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MATERNAL MORTALITY RISK AND SPOUSAL DIFFERENCES IN THE DEMAND FOR CHILDREN

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ABSTRACT

Fertility decisions are often made by partners who may disagree. We develop a model in which an initial gender gap in ideal fertility prevents effective communication between spouses about the costs of childbearing incurred by women. This mechanism is likely to further widen the spousal disagreement over fertility in environments where maternal health risk is high and imperfectly observed. We design an intervention to experimentally vary exposure to information about maternal health costs to either the husband or the wife on a sample of approximately 500 couples in peri-urban Lusaka, in Zambia. At baseline, husbands display lower knowledge of maternal mortality and morbidity compared to their wives. At followup, about one year after the intervention, women whose husbands are treated experience a 43% reduction in the probability of being pregnant. Consistent with our hypothesis, men who are directly treated report lower desired fertility and have more accurate beliefs about their wife's desired fertility than the husbands of treated women. Couples in which the husband is treated also increase communication about family planning, and experience greater marital satisfaction.

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Fertility decisions, like many other high-stakes economic choices, are more often made at the household rather than the individual level. Agents within a household may disagree, but different preferences do not necessarily lead to inefficient outcomes: a joint optimum can often be achieved through a compensating transfer. In some cases, however, when spouses have significantly different private optima, it may be difficult to reach efficient household outcomes (Ashraf, Field and Lee, 2014; Doepke and Kindermann, 2019). One reason this may happen, as we illustrate in this paper, is simply because spouses do not always have access to the same information about childbearing, and hence might hold systematically different beliefs about the costs and benefits of fertility choices over number and spacing of children. While we would expect communication between partners to generate convergence in beliefs, a conflict of interest may, in fact, impede the flow of information within the household, leading to fertility outcomes that depart from the joint optimum.

In this paper, we explore the role of information asymmetries and barriers to credible communication in shaping household decision-making over fertility. In particular, we examine spouses' knowledge of maternal health risk, how it spreads between partners, and how it influences gender differences in the demand for children. Our study takes place in Lusaka, Zambia, where married men on average report high desired fertility, both in absolute terms and relative to women, as is also seen across Sub-Saharan Africa (Westoff, 2010). Zambia also has one of the world's highest maternal mortality ratios amounting to a lifetime risk of maternal death of one in 59 (Central Statistical Office, 2014).

First, we document a significant gap in reproductive health risk awareness between husbands and wives, which we argue stems from gendered spheres of direct and indirect knowledge accumulation on maternal labor and delivery outcomes, which typifies much of the developing world. In particular, we collect novel data on beliefs about maternal health costs, which reveal that husbands in poor peri-urban Lusaka have limited knowledge relative to their wives of the average maternal mortality and morbidity risk, and also the risk *factors* that influence childbirth outcomes. This observation alone raises the immediate questions of what leads members of the same household to maintain systematically different beliefs about maternal health risk, and to what extent this gender gap in knowledge of maternal risk influences the gender gap in demand for children.

Second, to make sense of this stylized fact, we develop a theoretical model that explores information transmission and fertility decisions in the household when couples differ with respect to both knowledge on childbearing risk and *ex ante* preferences over optimal number of children. The model demonstrates how the combination of gender differences in both risk awareness and ideal fertility can represent a barrier to information sharing and prevent convergence in beliefs about maternal health risk within couples, resulting in an even greater wedge between male and female demand for children and - as a result - welfare-reducing fertility outcomes.

In the model, the wife controls fertility and can receive transfers from the husband to compensate for deviations from her private optimum: this asymmetry in spousal agency over fertility constitutes the third key dimension determining equilibrium information transmission between spouses. We show that asymmetries of information on maternal health risk are an important determinant of household fertility: when women are better informed than men about risk, households are unable to implement optimal contracts over fertility. This happens because initial spousal differences in preferences and control over fertility prevent effective communication and convergence in beliefs across spouses about the health cost of childbearing. As a result, when spouses are badly informed about maternal health risk, providing information to the wife will move the equilibrium fertility of the household closer to her private optimum only when the husband's desire for children is relatively low. Since she is unable to credibly communicate new information to him, contracting breaks down and transfers stop. In contrast, when the husband receives new information, fertility moves closer to the joint optimum across all levels of the ideal fertility of the husband. In this case, since the husband can implement his optimal fertility through transfers, credible communication across spouses is possible. However, again this happens only when the husband's demand for children or the cost of making transfers are relatively low.

We test the predictions of the model through a field experiment with over 500 couples that delivers information on maternal health risk to husbands and wives, and randomizes the identity of the recipient within each participating couple. Our results reveal that the intervention achieves different outcomes when it targets men compared to when it targets women. Consistent with our model's predictions, delivering information on maternal risk directly to men has a larger impact on belief convergence in the household than the same information targeted to their wives. After the intervention, relative to the control group, couples in which the husband is treated experience a 5.2 percentage point (pp) decline in the probability of having a child or being pregnant in the year following the intervention (a 43% reduction). Couples in which the wife is treated exhibit fertility responses of similar magnitudes, but treated women see transfers in their favor from their husband drop. Only treated husbands report lower demand for children and have more accurate beliefs about their wife's desired fertility and health risk, while we observe no change among husbands of treated women. Couples in which the husband is treated also increase communication about family planning, increase spousal closeness and exhibit greater marital satisfaction.

Beyond uncovering a central barrier to optimal decision-making over family planning that is likely to be relevant in many high fertility settings, a central contribution of our paper is to study the diffusion of information within the household and its long-term consequences. In the context of maternal mortality, we show that information asymmetries within households may persist as equilibrium outcomes, and thereby influence how public health campaigns affect household outcomes. While the vast literature on household decision-making assumes that household members have access to the same information, or that new information spreads seamlessly within the family (Chiappori, 1992; Lundberg and Pollak, 1996; Bourguignon et al., 1993), a smaller body of literature has examined the degree to which asymmetric information between spouses affects household decision-making (see de Laat (2005); Ashraf (2009); Stern and Friedberg (2010); Chen (2013); Baseler (2020)). This paper contributes to a novel body of recent work that has started to explore the transmission of information within the household (Ziparo, 2020; Apedo-Amah, Djebbari and Ziparo, 2020), and it is the first, to our knowledge, to study its implications for real-life decisions such as fertility.

Our paper also contributes to understanding the role of information more generally for economic outcomes, through providing evidence on both direct and spillover effects on behavior. A rich body of evidence has shown that information can have a substantial impact on educational choices in developing countries (Jensen, 2010; Dizon-Ross, 2019) and on health outcomes, through a process of beliefs updating or by enhancing salience (see, among others, Thornton (2008); Dupas (2011); De Paula, Shapira and Todd (2014); Delavande and Kohler (2016); Bennett, Naqvi and Schmidt (2018)). We contribute to this literature by highlighting that who in the household receives the information may be crucial for its effect. Just as a cash transfer may influence household behavior differently when delivered to a man or to a woman (Lundberg, Pollak and Wales, 1997; Attanasio and Lechene, 2002; Duflo, 2003), health information can have different effects depending on who in the household receives the information.

Measuring information spillovers and diffusion within the household also sheds light on motivations for information sharing and influencing joint decisions in group settings. Through the experimental design, we provide the first field experimental evidence to directly test models of strategic communication, wherein persistent preference differences and conflict of interest impede communication and belief updating (Crawford and Sobel, 1982; Mailath, 1987; Crawford, 1998, 2019). The effect of preferences misalignment on communication had been studied in the lab: Dickhaut, McCabe and Mukherji (1995) and Cai and Wang (2006) test the model of Crawford and Sobel (1982) in a laboratory set up, while Dickson, Hafer and Landa (2008) show responsiveness of communication to strategic incentives in a committee voting laboratory experiment.

Through its empirical application, our study also contributes to the literature on decision-making over fertility when spouses have different preferences.[1] By examining the role of beliefs about maternal mortality risk, we contribute to the literature on determinants of fertility decisions, especially in terms of expectations, including the work by Rosenzweig and Schultz (1982) on child mortality in Colombia and by Albanesi and Olivetti (2014) on maternal mortality in US history. We emphasize that initial differences in ideal fertility between men and women, which are large across sub-Saharan Africa and in Zambia (see figure 1 panel a), can generate persistent and systematic disagreement over the demand for children (panel b).[2]

From a policy perspective, we find that the reduction in fertility that we experimentally induce is of the same order of magnitude of other household-level interventions which have been shown to reduce pregnancy (Ashraf, Field and Lee, 2014), but is accompanied by an improvement in the marital surplus, as measured by greater marital satisfaction, communication, and closeness. As reducing unmet need for family planning in Sub-Saharan Africa becomes an increasingly important policy goal, finding strategies to decrease excess male demand for children that help enhance family unity, rather than underscore existing conflict within the household, will be critical.

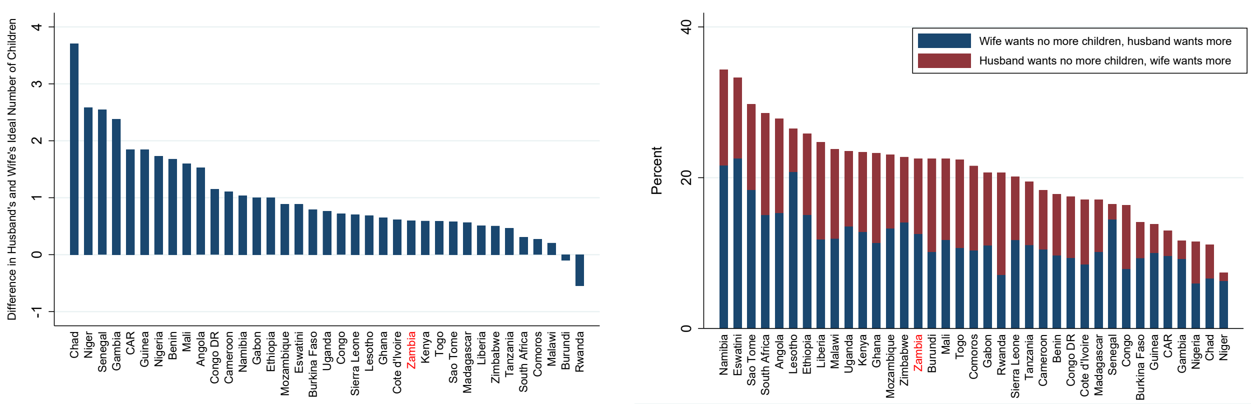
[1]While the sociology and demography literature studying spouses' interactions on fertility decisions is well established, few studies in economics have emphasized the role of intra-household interactions (Rasul (2008); Ashraf, Field and Lee (2014); Doepke and Kindermann (2019) and Rossi (2019)) and culture (Fernandez and Fogli, 2009) in this process.

[2]Outside of economics, see studies about fertility and contraceptives use from a theoretical perspective (Blanc, 2001; Miller, Severy and Pasta, 2004; Brehm and Schneider, 2019), in developed countries (Bauer and Kneip, 2012; Stein, Willen and Pavetic, 2014), and in Sub-Saharan Africa (Ezeh, 1993; Bond and Dover, 1997; Dodoo, 1998; DeRose et al., 2004; Pulerwitz et al., 2010; Gottert et al., 2018).

Figure 1: Spousal Disagreement in Ideal Fertility in Sub-Saharan Africa

(a) Difference in Reported Ideal Fertility between Husband and Wife

(b) Fraction of Couples that Disagrees over Having Another Child



Notes: Data from the most recent waves of Demographic and Health Surveys. Polygamous couples are excluded from each sample for which such information is available.

Our results imply that improving men's knowledge of maternal mortality risk has the potential to shrink the gender gap in demand for children, but only if this information is targeted directly to men. This speaks to the policy debate on male involvement in family planning, which has found mixed evidence at best.[3] Our paper suggests that family planning information is not sufficient to change men's attitudes and behavior as long as beliefs about health risk are significantly misaligned within the household. Existing differences in preferences impede communication in the household, but targeted maternal health risk information to men can overcome that barrier. The intervention also provides an inexpensive and easily scalable way to affect a crucial aspect of fertility demand, while improving marital satisfaction, a "family-centric" path forward for effectively reducing gender conflict over the demand for children across sub-Saharan Africa.

1 Context

We conducted this study in Lusaka, the capital city of Zambia. High fertility rates in Lusaka coupled with rapid rural-urban migration has led to the establishment of informal settlements

[3]Although some randomized public health studies found that providing health education to husbands may increase uptake of modern contraceptives (Wang et al., 1998; Terefe and Larson, 1983; Fisek and Sumbuloglu, 1978), one large study found no effect (Freedman and Takeshita, 1969). Recent evidence from rural Malawi and Tanzania suggests that promoting contraceptive use among men have the potential of substantially increasing take-up (Shattuck et al., 2011; McCarthy, 2019). Aligning spouses' fertility preferences has been indicated as an effective strategy to increase the takeup of contraceptives in Mozambique (Miller, De Paula and Valente, 2020).

(or compounds), in which a growing proportion of the city's population resides.[4] Our study took place in these communities. In this section, we describe the reproductive health challenges in Zambia more generally and in our sample from the compounds of Lusaka.

1.1 Fertility, desired fertility and contraceptive use

Zambian fertility rates are high. Estimates from the 2014 DHS indicate that the total fertility rate in Zambia is 5.3 children per woman aged 15-49, one child below the total fertility rate measured in the 1992 DHS. Urban areas have a lower rate, at 3.7 children per woman.

High fertility in Zambia is associated with a high unmet need for family planning services: 14% of married women have an unmet need for spacing births and 7% have an unmet need for limiting them. Nevertheless, desired fertility is also high and it differs significantly between married men and married women: in the 2014 DHS, the ideal number of children is 5.1 for married women and 5.7 for married men. Figure 2 highlights the discrepancy in the desire for additional children as a function of the current number of living children in that sample (panel a): when the current number of children exceeds one, women are substantially more likely than their husband to want no more children.

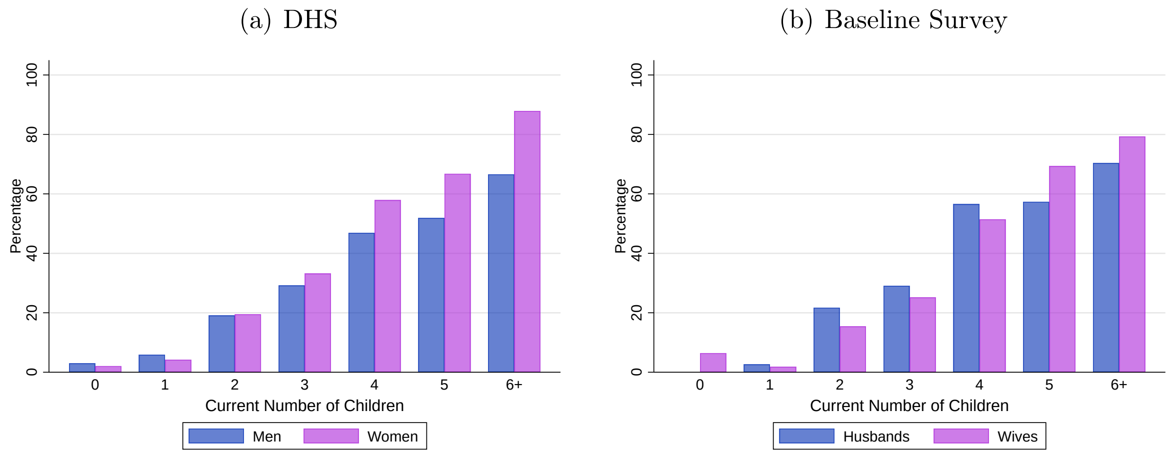
From our baseline sample, collected in the Fall of 2014 on 715 couples in peri-urban Lusaka, similar patterns emerge. Ours is a prime-age urban sample, and the average age for women is 28. Yet, women in the sample have on average 2.6 children, while their husbands have on average 2.9 (table 1, panel A).[5] Unmet need for family planning is high. Overall, 32% of the women in our sample report not using modern contraceptives. Of the 33% of women in our sample who want no more children, 27% are not using any modern contraceptive (8% of our sample). Similarly, of the 52% women in our sample who wish to delay giving birth by at least one year, 23% are not using any modern contraceptive (12% of our sample in total).

As observed in the nationally-representative sample from the DHS, men in our sample have higher desired fertility on average than their wives: 4.43 for men, 4.19 for women (table 1, panel A). Indeed, the distribution of women's reported ideal fertility first order stochastically dominates that of men (see figure 3, panel b). In 35.7% of couples, there is no gap between husband

[4] According to the World Bank, 43% of the Zambian population in 2017 resided in urban cities. Data available at https://data.worldbank.org/indicator/sp.urb.totl.in.zs, last accessed May 2019.

[5] Women aged 35 and above (16% of our sample), and hence closer to completed fertility, have on average 3.9 children.

Figure 2: Percent that Want No More Children by Current Number of Children in the DHS and in the Baseline Survey



Notes: Left-hand side bar graph summarizes percentages of men and women for DHS 2013-2014 data; right-hand side bar graph summarizes percentages of husbands and wives in our sample.

and wife in ideal number of children. In 36.6% of couples, the husband wants more children than the wife (on average 1.9 more children). In the remaining 27.7%, the wife wants more children than the husband (on average 1.6 more children). Nevertheless, given the particular age distribution in our sample, men already have more children than their wives because of prior relationships, and hence a larger fraction of women wants to have at least another child (71.4%) relative to men (65.8%).

In our sample, men and women also exhibit substantial differences in their attitudes towards family planning and contraception. For instance, 38.3% of men report thinking that contraceptives are bad for a woman's health, against 17.2% of women (table 1, panel A). Similarly, 31.0% of men report thinking that contraceptives reduce a woman's future ability to conceive, against 17.0% of women. In addition, 57.9% of men report thinking that contraceptives enable women to be unfaithful, against 37.6% of women.

1.2 Knowledge, beliefs and communication about maternal health risk

According to the 2014 DHS, the maternal mortality ratio in Zambia is equal to 398 deaths per 100,000 live births. Given the high rates of fertility in the country, this ratio implies that, in expectation, 1 in 59 Zambian women die giving birth. This lifetime risk has decreased from 1 in 27 based on the 2007 DHS.

Table 1: Fertility Outcomes, Preferences, Beliefs and Attitudes at Baseline

	Women	Men	Diff. SE
Panel A: Fertility and Family Planning			
Living children	2.598	2.890	(0.089)***
Ideal number of children	4.188	4.426	(0.082)***
Likelihood of having another child	6.490	6.171	(0.192)*
Want another child (dummy)	0.714	0.658	(0.026)**
Diff in ideal and current number of children	1.584	1.553	(0.084)
Fraction contrac. methods believed to be bad for health	0.172	0.383	(0.013)***
Fraction contrac. methods believed to lower fecundity	0.170	0.310	(0.013)***
Agrees that contrac. help women be unfaithful	0.376	0.579	(0.026)***
Panel B: Maternal Mortality and Morbidity			
Ideal space between children (m)	41.142	36.636	(0.955)***
Months woman should give body to recover post-birthing	27.058	26.132	(0.975)
Women with more kids at higher risk of complications	0.777	0.720	(0.023)**
Older women at higher risk of complications	0.846	0.743	(0.021)***
Likelihood of complications if woman gets immediately pregnant	8.000	7.880	(0.127)
Likelihood of complications if woman gets pregnant 12 months after delivery	4.722	4.686	(0.137)
Likelihood of complications if woman gets pregnant 24 months after delivery	2.400	2.155	(0.124)**
Likelihood of complications if woman has less than 4 kids	3.076	2.933	(0.121)
Likelihood of complications if woman has more than 4 kids	5.805	6.014	(0.136)
Likelihood of complications if woman is younger than 40	3.721	3.261	(0.130)***
Likelihood of complications if woman is older than 40	7.930	7.451	(0.118)***
Reports that infidelity increases risk of complications	0.420	0.555	(0.026)***
Relative infidelity weight	0.304	0.328	(0.009)***
Panel C: Maternal Complications Experience and Communication			
Past maternal and birth complications or difficulties	0.138	0.175	(0.019)*
Past maternal complications or difficulties	0.113	0.114	(0.017)
Immediate family member died from complications	0.039	0.032	(0.010)
Close relative died from complications	0.067	0.049	(0.012)
Close friend died from complications	0.110	0.068	(0.015)***
Distant friend died from complications	0.108	0.050	(0.014)***
Communicated info about future possibility of complications	0.534	0.276	(0.025)***
Observations	714	714	

Notes: *** p<0.01, ** p<0.05, * p<0.1. Baseline survey collected in the Fall of 2014 in Lusaka on a sample of 714 couples.

The primary causes of death in Zambia are obstructed labor, hemorrhage, blood pressure disorders and sepsis (Banda, 2015). The high incidence of maternal mortality is associated with high incidence of severe morbidity, which is typically believed to be orders of magnitude times larger than maternal mortality.[6] Data on morbidity, however, is not systematically available for Zambia nor in other comparable contexts.[7]

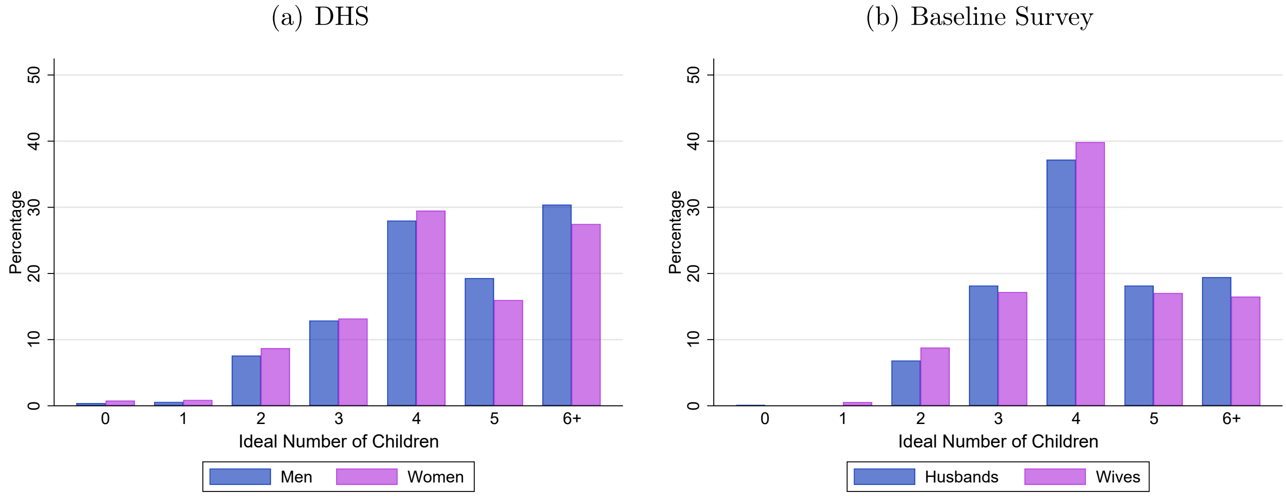
Our survey provides unique insights into men's and women's knowledge and attitudes towards

[6]Across Sub-Saharan Africa, for example, the range of instances of severe morbidity over 1,000 births is estimated between 109 for Nigeria and 9 for Tanzania, hence tens of times higher than mortality, see Geller et al. (2018).

[7]The exception is the Global Network Maternal and Newborn Health (MNH) Registry Data from 2014 and 2016, that places the ratio of extremely severe morbidity ("near miss") to mortality at 19:1 (Goldenberg et al., 2017). Such an incidence would place the lifetime risk of death or near miss to almost 50%.

Figure 3: Ideal Number of Children

DHS Data vs. Our Survey



Notes: Left-hand side bar graph summarizes means of men and women for DHS 2013-2014 data; right-hand side bar graph summarizes means of husbands and wives in our sample.

maternal health risk. Men are less likely than women to identify high parity (72.0% of men and 77.7% of women) and advanced maternal age (74.3% of men and 84.6% of women) as risk factors (table 1, panel B). In a sequence of questions in which respondents are asked to report the likelihood, on a scale from 0 to 10, that a hypothetical woman with given set characteristics (age, parity, most recent birth) may experience complications at birth, men report lower scores than women in six out of seven cases.[8]

As documented in Ashraf et al. (2017), a deeply-rooted traditional belief governs people's beliefs of the causes of maternal mortality in Zambia. Marital infidelity by either spouse is considered a primary cause of maternal health complications (Nsemukila et al., 1999; Umoiyoho et al., 2005; Garenne et al., 1997; Gennaro et al., 1998), often discouraging women from seeking medical help when complications arise (Phiri et al., 2014). Indeed, 55.5% of men and 42.0% of women report infidelity as a leading cause of maternal mortality, assigning to it about a third of the weight as a cause of maternal mortality, as opposed to lack of appropriate healthcare and poor health status.[9]

When asked about the wife's direct experience with complications and difficulties at birth,

[8]See Appendix D1 for the wording of the relevant question.

[9]When eliciting the perceived causes of maternal mortality, we did not prompt respondents. To elicit the weight that respondents attribute to different causes, we gave respondents 30 buttons and asked them to allocate between causes. See the Appendix for the wording of the questions.

men are more likely than women to report that such events have occurred (17.5% of men and 13.8% of women, table 1, panel C). To investigate the root of this difference, we coded the descriptions of these instances of complications. Men are substantially more likely to report miscarriages and stillbirths as maternal complications. Once these cases are removed, the majority of the reported complications involve hemorrhages, c-sections, breech presentations, obstructed or prolonged labor, and tearing. Men and women have very similar propensity to report such complications (11.4% of men and 11.3% of women).

Exposure to maternal mortality episodes within the community is similar for women and men when immediate family members or close family members are concerned, but substantially different as the social distance to the victim increases. Only 6.8% of men report knowing a close friend whose wife has died giving birth, while 11.0% of women know a close friend who has died giving birth. An even greater gap is observed for distant friends (table 1, panel C). Despite this gap in experience, only 27.6% of men and 53.4% of women report having attempted to discuss maternal health risk with their spouse.

One factor that appears to influence communication about maternal mortality risk is men's underlying high desired fertility. Indeed, both husbands and wives in our survey report that communication on maternal health is significantly more likely to occur and to not break down when men no longer want children compared to when they want children right away (Appendix table A1).

Overall, our data indicates that, while maternal health is a relevant source of concern for the couples in our sample, significant gaps in exposure to information and in the understanding of maternal health risk exist within the household.

2 Model

We construct a theoretical framework to examine how fertility decisions are made in the household, highlighting the role played by communication about maternal health cost. We first show that ex ante asymmetries of information on maternal health cost may break down the spousal agreement over fertility. We then show how our intervention may affect communication and realized fertility.

2.1 Environment

Men and women make fertility decisions, given their preferences for children and the maternal health cost of fertility. We model these decisions within a static framework as completed fertility is realized only once in a couple.

Maternal health cost Maternal health cost is a random variable denoted as θ. In Zambia, a high-cost environment, θ is distributed with probability density function (pdf) $f^Z(\theta)$ on the interval $[0, 1]$, with first and second moments equal to θ^Z and σ^Z respectively. Worldwide, instead, θ has a pdf denoted as $f^G(\theta)$ on the interval $[0, 1]$, with first and second moments equal to θ^G and σ^G respectively. Because Zambia is a (relatively) high maternal health cost environment, we assume that $\theta^G < \theta^Z$.

To match the descriptive statistics in our baseline sample (see table 1, panel B and panel C), we assume that there exist two types of households:

i) the *equally uninformed* households, in which, prior to the intervention, neither the husband nor the wife observe the realization of θ and they both believe that the wife cost is drawn from the worldwide distribution (with mean θ^G);

ii) the *asymmetrically informed* households, in which the wife knows the cost realization θ_j, while the husband does not observe the realization of the cost and believes the cost to be drawn from the worldwide distribution (with mean θ^G).[10]

Actions The woman chooses how many children the household has (n). She does so through a set of actions that encompass contraceptive use, frequency of sexual intercourse and investments in her health.

The husband can provide transfers t to influence the wife's actions, compensating her for fertility levels that depart from her private optimum.

Preferences Spouses have different preferences that depend on the realized number of children. In line with the literature (see for example Rossi (2019)), each spouse wants to minimize the distance between realized fertility and their net fertility objectives, which are determined by

[10] In the Appendix we discuss cases in which uninformed spouses know the real cost distribution in Zambia (with mean θ^Z). In this case, uninformed agents are not biased. We present the effect of the intervention on intra-household interactions when either the husband or the wife is treated. Allowing for bias in our baseline model allows us to explain the evidence from our the baseline data, that suggests that men have systematically different beliefs compared to women, on average.

the difference between ideal fertility and the maternal health cost. Formally, spouses' preferences are the following:

$$U_j^H = -\left(\alpha^H - \delta\theta_j - n\right)^2 - \gamma t$$

$$U_j^W = -\left(\alpha^W - \theta_j - n\right)^2 + t$$

where α^i is each spouse's ideal fertility, θ_j is the realized maternal health cost, n is the realized number of children in the household, $t \geq 0$ is the amount transferred by the man, γ is the man's (finite) disutility of (monetary or in-kind) transfers,[11] and $0 \leq \delta \leq 1$ captures the extent to which the husband internalizes the maternal health cost.

To match the empirical distribution of ideal fertility, we introduce the following assumption:

Assumption 1. *The average difference in ideal fertility $\alpha^H - \alpha^W$ is positive increases as α^H increases.*

This assumption reflects the correlation between the spouses' difference in ideal fertility and the ideal fertility of the husband observed in our data and in DHS data (figure A1).[12] This correlation is expected to arise when the distribution of the ideal fertility of the husband first order stochastically dominates that of the wife and spouses match assortatively on preferences.

2.2 Benchmark case: fertility under complete information

We start by describing optimal fertility levels with complete information on maternal health cost. We define

$$n_j^H = argmax_n \left[-\left(\alpha^H - \delta\theta_j - n\right)^2\right] = (\alpha^H - \delta\theta_j)$$

and

$$n_j^W = argmax_n \left[-\left(\alpha^W - \theta_j - n\right)^2\right] = (\alpha^W - \theta_j)$$

as the spouses' fertility private optima in this case.

[11] γ could also be interpreted as the Pareto weight of the wife in the household welfare function, representing her bargaining power in the household. In this case, γ should be considered as depending on distribution factors as the relative education of the wife with respect to that of the husband, her relative income, rights upon divorce, traditional gender norms.

[12] The assumption also allows to express our theoretical predictions with respect to α^H, matching our stratification variables for heterogeneity. However, all the theoretical results related to communication and transfers are symmetric around $\alpha^H - \alpha^W = 0$.

2.2.1 Structure of household decision making

The structure of the decision-making is as follows: given the knowledge the husband has of the wife's preferences, the husband computes the optimal mapping from transfers to fertility $n(t)$ so that the utility of the wife remains unchanged, and he chooses the optimal level of transfers t^*, making a take-it-or-leave-it offer to the wife. Then, optimal fertility n^* is realized. We have in mind an efficient contracting environment where the husband can compensate the wife for her utility loss. The model is solved by backward induction.

2.2.2 Equilibrium transfers and number of children

First, the husband computes the optimal transfers that would induce a fertility shift in favor of his own preferences. He knows that the wife will implement her optimum n_j^W unless she receives a transfer that compensates her for deviating. We characterize the wife's fertility choice as a function of transfers in the following way:

$$n(t) = \begin{cases} n_j^W & \text{if} \quad t = 0 \\ n_j^{Ht} & \text{if} \quad t \geq (\alpha^W - \theta_j - n_j^{Ht})^2 \end{cases}$$

where n_j^{Ht} is the optimal number of children for the husband when transfers occur. Maximizing the husband's utility function with transfers accounting for the wife's reaction, we have: $n_j^{Ht} = \frac{n_j^H + \gamma n_j^W}{1+\gamma}$. At the optimum, the husband chooses $t^* = (n_j^{Ht} - n_j^W)^2 > 0$.

In equilibrium, transfers always occur and the optimal number of children in equilibrium is the optimum for the husband in the presence of such transfers $n_j^* = n_j^{Ht}$.

2.3 Fertility with incomplete information

We now study equilibrium fertility for the two types of households that we consider, the equally uninformed households and the asymmetrically uninformed households. In the latter case, in which the wife has perfect knowledge of the cost realization and the husband does not, we study the communication game about the cost realization.

2.3.1 Equally uninformed household

Consider the case in which both spouses do not perfectly observe the realization of the health cost and they have a biased perception of the distribution of the health cost, that is assumed to have mean θ^G. The structure of the game is the same as before.

Privately Optimal Fertility Given the new assumption on the distribution of the maternal health cost, the privately optimal fertility of the wife is now equal to:

$$n_b^W = argmax \int_0^1 [-(\alpha^W - \theta - n)^2] f^G(\theta) d\theta = \alpha^W - \theta^G$$

and that of the husband is equal to

$$n_b^H = argmax \int_0^1 [-(\alpha^H - \delta\theta - n)^2] f^G(\theta) d\theta = \alpha^H - \delta\theta^G$$

The structure of the game is the same as before. The game is solved by backward induction.

Equilibrium transfers and number of children This time, maximising the husband utility function with transfers, we have: $n_b^{Ht} = \frac{n_b^H + \gamma n_b^W}{1+\gamma}$. Even with biased beliefs, the husband's incentive compatibility condition is always satisfied, so the optimal fertility in equilibrium is equal to $n_b^* = n_b^{Ht}$.

2.3.2 Asymmetrically informed household

We now consider the case in which the wife is perfectly informed about the cost realization θ_j and the husband is not. The structure of the game is modified as now there is the possibility of a communication stage in which the wife can try to provide information about her health cost realization. The structure of the game is modified as follows:

1. The wife communicates about θ^j
2. The husband updates θ^j and offers $t(n)$ with commitment
3. The wife chooses n_u^*
4. The husband pays $t(n_u^*)$

Again, the model is solved by backward induction.

Optimal Fertility and Transfers Given that the wife is informed, her privately optimal fertility is equal to the complete information case: $n_j^W = \alpha^W - \theta_j$, while that of the husband depends on his beliefs about θ_j, and is equal to $n_u^H = \alpha^H - \delta E_H[\theta_j]$, where $E_H[\theta_j]$ is the husband's posterior on the expected maternal health cost of the wife after communication takes place. Maximizing the husband's utility function with transfers, we have that equilibrium fertility with transfers is equal to $n_u^{Ht} = \frac{n_u^H + \gamma(\alpha^W - E_H[\theta_j])}{1+\gamma}$.

We know from the complete information case that the wife accepts to adapt to the fertility of the husband if $t \geq (\alpha^W - \theta_j - n_u^{Ht})^2$. Given the husband's posterior $E_H[\theta_j]$, the transfer offered to the wife would be $t = \left(\alpha^W - E_H[\theta_j] - \frac{n_u^H + \gamma(\alpha^W - E_H[\theta_j])}{1+\gamma}\right)^2$. This transfer would give a level of utility to the wife equal or greater than 0 (her outside option) only when $\theta_j \leq E_H[\theta_j]$, hence when the husband attributes a cost to the wife which is higher than the one she actually faces.

To understand when it is optimal for the husband to give a transfer to his wife, we need to study the communication game in the first stage.

Communication Studying information sharing by the wife and information updating by the husband, we have the following lemma.

Lemma 1. *When the wife perfectly observes the realization of θ_j, no informative communication occurs between her and her husband, unless preferences are aligned ($^H - \alpha^W = 0$ and $1 - \delta < \gamma + \delta$). Under Assumption 1, transfers and fertility behave as follows:*

(i) For a given α^W, when α^H is high enough, transfers occur and fertility is based on the husband's optimal choice;

(i) otherwise, fertility follows the woman's optimum $n_j^* = \alpha^W - \theta_j$.

Proof. See Appendix B ■

The lack of information transmission is linked to the control the wife has on fertility: when transfers do not occur, the wife implements her private optimum, that implies no utility loss. When she has to transmit information, her incentives are such that she tries to push transfers beyond her utility loss, to reach an indirect utility higher than her back-up option. Since these incentives are independent from the cost realisation, no information can be transmitted and a pooling equilibrium is the only equilibrium possible.

2.4 Fertility and communication after the intervention

We now discuss the effect of an informational intervention that credibly communicates θ_j to participants, such as the one in our study.

2.4.1 Wife treated

When the wife is treated, she gets a perfectly informative signal on her cost realization. When the wife is already informed prior to the intervention, no change occurs. When she and her husband are uninformed, however, the households may be affected by the information. Studying the aggregate change in communication and fertility after the intervention when the wife is treated, we have the following result:

Proposition 1. *After the intervention, when the wife is treated, no informative communication occurs between husband and wife. Under Assumption 1, when α^H is low, transfers and fertility decrease in households in which the wife was ex ante uninformed. When α^H is high, transfers slightly increase and fertility slightly decreases in households in which the wife was ex ante uninformed.*

Proof. See Appendix B ■

2.4.2 Husband treated

In the husband treatment arm, the spouse getting a perfectly informative signal is the husband. In this case, all types of households are affected. The households in which the wife was informed and the husband was not (the asymmetrically informed households) become households in which everybody is fully informed. For the other type of households, the equally uninformed ones, we now have asymmetry of information (but reversed by gender), and we have to study the information transmission from the husband to the wife.

Optimal actions when the husband is informed We now analyze the case in which the husband is perfectly informed about the cost realization and the wife is not. This corresponds to our intervention treatment, in which we provide precise information on maternal health to the husband, whenever the wife is not already perfectly informed herself.

The main difference with the case in which the wife has to communicate comes from the fact that the husband transmits information through the transfer he offers to the wife, and that he can get to his private optimum by offering the appropriate transfer. In other words, transfers can provide a signal of the health cost realization to the wife.

Structure of household decision making Again, the structure of the game is modified to account for the possibility of communication between husband and wife. The husband can provide information about the health cost realization θ_j to the wife. The structure of the game is as follows:

1. The husband offers $t(n(\theta^j))$ signaling θ^j
2. The wife updates about θ^j and chooses n^*
3. The husband pays $t(n^*)$

Transfers are based on the information set of the wife and fertility on the signal given by the husband. The model is again solved by backward induction.

Equilibrium transfers and number of children The equilibrium fertility that the husband asks when proposing the transfers to the wife is $n_v^{Ht} = \frac{n_h(m(\theta_j))+\gamma(\alpha^W - m(\theta_j))}{1+\gamma}$. This constitutes an informative signal of the cost realisation since the husband commits to pay transfers based on this fertility level.

Transfers are aligned to the wife's information set. When the wife has a posterior equal to $E_W[\theta_j]$, transfers are determined based on the fertility outcome and the wife receives $t = (\alpha^W - E_W[\theta_j] - n_v^{Ht})^2$, so that her level of indirect utility is equal to 0, her outside option.[13]

Communication To study information sharing by the husband and information updating by the wife, we have to understand the husband's incentives to truthfully report the maternal health cost θ_j.

When δ is sufficiently high and γ is sufficiently low, the husband always gets the highest level of utility telling the truth, so truthful communication occurs in equilibrium. When γ is very high, the husband has no incentives to tell the truth, and no communication occurs in equilibrium. This is due to the fact that the wife is aware that any information sharing by the husband would aim at minimizing transfers, regardless of the realization of θ. For intermediate

[13]The husband always prefers to make a transfer since, without a transfer, fertility would coincide with the wife's ideal fertility in expectation $n^W = \alpha^W - E_W[\theta_j]$.

levels of δ and γ, there is some information updating, without full information transmission. The information updating depends on the difference in ideal fertility between the husband and the wife (see the proof of proposition 2 for the details).

As soon as some information transmission occurs, average fertility is affected as well. Communication, transfers and fertility are affected in the following way:

Proposition 2. *After the intervention, when the husband is treated and both spouses were ex ante uninformed, for δ sufficiently high and α^H sufficiently small, or for γ sufficiently low, informative communication about θ_j occurs. Transfers increase in all households with sufficiently low α^H. Fertility decreases among:*

(i) households in which the wife was informed and α^H is high;

(ii) households in which the wife was previously uninformed and α^H is low.

(iii) households in which the wife was previously uninformed and γ is low.

Proof. See Appendix B ■

The results on information transmission between husband and wife rely on the specificity of the fertility agreement: the husband can implement his optimal fertility through transfers. When the difference in ideal fertility or the cost of transfers are sufficiently low, optimal transfers differ across types and this implies a unique separating equilibrium. For higher levels of difference in ideal fertility or transfers cost, partial or no information transmission occur. Standard refinements of equilibria apply.[14]

2.5 Testable predictions

In the previous subsections, we formally described how communication, transfers and fertility are affected by the intervention: while average fertility is expected to decrease both when we treat the husband and the wife, communication and transfers evolve very differently across the two treatments, leading to different implications for policy purposes.

We can hence formulate several predictions for how our outcomes of interest would be affected by the intervention, that we can formally test using our experimental data from Zambia. The first two predictions relate to primary outcomes are: maternal health knowledge and fertility.

[14]NITS condition applies for values of parameters not satisfying the monotonicity of the message function defined by the differential equation 5 (Chen, Kartik and Sobel, 2007).When a separating equilibrium exists, the intuitive criterion apply (Cho and Kreps, 1987). See the proof in appendix for details.

Prediction 1. ***Fertility.*** *After the intervention, fertility decreases both when men are treated and when women are treated, with a stronger average effect when men are treated.*

Prediction 2. ***Communication and beliefs updating.*** *After the intervention,*

(i) when the wife is treated, no information transmission occurs between husband and wife and beliefs evolve on average only for the wife;

(ii) when the husband is treated, information transmission occurs when interests are sufficiently aligned and beliefs evolve on average for both spouses.

The third prediction is about a secondary outcome, affected indirectly by the intervention: the transfers between husband and wife.

Prediction 3. ***Transfers.*** *After the intervention,*

(i) when the wife is treated, transfers to the wife decrease on average;

(ii) when the husband is treated, transfers to the wife increase on average.

Finally, we present some predictions about heterogeneous effects of the intervention along two dimensions: the idiosyncratic health cost faced by the wife and the fertility preferences of the husband.

Prediction 4. ***Ex ante health cost of the wife*** *After the intervention, heterogeneous effects according to the* ex ante *health cost of the wife are as follows:*

(i) when θ_j *is low, fertility does not change neither when the husband is treated nor when the wife is treated;*

(ii) when θ_j *is high, fertility decreases both when the husband is treated and when the wife is treated.*

Prediction 5. ***Ex ante fertility preferences*** *After the intervention, heterogeneous effects according to the husband's ex ante fertility preferences are as follows:*

(i) communication occurs when the husband is treated and α^H *is low;*

(ii) fertility decreases both when the wife is treated and when the husband is treated. When the wife is treated, the effect is concentrated in households in which α^H is low. When the husband is treated, fertility decreases for any value of α^H, with a strongest effect when α^H is low.

Prediction 2 is tested in sections 5.5 and 5.6. Prediction 1 is tested in section 5.2 and prediction 3 is tested in section 5.7. Finally, the heterogeneous effects described in prediction 4 and 5 above are tested in section 5.8.

3 The experiment

To study and compare the effect of providing information about maternal mortality to men and women, we designed a randomized experiment that also allows us to identify gender differences in the responsiveness to information separately from potential gender differences in take-up.

3.1 Design

Our intervention experimentally varied the provision of information about maternal health risk to either the husband or the wife of each household relative to a control group. Both spouses in all households were invited to participate in a gender-specific group meeting. Each household was randomly assigned to one of three study arms (see table 2):

i) The husband was exposed to both a maternal mortality curriculum and a family planning curriculum $(FP + MM)^h$ and the wife was exposed to the family planning curriculum FP^w. This arm is denoted in short as $FP + MM^h$.

ii) The wife was exposed to both the maternal mortality curriculum and the family planning curriculum $(FP+MM)^w$ and the husband was exposed to the family planning FP^h curriculum. This arm is denoted in short as $FP + MM^w$.

iii) Both spouses received the FP curriculum. This arm is hence denoted in short as FP.

In subsection 3.2, we discuss the rationale for the design and its implications for identification.

Table 2: Experimental design

	Husband	Wife
Husband treated	$FP + MM^h$	FP
Wife treated	FP	$FP + MM^w$
Control	FP	FP

3.2 Identification and empirical specification

The primary rationale for our design is the intent to identify the differential effects of providing information on maternal mortality to men and women. Because the information is delivered in a group meeting setting and alongside information about family planning, we have ensured that *all* participants are exposed to both the group meeting setting and the family planning information. While this design choice may make some effects harder to detect, given that the control group may be influenced by the family planning information itself, it also allows for the unambiguous identification of the effects of the maternal mortality curriculum.

Our experiment focuses on two sets of empirical objects. First, we are interested in separately estimating the average treatment effects of delivering both maternal health and family planning information ($(FP + MM)^j$) to each spouse $j \in \{h, w\}$ compared to just delivering family planning information ($(FP)^j$) on a hypothetical outcome of interest Y, which is often measured at the household level (e.g. take up of family planning and fertility) or at the individual level (e.g. knowledge of maternal health, attitudes towards family planning), for either the treated spouse (direct effect) or the untreated spouse (indirect or spillover effect). In order to estimate this object, we would ideally estimate $ATE^j = E[Y(FP + MM)^j] - E[Y(FP)^j]$. The second object we are interested in estimating is the comparison of the (direct or spillover) impact of providing the information about maternal mortality for men compared to women on household-level and individual-level outcomes, that is, for example, $\Delta ATE = ATE^h - ATE^w$.

The main challenge associated with estimating these objects is that, in our design, participants choose to attend a community meeting, generating an imperfect take-up problem. To address this challenge, we can adopt the standard double-blind approach: the surveyors who invite households to the community meetings do not know what type of meeting each individual is invited to and only one type of invitation card is provided to participants in all treatment arms, ensuring that selection into participation in the community workshop is the same within genders, and hence that we can estimate a treatment-on-the-treated effect TOT^j within husbands and wives separately.

Even with double-blind invitations, we may be left with a second concern: the pool of women and men who decide to attend the community meeting may come from different types of households, if the characteristics that govern the selection into participation of treated men differ from those governing the selection of treated women.[15] If this is the case, then the difference in the treatment-on-the-treated effects by gender may not only be driven by the differential impact of maternal health information on men compared to women, but also by the differential take-up:

$$\big[E[Y(FP+MM)^h - Y(FP)^h|p^h = 1]\big] - [E[Y(FP+MM)^w - Y(FP)^w|p^w = 1]]$$

where p^j takes value 1 when spouse j attends the community meeting and 0 otherwise (take-up).

To address this issue, we invited *both* spouses to attend workshops together, and hence having a three-arm design in which men and women in all households receive information on family planning, while the treated spouse receives maternal health information as well. Considering households in which both spouses have attended a community workshop implies estimating ΔTOT, which identifies the difference in the treatment-on-the-treated effects estimated on directly comparable samples:

$$\begin{aligned}\Delta TOT &= E[\big(Y(FP+MM^h) - Y(FP)\big)\,|p^h = 1, p^w = 1] \\ &\quad - E[(Y(FP+MM^w) - Y(FP))\,|p^h = 1, p^w = 1] \\ &= E[\big(Y(FP+MM^h) - Y(FP+MM^w)\big)\,|p^h = 1, p^w = 1]. \qquad (1)\end{aligned}$$

The cost of achieving this comparability is that we can estimate the effect of receiving a maternal mortality intervention when *both spouses* are exposed to the family planning curriculum ($TOT^j = E[(Y(FP+MM^j) - Y(FP))\,|p^h = 1, p^w = 1]$). This set up can then allows us to study both direct effects of the intervention on treated respondent and indirect effects on the respondent's spouse.

[15] Suppose, for example, that women from more conservative households are unable to attend a meeting on their own, while their husbands would be willing to participate. If conservative households have different treatment effects from the rest of the sample, we may detect a difference between treatment effects across arms that depends on take-up and not on differential effects across genders.

Our estimation equations follow straightforwardly from our design. When considering outcome Y for household i, we estimate the following specification on the sample of treated households:

$$Y_i = \alpha + \beta_H Husband\ Treated_i + \beta_W Wife\ Treated_i + \theta X_i + \epsilon_i \tag{2}$$

Variables $Husband\ Treated_i = \mathbb{1}\left[FP + MM^h\right]_i$ and $Wife\ Treated_i = \mathbb{1}\left[FP + MM^w\right]_i$ are indicators for assignment to either the husband's or the wife's treatment arm. Hence, β_H and β_W identify the average treatment-on-the-treated effects for men and women respectively, while their difference captures the difference in the effect of treating a different spouse (equation 1). In the tables, we report the p-value of this F-test. The vector of baseline control variables X_i includes wife's age, husband's age, wife's education, husband's education, number of children, age of last child born before the group meeting, number of people who attended the group meeting, modern contraceptive use at baseline, quadratic weekly income plus the stratification variables.[16]

We also consider specifications in which the outcome variable is measured at the individual, rather than household, level for spouse $j \in \{h, w\}$ in household i. Our design allows us to compare the direct effect of treatment on each spouse with the spillover (indirect treatment) effect on the partner, by estimating

$$\begin{aligned} Y_i^j = {} & \delta_H^h Husband\ Respondent_j \times Husband\ Treated_i + \delta_H^h Husband\ Respondent_j \times Wife\ Treated_i \\ & + \delta_H^w Wife\ Respondent_j \times Husband\ Treated_i + \delta_W^w Wife\ Respondent_j \times Wife\ Treated_i \\ & + \zeta X_i + \eta X_i \times Husband\ Respondent_j + \upsilon_{i,j} \end{aligned} \tag{3}$$

where $Husband\ Respondent_j = \mathbb{1}[j = h]$ and $Wife\ Respondent_j = \mathbb{1}[j = w]$ are dummies capturing the identity of the respondent. Here, the coefficient δ_H^h represents the direct effect of treating the husband on the husband's outcome variable Y_i^h and δ_W^h represent the spillover effect of treating the wife on the husband's outcome Y_i^h. Conversely, the coefficient δ_H^w represents the spillover effect of treating the husband on the wife's outcome variable Y_i^w and δ_W^w represent

[16] Stratification variables are a dummy for whether wife over 35, a dummy for whether the couple has no children, for whether the wife thinks that the husband wants another child later, for whether the wife thinks the husband does not want another child, for whether the husband does not know any woman who died at childbirth, for whether the wife is actively trying to get pregnant, and variables for block size and availability of baseline data.

the direct effect of treating the wife on the wife's outcome Y_i^w. We report the p-values of the following F-tests:

a) the difference between direct effects, i.e. between the effect of treating the husband on his answer and that of treating the wife on her answer ($\delta_H^h = \delta_W^w$), denoted as *Direct treatment effects F-test p-value*;

b) the difference between spillover effects, i.e. between the effect of treating the husband on the wife's answer and that of treating the wife on the husband's answer ($\delta_H^w = \delta_W^h$), denoted as *Symmetry of intra-household spillover effects F-test p-value*;

c) the difference between direct and spillover effects on the husband, i.e. between the effect of treating the husband himself or his wife on the husband's answer ($\delta_H^h = \delta_W^h$), denoted as *Direct vs. spillover effect on husband F-test p-value*;

d) the difference between direct and spillover effects on the wife, i.e. between the effect of treating the wife herself or her husband on the wife's answer ($\delta_W^w = \delta_H^w$), denoted as *Direct vs. spillover effect on wife F-test p-value.*

4 Implementation and data collection

The study involved two waves of a panel household survey, administered separately to both the husband and the wife of each household, and a randomized controlled trial.

4.1 Sample

Couples were recruited from the catchment area of Chipata and Chaisa Clinics, located in the poor suburbs of Lusaka. The sample is representative of the peri-urban population of Zambia. Eligibility for the study followed some exclusion criteria meant either to protect women that may face adverse consequences if using hormonal contraception or to exclude women that could not adjust their fertility behavior to the information provided in the intervention.[17]

[17] Any couple in which the wife was aged between 18 and 40 and lived in the catchment area of the Chipata and Chaisa clinic was eligible to be recruited. A random-address generator was used to recruit couples. The following exclusion criteria was agreed upon with the competent Research Ethics Committees: (i) households in which the wife had diabetes, heart disease or high blood pressure at baseline; (ii) households in which the wife was younger than 18 years of age or older than 40 at baseline; (iii) households in which the wife was less than 8 weeks postpartum; (iv) households in which the wife has been sterilized or had a hysterectomy; (v) men or women who were not currently married; (vi) households in which the wife was pregnant at any point between the recruitment and the intervention phase; (vii) households in which the spouses were actively trying to have a baby when invited for the intervention; (viii) households in which the wife was on long-term contraceptives when

4.2 Data collection and intervention

The first wave of data consisted of a baseline survey in the first visit administered both to the husband and the wife. Baseline data collection occurred between August and December 2014. 715 couples were interviewed, with the husband and the wife surveyed separately. The sample was re-screened prior to the actual start of the intervention, which occurred in November 2015. In order to determine which treatment arm each household was assigned to, we randomized treatment at the couple level stratifying on the following characteristics: (i) whether the couple had a child or not; (ii) whether the wife was older or younger than 35 years old; (iii) whether the couple wanted another child at baseline; (iv) residential size of the block in which the couple lived; (v) whether the wife believed that the husband wanted another child; (vi) whether the wife believed that the husband wanted another child as soon as possible; (vii) whether the husband knew someone who died at childbirth.

The intervention stage took place between November 2015 and May 2016. It involved a community meeting - in which spouses would receive information on maternal health related issues and family planning - occurring during weekends. Households were invited to attend on a weekly roll-out basis. We randomly varied the first intervention week by treatment arm for each household. To avoid contamination across treatment arms, each type of community meeting took place in a different time slot. This implied that there was a non-negligible amount of time between the randomization and the actual invitation to the intervention.

The lag between the baseline data collection and the intervention led to a strong reduction in eligibility in the sample. Hence, between October 2015 and February 2016, 442 households were subsequently included in the sample. For these households, a subset of baseline questions was asked to the wife for stratification purposes.[18] Thus, the sample of households eligible for intervention consists of 1,137 couples. Of these, in total, 772 households were eligible to be invited to the intervention. This implies that 21% of the sample became ineligible between baseline and intervention, mostly due to pregnancy and to shifts outside the catchment area of our partner clinics. Recruitment and invitations were double-blind and drop-outs occurred

invited for the intervention. Exclusion criteria (iv) to (vii) relate to our study objectives, but are not medically motivated.

[18] These additional couples were enrolled in the study if they satisfied the eligibility criteria and consented to participate. While other study participants took part in a baseline survey before being invited to community meetings, these couples did not undergo a complete baseline. We recruited them first, then went back and conducted the invitations to community meetings, similar to the rest of the sample.

before treatment assignment, and hence should be orthogonal.

Participants were asked to show up for the meetings together with their spouse, and were separated into different rooms for parallel, gender-specific sessions. Participants were not told the content of their partner's session. Each session involved approximately 20 participants and was led by two trained local facilitators, one man and one woman, who worked with meetings of men and women to ensure we do not risk identifying a facilitator-specific effect. In the FP curriculum, the educators discussed the types of modern contraceptives available at the clinic, dispelled common misconceptions surrounding family planning, and referred the participants to the public clinic for further information. In the FP+MM curriculum, the educators delivered this same information, but also added informational content about maternal health risk. The material focused on the magnitude of the risk of maternal mortality in Zambia, the primary medical causes of maternal mortality and morbidity and the risk factors such as low birth spacing, high parity and advanced age.

The trained facilitators followed a scripted curriculum, helped by visual material that was designed for the study. These features allowed our team to extensively monitor the information presented and ensure consistency across all groups. All scripts are included in Appendix C. Illustrated materials, designed by a local artist for the study and organized in flipcharts, supported the group meeting.

We tested and implemented a number of steps to maximize participants' attendance to the community workshops. First, workshops were held on weekends. The exact time of the workshops was decided based on focus group discussions and a small survey. Assignment of workshop time slots to study arms was randomized. Second, couples who missed their first community workshops were re-invited again several additional times. Third, each spouse received 25 Zambian Kwacha (approximately 5 USD at the time of the intervention) as transport reimbursement, an amount comparable to the amounts households receive in Lusaka for attending this type of events. Last, a raffle was associated with each set of workshops, and only participants to the workshop received a raffle ticket. Each couple had approximately a 1 in 10 chances of winning the prize, which was a small electric cooking stove. In the end, a total of 562 attended couples out of 772 (73% of invited couples) attended a group meeting.

After the group meetings, we used a Becker-DeGroot-Marschak mechanism to elicit the participants' willingness to pay (WTP). We elicited the husband's WTP for a voucher to get priority access to family planning services at the public clinic. The facilitators explained to the participants that the voucher granted access to a nurse dedicated to the study, who would provide them with information about family planning and with any method of their choice.

Finally, between October 2016 and March 2017, we collected follow-up data for the households that attended the intervention, with an attrition rate of 10%: for those households, we recollected measures of knowledge of maternal health, use of and attitudes toward contraception, balance of power, fertility demand and realized fertility. Attrition is comparable across treatment arms.

5 Empirical results

We begin by examining our main outcome variable, which is realized fertility. We then move to study whether differences in realized fertility between the treatment groups and the control group arise from differences in contraceptive use and are motivated by differences in the demand for children. Last, we examine whether communication between spouses and respondents' own beliefs change as a result of the intervention. We also examine heterogeneous treatment effects by baseline demand for children.

5.1 Balance

The intervention sample is balanced on both demographic characteristics and baseline fertility preferences. We also verify that there is no selective attrition across treatment arms from participation in the intervention and endline completion (Appendix table A3).

5.2 Realized and expected fertility

In table 3, we report estimates of realized and expected fertility outcomes at endline: whether the wife is currently pregnant (column 1), the probability of giving birth starting at 8 months following the intervention (column 2), the likelihood of having more children on the 0-10 ladder scale as assessed by the wife (column 3) and by the husband (column 4), and the spacing between the intervention and birth (column 5).[19]

[19] To construct the birth spacing variable, we assume a due date of 4.5 month after the survey for pregnant women.

Table 3: Realized and Expected Fertility

	(1) *Wife:* Currently Pregnant	(2) *Wife:* Became Pregnant Post-Int.	(3) *Wife:* Likelihood Have More Kids	(4) *Husband:* Likelihood Have More Kids	(5) *Wife:* Birth Spacing (mo)
Husband Treated (β_H)	-0.052*	-0.051*	-0.81**	-0.60*	0.28
	(0.029)	(0.030)	(0.36)	(0.31)	(0.48)
Wife Treated (β_W)	-0.040	-0.033	-0.62	-0.36	-0.20
	(0.031)	(0.033)	(0.38)	(0.30)	(0.43)
Stratification Variables	Yes	Yes	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes	Yes	Yes
F-test p-value (β_H=β_W)	0.70	0.60	0.56	0.45	0.32
Mean of Control Group	0.12	0.17	6.45	5.89	9.98
Observations	534	534	534	516	534

Notes: *** p<0.01, ** p<0.05, * p<0.1. SE clustered at the meeting level. Stratifying control variables include if couple has children, wife over 35, wife thinks that husband wants another child later, wife thinks husband does not want another child, husband does not know of women who died at childbirth, block size, and baseline data present. Demographic control variables include wife age, husband age, wife education, husband education, number of children, age of last child born before meeting, wife is actively trying to get pregnant, baseline contraceptive use, and household weekly income.

When the husband is treated, we observe a 5.2pp decrease in the probability of the wife being pregnant at endline and a 5.1pp decrease in the probability of giving birth after the intervention (in both cases, $p < 0.10$). The former corresponds to a 43% reduction relative to the control group, the latter corresponds to a 30% reduction. No significant effect is observed when the wife is treated, but we cannot rule out that the effect of treating wives or husbands on fertility is the same (the p-values for the F-test are reported in table 3 and are equal to 0.70 and 0.60 respectively).

Assessed likelihood of future births is also significantly lower when the husband is treated both in the wife's report and in the husband's one (with 13% and 10% reductions relative to the control group, respectively), again with no discernible difference with respect to the $Wife\ Treated$ case. In Appendix figure A2 , we plot the coefficients of a set of linear probability models in which the dependent variable takes value 1 if the ladder point answer is greater or equal to the value reported on the horizontal axis. Both in the case of the husband's assessment (panel a) and in the wife's assessment (panel b) the reduction in the ladder point answer is driven by the highest values of assessed likelihood.

Finally, we examine birth spacing from the time of the intervention till the occurrence of birth, assuming that women who are pregnant at the time of the survey are 4.5 months pregnant. We find no difference in this measure of spacing by treatment arm (column 5), due to the fact that the followup time horizon allows us to observe pregnancies better than births. Overall, the findings are in line with prediction 1 of the model.

5.3 Demand for children

In table 4, we examine the effect of the intervention on two measures of desired fertility: a dummy for whether the respondent wants another child (column 1) and a dummy for whether the respondent wants another child over the next two years (column 2). We also examine each respondent's belief about their spouse's desired fertility: a dummy for whether the respondent believes that the spouse wants at least another child (column 3), and a dummy for whether the respondent believes that the spouse wants more children than self (column 4) or fewer (column 5).

We find that treated husbands are 7.3pp less likely to report to want another child ($p < 0.10$, an 11% reduction relative to the control group), 13pp less likely to believe that their wife wants another child ($p < 0.01$, a 17% reduction relative to the control group) and 7.9pp less likely to report that they believe the wife wants more children than themselves (a 34% reduction relative to the control group). Effects on the other outcome variables exhibit similar magnitudes but are imprecisely estimated. Husbands whose wife is treated do not exhibit any statistically significant change in their reported desired fertility or in their belief about their wife's desired fertility. We can, therefore, rule out that the effect on these outcomes of treating the husband is the same as the effect of treating the wife (p-values are 0.01, 0.03 and 0.10 respectively).

5.4 Contraceptive use

After the intervention, men exposed to maternal mortality information do not exhibit higher willingness-to-pay for a voucher that grants access to contraceptives at the clinic (table 5 column 1) and, in fact, are no more likely to use it.[20] At endline, their wives, or wives who have been

[20] The voucher for free contraceptives was provided for comparability with Ashraf, Field and Lee (2014). However, since we conducted the study nine years after the one in Ashraf, Field and Lee (2014), the value of such a voucher is greatly reduced because of the vast improvement in access to contraceptives in the years preceding our study. For example, use of modern contraceptives by prime age women in Zambia increased from 33% to

Table 4: Demand for Children

	(1) Wants More Kids	(2) Wants Ano. Kid in < 2yrs	(3) Believes Spouse Wants Ano. Kid	(4) Believes Spouse Wants More Than Self	(5) Believes Spouse Wants Less Than Self
H Respondent	-0.073*	-0.064	-0.13***	-0.079**	0.012
× H Treated (δ_H^h)	(0.039)	(0.050)	(0.035)	(0.039)	(0.041)
H Respondent	0.020	-0.032	-0.037	-0.0094	-0.016
× W Treated (δ_W^h)	(0.036)	(0.050)	(0.040)	(0.045)	(0.046)
W Respondent	-0.016	0.018	-0.013	0.067	-0.051
× H Treated (δ_H^w)	(0.040)	(0.053)	(0.044)	(0.054)	(0.032)
W Respondent	0.033	-0.027	0.017	-0.00053	0.017
× W Treated (δ_W^w)	(0.038)	(0.049)	(0.038)	(0.054)	(0.033)
Stratification Variables	Yes	Yes	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes	Yes	Yes
H Respondent Interactions	Yes	Yes	Yes	Yes	Yes
F-test p-values:					
Direct treatment effects (δ_H^h=δ_W^w)	0.05	0.56	0.00	0.26	0.92
Symmetry of intra-hh spillover effects (δ_H^w=δ_W^h)	0.50	0.45	0.67	0.30	0.52
Direct vs. spillover effect on husband (δ_H^h=δ_W^h)	0.01	0.51	0.03	0.10	0.54
Direct vs. spillover effect on wife (δ_W^w=δ_H^w)	0.30	0.40	0.43	0.15	0.04
Mean of Control Group for H	0.67	0.36	0.75	0.23	0.19
Mean of Control Group for W	0.70	0.29	0.73	0.24	0.15
Observations	1050	1050	1018	1050	1050

Notes: *** p<0.01, ** p<0.05, * p<0.1. SE clustered at the meeting level. Stratifying control variables include if couple has children, wife over 35, wife thinks that the husband wants another child later, wife thinks husband does not want another child, husband does not know of women who died at childbirth, block size, and baseline data present. Demographic control variables include wife age, husband age, wife education, husband education, number of children, age of last child born before meeting, wife is actively trying to get pregnant, baseline contraceptive use, and household weekly income.

exposed to maternal mortality information directly, do not report a higher use of modern or traditional contraceptives (columns 2 to 6). Hence, comparing self-reported contraceptive use between the treatment groups and the control group at endline suggests that the intervention had no detectable effect on this margin. This outcome may reflect the challenge of measuring contraceptive use with extensive margin questions in an environment where self-reported extensive margin use is very high.

To further investigate the channels by which the fertility effects may arise, we exploit the fact that, for 330 households in the endline sample, we have baseline information about use, attitudes and knowledge of contraceptives. We can hence compare the evolution of behavior and beliefs across treatment arms between the baseline survey and the endline survey.

45% between the 2007 and the 2014 waves of the Zambia Demographic and Health Survey.

Table 5: Demand for and Use of Modern Contraceptives

	(1) *Husband:* WTP for voucher	(2) *Wife:* Using any contrac.	(3) *Wife:* Using modern contrac.	(4) *Wife:* Consis-tently using any contrac. for contrac. users	(5) *Wife:* Using trad. contrac.	(6) *Wife:* Using contrac. while partner unaware
Husband Treated (β_H)	0.23	-0.027	-0.018	0.039	-0.026	-0.026
	(0.53)	(0.042)	(0.049)	(0.030)	(0.038)	(0.020)
Wife Treated (β_W)		-0.017	-0.022	0.015	0.013	-0.025
		(0.045)	(0.050)	(0.032)	(0.040)	(0.024)
Stratification Variables	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes	Yes	Yes	Yes
F-test p-value (β_H=β_W)		0.84	0.95	0.40	0.33	0.96
Mean of Control Group	9.26	0.78	0.68	0.93	0.15	0.05
Observations	533	534	534	354	534	534

Notes: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. SE clustered at the meeting level. Stratifying control variables include if couple has children, wife over 35, wife thinks that husband wants another child later, wife thinks husband does not want another child, husband does not know of women who died at childbirth, block size, and baseline data present. Demographic control variables include wife age, husband age, wife education, husband education, number of children, age of last child born before meeting, wife is actively trying to get pregnant, baseline contraceptive use, and household weekly income.

We begin by examining changes between baseline and endline in contraceptive use on the intensive margin according to the wife's reports. We find no change in the occurrence or the frequency of sexual intercourse, but, for the arm in which the husband was treated, we find a decrease in the instances of reported unprotected sexual intercourse (table 6), concentrated among those women who do not consistently use contraceptives.

We also examine changes in attitudes towards contraceptives, as reported in Appendix table A9, and in particular whether respondents agree or disagree with statements on contraceptives can fuel infidelity, grant women full control over fertility, and be bad for a woman's health. As expected, all experimental arms exhibit an improvement in attitudes about contraceptives, particularly among men. This is consistent with the fact that all participants in the study were exposed to a family planning curriculum. In the absence of an experimental arm that does not receive the FP curriculum nor the MM curriculum, it is not possible, however, to attribute this shift to our intervention rather than to other changes occurring in the community, or to an experimenter demand effect.

Table 6: T-test: Evolution from Baseline to Endline - Contraceptive Use during Sex with Husband

	Baseline	Endline	E-B Difference	SE	Obs
Any Sex					
Hus Treated	0.87	0.82	-0.05	0.05	121
Wife Treated	0.84	0.77	-0.07	0.05	105
Control	0.79	0.82	0.03	0.05	95
Sex frequency past week					
Hus Treated	2.39	2.46	0.07	0.23	121
Wife Treated	2.15	2.03	-0.12	0.21	105
Control	2.19	2.46	0.27	0.31	95
Times using contrac. past week					
Hus Treated	1.78	2.46	0.68***	0.25	85
Wife Treated	1.89	1.90	0.01	0.22	70
Control	1.83	1.79	-0.03	0.27	63
Proportion using contrac. past week					
Hus Treated	0.70	0.79	0.09	0.07	85
Wife Treated	0.80	0.81	0.01	0.06	70
Control	0.70	0.68	-0.02	0.08	63
Unprotected Sex					
Hus Treated	0.27	0.17	-0.10*	0.05	121
Wife Treated	0.20	0.16	-0.04	0.05	105
Control	0.21	0.22	0.01	0.05	95

*** p<0.01, ** p<0.05, * p<0.1.

Notes: *** p<0.01, ** p<0.05, * p<0.1. Mean comparison between baseline and endline, by treatment arm. Variables are from wife's report.

5.5 Knowledge of maternal mortality and morbidity

To study how the intervention affected the respondents' knowledge of maternal mortality and morbidity, both directly on the treated spouse and indirectly on the partner, we examine the respondents' knowledge of the primary risk factors and a set of ordinal measures of risk perceptions. In table 7, we measure whether the respondent reports any of the main factors affecting maternal mortality and morbidity (advanced age, high parity and low birth spacing, column 2). As expected, we find that treated husbands are more likely to identify these variables as key risk factors in their reports, relative to the control group (a 14pp increase in total, $p < 0.01$). A similar, but less stark increase can be observed in the reports of the husbands of treated wives. Treated wives are also more likely to identify these variables as key risk factors in their reports, relative to the control group. Also, wives of treated men exhibit small and imprecise changes in their understanding of risk factors.

Table 7: Perceived Risk Factors of Maternal Mortality and Morbidity

	(1) Months to recover	(2) Any of the 3 Risk Factors	(3) Correct on age	(4) Correct on parity	(5) Correct on either
H Respondent	1.09	0.14***	0.050	0.044	0.039
× H Treated (δ_H^h)	(1.89)	(0.051)	(0.041)	(0.033)	(0.025)
H Respondent	-3.86**	0.076	-0.062	-0.069	-0.031
× W Treated (δ_W^h)	(1.67)	(0.050)	(0.038)	(0.043)	(0.025)
W Respondent	7.75**	0.029	0.024	0.030	0.034*
× H Treated (δ_H^w)	(3.07)	(0.045)	(0.028)	(0.032)	(0.019)
W Respondent	1.35	0.088*	0.016	0.022	-0.0061
× W Treated (δ_W^w)	(1.84)	(0.052)	(0.030)	(0.026)	(0.023)
Stratification Variables	Yes	Yes	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes	Yes	Yes
H Respondent Interactions	Yes	Yes	Yes	Yes	Yes
F-test p-values:					
Direct treatment effects (δ_H^h=δ_W^w)	0.92	0.46	0.52	0.60	0.16
Symmetry of intra-hh spillover effects (δ_H^w=δ_W^h)	0.00	0.50	0.08	0.07	0.03
Direct vs. spillover effect on husband (δ_H^h=δ_W^h)	0.01	0.18	0.01	0.01	0.00
Direct vs. spillover effect on wife (δ_W^w=δ_H^w)	0.04	0.26	0.75	0.79	0.03
Mean of Control Group for H	28.85	0.30	0.83	0.84	0.92
Mean of Control Group for W	36.22	0.47	0.91	0.87	0.95
Observations	1050	1049	1050	1050	1050

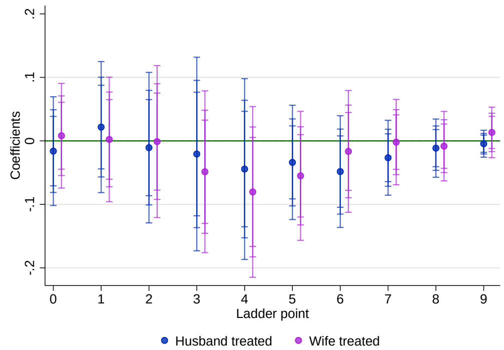
Notes: *** p<0.01, ** p<0.05, * p<0.1. SE clustered at the meeting level. Stratifying control variables include if couple has children, wife over 35, wife thinks that husband wants another child later, wife thinks husband does not want another child, husband does not know of women who died at childbirth, block size, and baseline data present. Demographic control variables include wife age, husband age, wife education, husband education, number of children, age of last child born before meeting, wife is actively trying to get pregnant, baseline contraceptive use, and household weekly income.

With respect to risk perceptions, we examine differences in the assessment of risk on a 0-10 ladder scale for different hypothetical women (Appendix table A4, columns 1 to 6) and for the wife herself (column 7). When examining effects on the ladder point answers, two similar patterns arise. When we examine the assessment of the risk of a young woman, we find no effect on average nor across the distribution of ladder point answers (figure 4, panel a and b). However, when asked to assess the risk of a hypothetical older woman, treated men significantly raise their assessment (direct effect), as do their wives (spillover effect). Men whose wife are treatment do not raise their assessment (no spillover effects), while their wife does (direct effect, panel c and d).

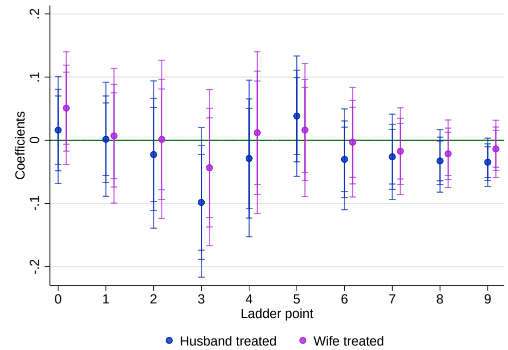
Similarly, when we examine the assessment of the risk of a woman with high or low parity (Appendix figure A3), we find a positive direct effect on treated female respondents that does not translate into any difference in the assessment provided by their husband. Also, we find no

Figure 4: Effect on Assessed Likelihood of Complication - Age

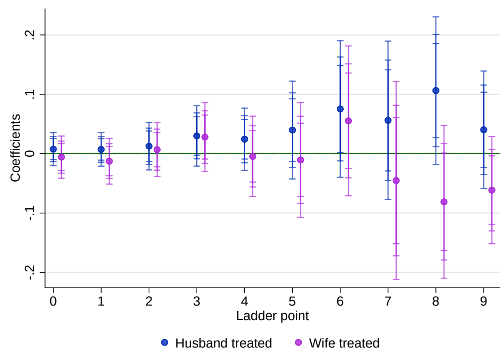
(a) Younger than 40: Husband Respondent



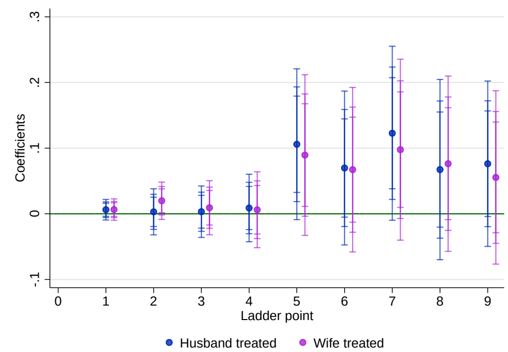
(b) Younger than 40: Wife Respondent



(c) Older than 40: Husband Respondent



(d) Older than 40: Wife Respondent



Notes: The figure depicts the effect of the intervention on the assessed likelihood of having pregnancy complications, as expressed by a ladder from 0 to 10, for a woman younger or older than 40 years old. The respondents are the husband (left) and wife (right). The different colors indicate which spouse was treated.

differences in response by birth spacing nor in the risk assessment of the wife's own risk (see also Appendix). As we discuss below, it appears that this variable increases not only for the treated groups, relative to baseline, but also for the control group.

In line with prediction 2 of our model, these results point towards a differential pattern of information transmission within the household: while wives of treated husbands report different answers than the control group, the husbands of treated women do not. In fact, we can often rule out that direct and spillover effects on husbands' answers (δ^h_W vs. δ^h_H) are the same. Information diffusion from the wife to the husband appears to be limited.

Our intervention does not focus on directly dispelling superstition beliefs (a challenging endeavor given how rooted such beliefs our in these communities), but rather to rationalize maternal mortality into a medical framework, where promiscuity can lead to sexually transmitted diseases. Possibly for this reason, we find that respondents do not change or may increase the likely to think that infidelity can cause maternal mortality (Appendix table A5).

5.5.1 Comparison with beliefs at baseline

We now study the evolution of beliefs over time and within the household across experimental arms. In particular, we examine changes in the seven main ladder scale answers at baseline for the intervention sample and at endline for each treatment arm. As reported in Appendix table A6 and Appendix table A7, in most cases, the ladder-scale answer given by respondents increases when they are treated compared to their baseline report. Nevertheless, we observe an increase in the ladder answer for some questions also in the control group, notably in the risk assessment of the respondent's own wife. This change may be due to changes occurring in the community, or to the fact that the FP curriculum, by encouraging men to support their wives in talking to a nurse at the health clinic, may have had a small effect on the assessment of maternal mortality risk as well. These changes are likely to attenuate the estimated treatment effect in the main analysis.

5.6 Communication between spouses

In order to measure whether (and how) our intervention affected the interactions between spouses, we employ several measures of intra-household communication, as reported by each spouse (table 8): a dummy measuring whether the respondent communicated about maternal mortality risk with the spouse (column 1), whether the spouse communicated about maternal mortality risk with the respondent (column 2), whether spouses agree on using contraceptives (column 3), whether the respondent tried to convince his/her spouse to use contraceptives (column 4), whether the partner changed the respondent's mind (column 5), and whether the partner tried to convince the respondent to use contraceptives (column 6). When the husband is treated, we observe a shift in all of these variables in the husbands' reports. A similar, but less precise pattern of response arises from the reports by wives of treated husbands. We find limited change in these variables reported by husbands of treated wives or by the treated wives themselves.

This finding is consistent with the prediction that maternal health communication would be more likely to occur from treated husbands to untreated wives than from treated wives to untreated husbands (prediction 2).

Table 8: Communication between Spouses

	(1) Comm. MM risk to partner	(2) Partner comm. MM risk	(3) Agreement on contrac. Use	(4) Tried Convince Partner Use contrac.	(5) Partner Changed Resp's mind of contrac. using	(6) Partner Tried to Convince Resp Use contrac.
H Respondent	0.13**	0.077*	-0.094**	0.072**	0.030	0.051*
× H Treated (δ_H^h)	(0.052)	(0.044)	(0.044)	(0.033)	(0.029)	(0.030)
H Respondent	-0.031	-0.033	-0.046	0.020	0.027	0.046*
× W Treated (δ_W^h)	(0.059)	(0.052)	(0.039)	(0.028)	(0.026)	(0.028)
W Respondent	-0.020	-0.026	-0.024	0.044	0.0087	0.022
× H Treated (δ_H^w)	(0.051)	(0.055)	(0.044)	(0.027)	(0.017)	(0.019)
W Respondent	-0.020	0.019	-0.013	0.029	0.016	0.031
× W Treated (δ_W^w)	(0.050)	(0.048)	(0.039)	(0.024)	(0.018)	(0.021)
Stratification Variables	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes	Yes	Yes	Yes
H Respondent Interactions	Yes	Yes	Yes	Yes	Yes	Yes
F-test p-values:						
Direct treatment effects (δ_H^h=δ_W^w)	0.02	0.35	0.14	0.30	0.69	0.60
Symmetry of intra-hh spillover effects (δ_H^w=δ_W^h)	0.88	0.92	0.67	0.56	0.57	0.49
Direct vs. spillover effect on husband (δ_H^h=δ_W^h)	0.00	0.02	0.27	0.16	0.92	0.87
Direct vs. spillover effect on wife (δ_W^w=δ_H^w)	1.00	0.37	0.80	0.59	0.68	0.67
Mean of Control Group for H	0.48	0.46	0.86	0.05	0.05	0.05
Mean of Control Group for W	0.42	0.71	0.83	0.04	0.02	0.02
Observations	1049	1047	1046	1046	1046	1046

Notes: *** p<0.01, ** p<0.05, * p<0.1. SE clustered at the meeting level. Stratifying control variables include if couple has children, wife over 35, wife thinks that husband wants another child later, wife thinks husband does not want another child, husband does not know of women who died at childbirth, block size, and baseline data present. Demographic control variables include wife age, husband age, wife education, husband education, number of children, age of last child born before meeting, wife is actively trying to get pregnant, baseline contraceptive use, and household weekly income.

5.7 Transfers and well-being

In table 9, we explore the effects of the maternal mortality curriculum on transfers made. Husbands whose wives are treated report being 13pp less likely to have made a gift to the wife in the past month (column 1), leading to a decline in value of gift equal to 40% of the mean of the control group (column 2), while we observe no difference in the fraction of income left for the wife to spend or in reported domestic violence (column 3). We do not detect a positive shift of transfers in favor of women when their husbands are treated, unlike what the model predicts with prediction 3. We can, however, rule out that the effect of treating husbands and that of treating wives is the same (p-values 0.00 in column 1 and 0.02 in column 2).

In table 10, we study four different measures of self-reported marital and personal satisfaction. We find that treated husbands and their wives both report higher marital satisfaction. For

Table 9: Marital Transfers

	(1) Gifts to wife past month (dummy)	(2) Value of gifts last month	(3) Hit wife last month (freq.)
Husband Treated (β_H)	0.017	-9.29	-0.023
	(0.052)	(16.5)	(0.038)
Wife Treated (β_W)	-0.13**	-37.9**	-0.00020
	(0.058)	(14.9)	(0.043)
Stratification Variables	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes
F-test p-value (β_H=β_W)	0.00	0.02	0.54
Mean of Control Group	0.49	93.83	0.08
Observations	502	502	502

Notes: *** p<0.01, ** p<0.05, * p<0.1. SE clustered at the meeting level. Stratifying control variables include if couple has children, wife over 35, wife thinks that husband wants another child later, wife thinks husband does not want another child, husband does not know of women who died at childbirth, block size, and baseline data present. Demographic control variables include wife age, husband age, wife education, husband education, number of children, age of last child born before meeting, wife is actively trying to get pregnant, baseline contraceptive use, and household weekly income.

instance, treated husbands are 6.3pp more likely to report to be happy with their own marriage (an 7.8% increase relative to control, $p < 0.10$), while their wives are 7.2pp more likely to report to be happy with their own marriage (a 9.6% increase, $p < 0.10$). Husbands of treated wives also report comparable increases in marital satisfaction, while the treated wives themselves report worse marital satisfaction, albeit not statistically significant.

5.8 Heterogeneity analysis

In this subsection, we present the heterogeneity analysis of treatment effect depending on the husband's demand for more children and the wife's risk status to further match the theoretical predictions. We first show that treatment effects on fertility are concentrated among higher-risk women. We then also show that they are strongest when husbands do not want more children.

5.8.1 Risk Status

Following our model, we examine the heterogeneous effect of treatment by risk type (prediction 4). We use two variables that we have available for the entire intervention sample, among

Table 10: Spousal Closeness and Satisfaction after Intervention

	(1) IOS scale	(2) Happy with marriage	(3) Satisfied with sex life	(4) Satisfied with life
H Respondent	0.26*	0.063*	0.051	0.0034
× H Treated (δ_H^h)	(0.13)	(0.037)	(0.038)	(0.057)
H Respondent	0.16	0.076**	0.037	-0.0021
× W Treated (δ_W^h)	(0.16)	(0.038)	(0.038)	(0.055)
W Respondent	0.065	0.072*	-0.0067	-0.032
× H Treated (δ_H^w)	(0.18)	(0.038)	(0.040)	(0.043)
W Respondent	-0.079	-0.054	-0.083*	-0.041
× W Treated (δ_W^w)	(0.18)	(0.046)	(0.048)	(0.048)
Stratification Variables	Yes	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes	Yes
H Respondent Interactions	Yes	Yes	Yes	Yes
F-test p-values:				
Direct treatment effects (δ_H^h=δ_W^w)	0.14	0.04	0.02	0.57
Symmetry of intra-hh spillover effects (δ_H^w=δ_W^h)	0.70	0.93	0.39	0.68
Direct vs. spillover effect on husband (δ_H^h=δ_W^h)	0.39	0.69	0.66	0.92
Direct vs. spillover effect on wife (δ_W^w=δ_H^w)	0.43	0.00	0.13	0.85
Mean of Control Group for H	6.06	0.81	0.83	0.53
Mean of Control Group for W	5.63	0.75	0.79	0.65
Observations	1017	1017	1017	1050

Notes: *** p<0.01, ** p<0.05, * p<0.1. SE clustered at the meeting level. Stratifying control variables include if couple has children, wife over 35, wife thinks that husband wants another child later, wife thinks husband does not want another child, husband does not know of women who died at childbirth, block size, and baseline data present. Demographic control variables include wife age, husband age, wife education, husband education, number of children, age of last child born before meeting, wife is actively trying to get pregnant, baseline contraceptive use, and household weekly income.

those we collected even for the non-baseline sample: a woman's age and history of complications. We combine these two measures into a risk type dummy: a woman is defined as high risk type if the wife is higher than 35 years old or has experienced birth/pregnancy complications before. High-risk women exhibit significant change in fertility outcome, with a 13pp decrease in the probability of pregnancy for husband treated sample and 12pp for wife treated sample (table 11). While there is no statistically significant shift in the realized fertility of low risk type, they improve on learning outcomes: treated husbands are 21pp more likely to correctly identify the risk factors affecting maternal health ($p < 0.01$). The comparison suggests that learning is effective in households with low complication risk too, while it contributes more to the fertility outcome of high risk households. In Appendix tables A10 and A11, we show similar patterns when considering the two components of the index separately.

Table 11: Heterogeneity Analysis by Risk Status

	(1) *Wife:* Currently Pregnant	(2) *Husband:* Wants More Kids	(3) *Wife:* Any of the 3 Risk Factors	(4) *Husband:* Any of the 3 Risk Factors
Husband Treated	-0.022	-0.059	0.023	0.21***
× Low Risk (β_H^1)	(0.033)	(0.049)	(0.057)	(0.067)
Husband Treated	-0.13**	-0.099	0.047	-0.0094
× High Risk (β_H^2)	(0.052)	(0.083)	(0.081)	(0.089)
Wife Treated	-0.013	0.043	0.11*	0.10*
× Low Risk (β_W^1)	(0.034)	(0.049)	(0.060)	(0.060)
Wife Treated	-0.12**	-0.030	-0.0035	0.026
× High Risk (β_W^2)	(0.055)	(0.082)	(0.10)	(0.094)
High Risk	0.095	0.10	-0.024	0.089
	(0.070)	(0.084)	(0.11)	(0.093)
Stratification Variables	Yes	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes	Yes
F-test p-value Low Risk H=W (β_H^1=β_W^1)	0.79	0.02	0.13	0.06
F-test p-value High Risk H=W (β_H^2=β_W^2)	0.74	0.33	0.60	0.72
F-test p-value H Low risk=High risk (β_H^1=β_H^2)	0.07	0.70	0.82	0.07
F-test p-value W Low risk=High risk (β_W^1=β_W^2)	0.10	0.50	0.31	0.49
Mean of Control Group	0.12	0.67	0.47	0.30
Observations	534	516	534	515

Notes: *** p<0.01, ** p<0.05, * p<0.1. SE clustered at the meeting level. Stratifying control variables include if couple has children, wife over 35, wife thinks that husband wants another child later, wife thinks husband does not want another child, husband does not know of women who died at childbirth, block size, and baseline data present. Demographic control variables include wife age, husband age, wife education, husband education, number of children, age of last child born before meeting, wife is actively trying to get pregnant, baseline contraceptive use, and household weekly income.

5.8.2 Husband's Demand for Children

In table 12, we present results for the heterogeneity on the husband's demand for children: we stratified treatment assignment on whether they want another child within 1 year, after 1 year or not at all, and consider each group separately. Significant changes in fertility outcome occur in the sample of households in which husbands want no more children or want children later, in line with prediction 5 of our model. Households with low husband's demand for children are more prone to changing behavior when they receive maternal health information.

5.9 Robustness checks

In the main specification, we have selected a small set of controls, that are held fixed in all specifications. To further limit the discretion in the choice of control, we perform post

Table 12: Heterogeneity Analysis by Husband's Demand for children

	(1) *Wife:* Currently Pregnant	(2) *Husband:* Wants More Kids	(3) *Wife:* Any of the 3 Risk Factors	(4) *Husband:* Any of the 3 Risk Factors
Husband Treated	-0.035	0.0028	0.055	0.076
× H Wants Kids Now (β_H^1)	(0.048)	(0.12)	(0.15)	(0.16)
Husband Treated	-0.094*	-0.14	0.17	0.25**
× H Wants Kids Later (β_H^2)	(0.055)	(0.10)	(0.11)	(0.11)
Husband Treated	-0.095**	-0.12**	-0.047	0.087
× H Wants Kids Never (β_H^3)	(0.046)	(0.051)	(0.067)	(0.069)
Wife Treated	0.042	-0.042	-0.049	0.11
× H Wants Kids Now (β_W^1)	(0.071)	(0.12)	(0.12)	(0.15)
Wife Treated	-0.043	-0.12	0.065	0.14
× H Wants Kids Later (β_W^2)	(0.064)	(0.11)	(0.11)	(0.12)
Wife Treated	-0.12**	0.089*	0.17*	0.062
× H Wants Kids Never (β_W^3)	(0.046)	(0.050)	(0.086)	(0.073)
H Wants Kids Later	0.020	-0.14	-0.25*	-0.050
	(0.069)	(0.15)	(0.14)	(0.12)
H Wants Kids Never	0.086	0.057	-0.18	0.038
	(0.067)	(0.096)	(0.12)	(0.12)
Stratification Variables	Yes	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes	Yes
F-test p-value Now H=W (β_H^1=β_W^1)	0.19	0.67	0.47	0.84
F-test p-value Later H=W (β_H^2=β_W^2)	0.22	0.76	0.29	0.39
F-test p-value Never H=W (β_H^3=β_W^3)	0.60	0.00	0.01	0.71
F test p-value H Now=Never (β_H^1=β_H^3)	0.41	0.34	0.56	0.95
F test p-value W Now=Never (β_W^1=β_W^3)	0.08	0.31	0.14	0.80
Mean of Control Group	0.14	0.66	0.50	0.30
Observations	440	426	440	426

Notes: *** p<0.01, ** p<0.05, * p<0.1. SE clustered at the meeting level. Stratifying control variables include if couple has children, wife over 35, wife thinks that husband wants another child later, wife thinks husband does not want another child, husband does not know of women who died at childbirth, block size, and baseline data present. Demographic control variables include wife age, husband age, wife education, husband education, number of children, age of last child born before meeting, wife is actively trying to get pregnant, baseline contraceptive use, and household weekly income.

double selection LASSO to select control variables (Belloni, Chernozhukov and Hansen, 2014). The results of this exercise for all of our main dependent variables are reported in Appendix tables A12 and A12. The qualitative and quantitative implications of our analysis are broadly unchanged, but coefficients become more precise in some instances.

6 Concluding remarks

In an intervention in which men or women in Lusaka (Zambia) receive information about maternal health risk, we find that pregnancy declines over the following year, particularly when men are treated. The intervention, nonetheless, has different effects on participating households depending on who receives the information. Treated men and their wives update their beliefs over the risk factors of maternal health complications. The same happens to treated women, but not to their husband. When men are treated, communication about reproductive health, self-reported spousal closeness and marital satisfaction all increase. When women are treated, we see no change in these outcomes, and transfers in their favor from the husband decline.

These findings are consistent with a model in which the existence of conflict of interest over fertility outcomes within the household can prevent women from effectively communicating with their husband about maternal health risk. The model can also explain the findings from our baseline data: women, in general, have more accurate knowledge of the risk factors for maternal mortality. Because of the friction caused by conflict of interest, as well as other barriers to communication such as the stigma associated with maternal mortality in many parts of Africa, women face a cost in protecting their health by appropriately spacing births. Hence, there may be significant gains to interventions that target men as the recipients of maternal health information, which are currently rare.

In a domain where separate spheres are important, in that women are more likely to learn about a phenomenon than men (or viceversa), it may be difficult for the information to spread within the household, and hence public intervention may be particularly important. Such domains may arise not only with maternal health, but also child health, investments in children's human capital, and other important household decisions whose costs or benefits, in many contexts, are observed primarily by one household member, but influence the decision making of the entire household.

A simple policy intervention is to educate couples together. While our model would predict that similar updating would occur from educating men alone versus a husband and a wife together (because educating him spreads to the wife), we cannot assess how much of the effect we see is due to men learning this information on maternal health information together with other men around them, rather than other couples around them (or solely with their wife). We leave this to future research.

More generally, this paper reveals how small differences in preferences can be exacerbated by information frictions, creating greater polarization and enabling significant inefficiencies to arise. Overcoming the information frictions breaks this cycle. In our setting, treating men directly leads to updating of information for both spouses, a greater alignment in fertility demand, reduced fertility and greater marital satisfaction. In a world in which there is often pressure from donor organizations for sub-Saharan African country governments, in particular, to reduce fertility, our paper describes a "family-centric" solution that does not sacrifice marital happiness to achieve health policy goals.

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