are unlikely to become

pregnant are much less likely to report knowing of complications than men who are married to women who are likely to become pregnant.

Turing to preparedness for delivery. Men under 20 years of age report thinking about payment, transportation and blood donors more than any other age group of men. For women, preparedness does not seem to vary by age. Urban men and women

**Table 16. Distribution of knowledge of danger signs and preparedness for delivery by gender and socioeconomic characteristics**

| | | Residence | | Age | | | Likely to become pregnant | | Education | | Children ever born | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Full sample | Rural | Urban | < 20 | 20 to 34 | 35 + | Likely | Unlikely | Primary or more | Primary or less | Has a child | Childless |
| **Panel A. Danger signs of complications** | | | | | | | | | | | | |
| *Knows any danger sign* | | | | | | | | | | | | |
| Women | 47 | 41 | 53 | 31 | 53 | 46 | 46 | 48 | 54 | 34 | 51 | 35 |
| Men | 14 | 11 | 17 | 17 | 24 | 9 | 17 | 11 | 19 | 7 | 15 | 0 |
| *Knows bleeding* | | | | | | | | | | | | |
| Women | 44 | 39 | 49 | 25 | 50 | 45 | 42 | 46 | 51 | 32 | 49 | 30 |
| Men | 9 | 7 | 11 | 3 | 16 | 6 | 11 | 7 | 13 | 4 | 10 | 0 |
| *Knows anything other than bleeding* | | | | | | | | | | | | |
| Women | 54 | 48 | 59 | 32 | 59 | 56 | 51 | 57 | 60 | 44 | 60 | 38 |
| Men | 9 | 7 | 12 | 14 | 15 | 6 | 11 | 8 | 13 | 4 | 10 | 0 |

N women = 42,474
N men = 7,666

**Panel B. Planning for Delivery**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Location* | | | | | | | | | | | | |
| Women | 80 | 74 | 87 | 74 | 82 | 77 | 82 | 79 | 86 | 69 | - | - |
| Men | 76 | 67 | 83 | 39 | 78 | 75 | 77 | 75 | 80 | 64 | - | - |
| *Assistance* | | | | | | | | | | | | |
| Women | 80 | 76 | 85 | 74 | 81 | 78 | 81 | 79 | 86 | 70 | - | - |
| Men | 78 | 82 | 71 | 68 | 76 | 81 | 76 | 80 | 79 | 71 | - | - |
| *Transportation* | | | | | | | | | | | | |
| Women | 59 | 52 | 67 | 47 | 61 | 57 | 60 | 58 | 66 | 46 | - | - |
| Men | 55 | 44 | 62 | 66 | 53 | 57 | 57 | 52 | 58 | 42 | - | - |
| *Payment* | | | | | | | | | | | | |
| Women | 77 | 72 | 82 | 73 | 78 | 75 | 78 | 75 | 81 | 68 | - | - |
| Men | 72 | 66 | 77 | 99 | 72 | 72 | 71 | 74 | 73 | 67 | - | - |
| *Blood donor* | | | | | | | | | | | | |
| Women | 15 | 13 | 16 | 11 | 15 | 14 | 15 | 14 | 17 | 10 | - | - |
| Men | 24 | 22 | 26 | 44 | 23 | 25 | 24 | 24 | 26 | 17 | - | - |

N births for women = 14,261
N births for men = 1,162

Note. Table displays weighted percentages for analytical sample weighted by individual sampling weights.

typically report more planning than rural individuals; however, men in rural areas report thinking about who will assist during the delivery just as often as women in urban areas. Those with primary education or more report more planning across all categories than those with primary education or less. There are no notable differences in planning for a recent birth by those who are likely and unlikely to become pregnant again.

### 3.4.1 Knowledge and Preparedness for Delivery

Table 17 displays the results of estimating Eq. 3.1 separately for women and men with knowledge of complications as the outcome. Results for women are in Columns 1-3 and results for men are in Columns 4-6. Women who are likely to become pregnant are more likely to know any complication and are more likely to know bleeding but the results are only weakly significant at the 10% level. Women are significantly likely to know a complication other than bleeding if they are defined as likely to become pregnant. The interesting results are found in the bottom portion of Table 17 when likelihood of becoming pregnant is interacted with the type of program village a woman resides in. Compared to women in villages that never had a Poskesdes, women who live in villages that have had the program in 2008 and 2011 are significantly more likely to know about complications during pregnancy, delivery or the postpartum period ($p< 0.01$) and are significantly more likely to know about bleeding as a danger sign that women in villages that never had the program. These results are net of the observable

**Table 17. Regression results for women's and men's knowledge of danger signs**

| | Women | | | Men | | |
|---|---|---|---|---|---|---|
| | Knows Any | Knows Bleeding | Knows Any Other | Knows Any | Knows Bleeding | Knows Any Other |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Gains a Poskesdes in 2011 | 0.90 | 0.93 | 0.91 | 1.14 | 1.20 | 1.20 |
| | [0.78,1.04] | [0.80,1.08] | [0.79,1.04] | [0.74,1.77] | [0.76,1.91] | [0.70,2.04] |
| Has a Poskesdes in 2008 and 2011 | 0.85+ | 0.82* | 1.01 | 1.05 | 1.43 | 1.05 |
| | [0.70,1.03] | [0.67,1.00] | [0.84,1.22] | [0.62,1.79] | [0.80,2.55] | [0.57,1.92] |
| Has a Poskesdes in 2008 Only | 0.97 | 1.03 | 1.08 | 0.71 | 1.03 | 0.82 |
| | [0.75,1.27] | [0.81,1.30] | [0.84,1.40] | [0.36,1.40] | [0.46,2.30] | [0.35,1.88] |
| Likely to become pregnant | 1.10+ | 1.11+ | 1.12* | 0.83 | 0.90 | 0.82 |
| | [0.99,1.23] | [0.98,1.25] | [1.01,1.25] | [0.56,1.23] | [0.57,1.41] | [0.53,1.26] |
| Gains a Poskesdes in 2011 | 1.03 | 1.04 | 1.03 | 0.84 | 0.90 | 0.75 |
| X Likely to become pregnant | [0.90,1.18] | [0.89,1.21] | [0.90,1.18] | [0.52,1.37] | [0.53,1.53] | [0.41,1.35] |
| Has a Poskesdes in 2008 and 2011 | 1.26** | 1.25* | 1.07 | 1.12 | 0.83 | 1.21 |
| x Likely to become pregnant | [1.07,1.50] | [1.03,1.51] | [0.92,1.25] | [0.61,2.08] | [0.41,1.67] | [0.59,2.48] |
| Has a Poskesdes in 2008 Only | 1.19 | 1.04 | 1.05 | 1.65 | 1.19 | 1.10 |
| x Likely to become pregnant | [0.95,1.48] | [0.82,1.32] | [0.82,1.34] | [0.74,3.71] | [0.45,3.15] | [0.40,3.01] |
| Mean in villages without Poskesdes | 46 | 43 | 52 | 31 | 20 | 21 |
| Observations | 42,436 | 42,433 | 42,436 | 7,661 | 7,661 | 7,661 |
| Pseudo $R^2$ | 0.06 | 0.06 | 0.07 | 0.15 | 0.15 | 0.14 |

Note: Table displays exponentiated coefficients; 95% confidence intervals in brackets. Each column includes controls for endogenous program placement measured in the 2008 PODES (village has a midwife, traditional birth attendant, village delivery

post and widest road is passable year-round), men's or woman's age, education, number of children, rural residence, wealth quintile and province fixed effects. DHS individual women's weights are used for women and men's sampling weights are used for men. Standard errors are clustered at the village level.

$^{+}$ $p < 0.10$, $^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

**Table 18. Regression results for women's and men's planning for delivery**

| | Location | Assistance | Transportation | Payment | Blood Donor |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| **Panel A. Women** | | | | | |
| Has a Poskesdes in 2011 | 0.87 | 1.01 | 0.83 | 1.06 | 1.04 |
| | [0.69,1.11] | [0.83,1.23] | [0.66,1.05] | [0.86,1.32] | [0.83,1.31] |
| Has a Poskesdes in 2008 and 2011 | 0.96 | 1.15 | 0.93 | 1.20 | **1.30**$^{+}$ |
| | [0.70,1.31] | [0.91,1.45] | [0.69,1.26] | [0.91,1.58] | [0.97,1.75] |
| Has a Poskesdes in 2008 Only | 0.75 | 1.01 | 1.16 | 1.23 | **1.43**$^{*}$ |
| | [0.51,1.10] | [0.73,1.40] | [0.77,1.73] | [0.87,1.75] | [1.00,2.04] |
| First child | 1.03 | 0.96 | 1.08 | 1.04 | 0.81 |
| | [0.79,1.34] | [0.79,1.17] | [0.86,1.37] | [0.84,1.31] | [0.62,1.05] |
| Mean in villages without Poskesdes | 78 | 79 | 58 | 75 | 14 |
| Observations | 3,945 | 3,945 | 3,943 | 3,944 | 3,938 |
| Pseudo $R^2$ | 0.17 | 0.12 | 0.12 | 0.12 | 0.09 |

| | Location | Assistance | Transportation | Payment | Blood Donor |
|---|---|---|---|---|---|
| **Panel B. Men** | | | | | |
| Has a Poskesdes in 2011 | 0.47$^{+}$ | 1.23 | 1.43 | 0.96 | 2.50$^{*}$ |
| | [0.22,1.02] | [0.64,2.39] | [0.71,2.85] | [0.48,1.92] | [1.16,5.40] |
| Has a Poskesdes in 2008 and 2011 | 0.36$^{*}$ | 0.98 | 0.84 | 0.75 | 1.12 |
| | [0.14,0.96] | [0.40,2.39] | [0.32,2.24] | [0.34,1.66] | [0.36,3.49] |
| Has a Poskesdes in 2008 Only | 0.49 | 0.70 | 0.96 | 1.58 | 1.92 |
| | [0.13,1.82] | [0.23,2.13] | [0.21,4.42] | [0.37,6.84] | [0.49,7.56] |

| | | | | | |
|---|---|---|---|---|---|
| First child | 1.41 [0.46,4.30] | 2.08* [1.01,4.32] | 1.02 [0.37,2.78] | 1.67 [0.63,4.45] | 0.85 [0.29,2.53] |
| Mean in villages without Poskesdes | 87 | 83 | 63 | 81 | 23 |
| Observations | 482 | 492 | 478 | 473 | 459 |
| Pseudo $R^2$ | 0.15 | 0.14 | 0.18 | 0.09 | 0.12 |

Note: Table displays exponentiated coefficients; 95% confidence intervals in brackets. Each column includes controls for endogenous program placement measured in the 2008 PODES (has a midwife, traditional birth attendant, village delivery post and widest road is passable year-round), men's or woman's age, education, number of children, rural residence, wealth quintile and province fixed effects. DHS individual women's weights are used for women and men's sampling weights are used for men. Standard errors are clustered at the village level.

$^{+}$ $p < 0.10$, $^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

characteristics that governed placement of the Poskesdes program and socioeconomic characteristics of women. Turning to men in Columns 4-5, men tend to have low knowledge of complications regardless of the type of village they live in; being part of the program does not seem to improve men's knowledge of the danger signs during pregnancy – a result that is in direct contrast to current studies of men's knowledge through the Suami Siaga program (Sood, 2004).

Table 18 explores planning behavior in response to the Poskesdes program. I limit both samples to only those births that occurred recently, defined here as the 15 months between the 2012 IDHS survey and the 2011 PODES. Guidance from the BPCR program evaluation literature suggests that the focus of measurement of planning behavior should be those women who have given birth recently (Stanton, 2004; WHO, 2015). Few differences emerge for either women or men based on whether or not they live in a village that got a Poskesdes in 2011. It does seem that the program had an effect on the probability that a husband or wife would talk about finding a blood donor. For women in villages that had the program in both years and those that had the program in 2008 but not in 2011, these women are 30 and 43% more likely to talk about finding a blood donor than women in villages without the program. The result for women in villages that gained the program in 2011 is positive but not statistically significant. Men who live in villages that gained a Poskesdes in 2011 were 2.5 times more likely to talk about finding a blood donor than men in villages that never got a Poskesdes. It's not

clear how to interpret why men are less likely to report talking about where the birth would be delivered and why that decreases if a village had a Poskesdes or not. All models control for endogenous program placement measured in 2008.

Results so far indicate that the Poskesdes program improved the likelihood that women who are at risk of becoming pregnant and live in villages that had a Poskesdes in 2008 and 2011 will know about any complications and in particular will know about bleeding compared to woman living in villages that never had the program; however, men do not report levels of knowledge that vary significantly by whether the village had a Poskesdes. When it comes to preparedness for delivery, it does seem like the program is associated with increased likelihood that men in villages that gained a Poskesdes in 2011 and women in villages that had a Poskesdes in 2008 will be more likely to report discussing finding a blood donor during births that occurred in the period after the 2011 PODES (the post period for this analysis).[4]

### 3.4.2 Use of Reproductive Services

The BPCR theory argues that educating women about the danger signs during pregnancy and encouraging planning for delivery will lead to uptake of behaviors that reduce the risk of maternal death. Since maternal death is an outcome too rare to

[4] Preparedness for delivery is measured for some births in what I refer to as the pre-period (the 15 months after the 2008 PODES). I estimate models of preparedness using Eq. 3.2 and no significant results emerge. Given the recommendation from the BPCR literature to focus on recently delivered women, I chose to only present results from the post-period controlling for endogenous program placement. Additional analysis is available from the author upon request.

**Table 19. Regression results predicting use of a skilled birth attendant (SBA), antenatal care and postpartum care**

| | Skilled Birth Attendant (SBA) | No Antenatal Care (ANC) | Any Postpartum Care for Mothers |
|---|---|---|---|
| | (1) | (2) | (3) |
| Post | 1.61$^{+}$ | 1.11 | 0.66 |
| | [0.92,2.84] | [0.46,2.66] | [0.37,1.18] |
| Gains Poskesdes in 2011 x Post | 0.85 | 0.42$^{*}$ | 1.11 |
| | [0.56,1.28] | [0.19,0.94] | [0.70,1.75] |
| Has Poskesdes in 2008 and 2011 x Post | 0.88 | 1.11 | 1.15 |
| | [0.52,1.48] | [0.31,3.95] | [0.66,2.01] |
| Has Poskesdes in 2008 Only x Post | 0.90 | 0.20$^{*}$ | 0.96 |
| | [0.48,1.67] | [0.05,0.82] | [0.44,2.12] |
| Gains Midwife x Post | 1.00 | 1.55 | 2.71* |
| | [0.47,2.10] | [0.39,6.14] | [1.19,6.14] |
| Loses Midwife x Post | 1.07 | 0.68 | 1.56 |
| | [0.48,2.41] | [0.19,2.45] | [0.61,3.98] |
| Maintains Midwife x Post | 1.11 | 1.54 | 1.46 |
| | [0.60,2.04] | [0.58,4.13] | [0.78,2.73] |
| Community fixed effect | X | X | X |
| Mean in villages without Poskesdes in 2008 or 2011 | 80 | 5 | 87 |
| Observations | 3,339 | 1,044 | 2,562 |
| Pseudo $R^2$ | 0.13 | 0.13 | 0.06 |

Note. Table displays exponentiated coefficients; 95% confidence intervals in brackets. Each model controls for factors that vary for each birth including woman's age and parity. All models include village fixed effects. Standard errors are clustered at the village level.
$^{+}$ $p < 0.10$, $^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

measure empirically without very large sample sizes, programs typically focus on improving skilled attendance at delivery, antenatal care uptake and postpartum care.

And so these are the indicators I focus on in this paper. Table 19 shows the results of estimating Eq. 3.2 with village fixed effects. There appears to be no significant effect of the Poskesdes program on use of skilled birth attendance, a result that is not surprising since 83% of births between 2007 and 2012 already were delivered by skilled birth attendants. Column 2 turns to results for use of antenatal care. Here, the outcome is whether a pregnancy had no antenatal care. Some positive results emerge. Women in villages that got a Poskesdes in 2011 were less likely ($p<0.05$) to have no antenatal care than women in villages that did not get the program in any year. Women who had the program in 2008 but not in 2011 are also less likely ($p<0.05$) to go without antenatal care during their pregnancy. Given that only 5% of women in villages that did not get the program had no antenatal care, this represents a definite improvement attributable to the Poskesdes. Lastly, I examine whether recently delivered women were more likely to get a postpartum check-up if they lived in villages that the got Poskesdes program. There are no significant results associated with the Poskesdes program; however, women in villages that gained a midwife between 2008 and 2011 were 2.71 ($p<0.05$) times more likely to have postpartum checks than women in villages that did not have midwives. I examined several other outcomes including facility deliveries, use of iron supplements during pregnancy, and other ways of defining postpartum care for women and newborns; no significant results were robust to the inclusion of village fixed-effects.

## 3.5 Discussion

In this paper, I reconsider the evidence on the Desa Siaga campaign in Indonesia. Current studies have ignored the endogenous placement of the Desa Siaga program and relied on post-only estimates of outcomes and self-reported exposure to the program. To improve on these techniques, I construct a measure of exposure from the PODES survey, a village-level census in Indonesia that collects information on the availability of health, religious and educational infrastructure at three-year intervals. I merge this dataset to the 2012 Indonesia Demographic and Health Survey (DHS) which collects information on reproductive behaviors and births within the same villages over time. The combination of these two datasets allows me to divide villages into those that had a Poskesdes and those that did not into two separate periods and compare their trajectories over time. The use of a village fixed-effect allows the comparison of births in the same villages that got the program those that did not. In estimates based on outcomes measured only at one point in time, I control for the endogenous placement of the program which seemed to target infrastructure-rich locations in Indonesia.

I uncover a set of results that provide some support for aspects of the Poskesdes program. One interesting result is that, more often, villages that had the program in both 2008 and 2011 had outcomes that were significantly better than villages that never got the program. For instance, women who are likely to become pregnant in villages that had the program in both 2008 and 2011 were 26% more likely ($p<0.01$) to be able to

name a danger sign during pregnancy, delivery or the postpartum period than women in villages that never got the program. These women were more likely to name bleeding than any other complication. For planning behaviors, women in villages that had the program by 2008 and either still had the program in 2011 or lost the program were more likely to report discussing finding a blood donor during their last delivery than women in areas that never had the program. Men in areas that gained the program in 2011 were 2.5 times more likely ($p<0.05$) to report discussing finding a blood donor than in villages that never had the program. These results are similar to published results from the MNH program (Sood et al, 2009) though fewer variables in the current analysis are significant.

Turning to service use, few significant results are uncovered by this study. There seem to be no association between use of a skilled birth attendant and the Poskesdes program (Sood, 2009 finds similar results for use of a skilled birth attendant). This study does find that compared to births before and after the program begins in villages that gain the program in 2011, births occurring after the program begins are 58% less likely to go without antenatal care ($p<0.05$). For postpartum care, the program does not appear to be associated with improvements in service use, however 90% of births already had postpartum care over this time period. Gaining a midwife (even with the Poskesdes program), does improve the chances that a woman will have a postpartum check (OR 2.71, $p<0.05$). Sood (2009) found knowledge of complications and planning improved

but not use of skilled birth attendance or antenatal care. The results of this study are similar.

Though this paper uses a more rigorous empirical strategy than previous research there are still limitations. A village fixed-effect compares births before and after the program within the same village but stronger causal inferences could be made using an individual fixed-effect to compare reproductive behaviors of the same woman who gives birth both before and after the program. The IDHS lacks enough observations to make this strategy possible. Lack of results for use of skilled birth attendance and postpartum check-ups could mean that the community is already saturated with these services and new, more targeted strategies are needed get to women who are still not availing of these obstetric services to use them – this could be a focus of future iterations of the Desa Siaga activities. It is also possible that for villages that gained or lost a Poskesdes between 2008 and 2011, using the 15 month period after either PODES does not accurately capture the timing of when all villages received the program. Analysis of DHS data (not shown) implies that this may be the case for a few villages, but that uptake of services directly from the Poskesdes is low even for villages that have one continuously throughout the period I study. This could reflect the outreach nature of the program which seeks to spread health promotion messages by using village health volunteers to visit women in their homes and identify pregnant women for surveillance rather than encouraging women to come to the Poskesdes to receive services.

This evaluation has shown that women in villages that are part of the Poskesdes program and are likely to become pregnant are more likely to know about bleeding as a complication of pregnancy, delivery or the postpartum period than women in villages without the program; men's knowledge is no higher across villages depending on whether they have a Poskesdes or not. Both women and men are more likely to report identifying a blood donor in case of obstetric emergency in villages that had the program compared to those that did not. Postpartum hemorrhage is responsible for 30% of maternal deaths in Indonesia (Kassebaum, 2014) and so improvement in knowledge and planning around bleeding as an obstetric complication should contribute to reducing maternal deaths. Use of antenatal care was more prevalent for women in villages with a Poskesdes and this could contribute to increased knowledge and planning. However, use of skilled assistance at delivery and postpartum care were not associated with the program, though these levels were already very high in Indonesia.

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## Biography

Amy Finnegan was born in Watertown, South Dakota on January 3, 1984 to James, a farmer, and Tamara, a registered obstetrics nurse, Finnegan. She was raised with her two sisters on a farm outside of Clear Lake, South Dakota. As part of the debate team at Deuel High School in Clear Lake, Amy was a member of the 2002 State A Policy Debate Championship Team and qualified for the National Forensics League (NFL) national tournament in both policy debate (2001) and humorous interp (2002). Amy received her Bachelor of Arts (BA) in 2006 from the Honors College of South Dakota State University (SDSU) where she graduated *magna cum laude* with a degree in Political Science. She holds a Master's of Public Administration (MPA) in International Development Policy and Management from the Robert F. Wagner Graduate School of Public Service at New York University which she received in 2011. Amy was a recipient of the Critical Languages Scholarship (CLS) to study Indonesian in 2014. She has also received several competitive fellowships while at Duke including the Anne M. and Robert T. Bass Fellowship for undergraduate teaching and research fellowships from the graduate school to travel to Indonesia.