Maternal Mortality at the Community Level: An innovative approach to measurement

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Introduction:

Globally 350,000-500,000 women die each year from complications during pregnancy and childbirth (WHO, 2010). Despite intensive efforts over the past decade to improve the quality of data collection for maternal mortality, methodological challenges remain. In the least developed countries, vital registration systems are incomplete or nonexistent, census data collection typically occurs only on a decennial basis, and research-intensive data collection such as population-level household surveys are costly and unsustainable. In countries where the majority of births happen at home, vital registrations systems fail to record maternal deaths that occur outside of health facilities. The overall lack of reliable data on maternal mortality at district or regional level hinders prevention efforts, advocacy, prioritization, and budget allocation.

Maternal Mortality in Ethiopia:

Like many other countries in the region, Ethiopia has not made sufficient progress in reducing maternal mortality. In 2008, the adjusted Maternal Mortality Ratio (MMR) for Ethiopia was 470 per 100,000 live-births (WHO, 2010). While keen interest exists in Ethiopia to reduce maternal and child mortality as rapidly as possible, key decision-makers face difficult choices when setting priorities and allocating scarce resources. Accurate, reliable data on the levels, trends, and differentials in maternal and child mortality are sorely needed. Without such data, policies and programs will continue to be implemented without clear evidence to indicate which interventions are the most cost-effective, feasible, and have the greatest potential for impact.

Through an ongoing pilot study conducted in Tigray Ethiopia, we are testing an innovative approach to obtain timely data on maternal mortality and distribution by cause of death (COD). The pilot methodology maximizes existing local health care infrastructure and human capacity, by training community-based and mid-level providers in Sentinel Surveillance (SS), Vital Registration (VR) and Verbal Autopsy (VA) methodologies. The system enables Traditional Birth Attendants (TBAs), community-based health workers, and mid-level providers (including nurses and nurse-midwives) to collect and maintain the data necessary to produce maternal mortality estimates. In addition to testing a system with proven methodologiesof data

collection, to our knowledge, this study is the first to attempt to determine whether mid-level providers can effectively identify cause of maternal death using VA.

Improving Measurement: rationale for a new, mixed-methods approach

Measuring Maternal Mortality: Gaps in Current Data Sources
Maternal mortality is a crucial and complex measure of the overall health and development status of a given country or region. The increasing global demand for data in the face of massively flawed data-collection systems has been described as a "gathering storm" (Kulmala et al, 2000). Existing sources of data on maternal mortality include (1) vital registration, (2) health facility statistics, (3) census, and (4) population-based approaches. When cause of death is unknown, verbal autopsy can be coupled with any and all of these data sources to determine COD.

Vital Registration (VR)
The WHO has prioritized the strengthening of global vital registration, but few developing countries have managed to establish accurate and comprehensive VR systems (Mathers et al, 2005). VR systems are advantageous when designed and implemented with sufficient scope and quality to accurately capture levels and trends in mortality. In places where most births occur in hospitals and all deaths are officially registered, VR systems are largely effective. In countries where large proportions of maternal and neonatal deaths occur outside of facilities, however, passive civil vital registration systems run the risk of missing the majority of maternal deaths (Setel et al, 2005). Underreporting and misclassification, especially of stillbirths, early neonatal deaths, and abortion-related maternal deaths are pervasive and problematic (AbouZahr and Wardlaw, 2001). A high-quality VR system must capture all deaths by age, sex, cause, and place of death. In the world's least developed countries, given the current health infrastructure, this is often impractical and infeasible. Mathers et al estimate that just one-third of deaths worldwide are recorded, and that more than 90% of countries in Africa have not collected mortality data from existing vital registries since 1990 (Mathers et al, 2005). Given the myriad challenges of vital registration, countries in sub-Saharan Africa have traditionally relied on *sample* VR and population-based approaches to derive mortality estimates (WHO, 2010; Gülmezoglu, 2004). However, because maternal mortality is a relatively rare event, the omission of a small number of deaths can vastly distort estimates of MMR.

Health Facility Statistics:
Health facility-based data are of limited use in resource-poor settings where such large numbers of births and deaths occur outside of health facilities. Estimates of national maternal mortality ratios (MMRs) derived from facility-based data often lead to biased estimates, as neither the

numerator (*facility-based female deaths*) nor the denominator (*facility-based births*) are representative of the general population. Even through the use of complex algorithms which integrate facility-based estimates with data from VR systems, few developing countries are able to capture a sufficient proportion of maternal deaths to produce valid estimates (Gülmezoglu, 2004; Khan, 2006).

Census:

Census data are often the most reliable mortality data produced in developing countries, generating disaggregated measures at regional levels. However, census implementation is expensive, and in most countries only occurs once per decade. Within the last decade only 5 developing countries (Benin, Iran, Laos, Madagascar, and Zimbabwe) have collected the data necessary to estimate MMR in their national census (Hill et al, 2007).

Population-Based Approaches:

Population-based household surveys produce far more representative data than facility-based estimates. Although they have frequently been used to estimate maternal mortality, major limitations still exist, namely: 1) Maternal death is a relatively rare event that requires large sample sizes for household surveys to produce reliable results; 2) Population-based surveys are commonly carried out every 3 to 5 years; 3) If an indirect method is used, the generated point-estimate is not a true MMR, and in fact averages maternal death over the previous 5 -7 years, which makes the interpretation of current trends and the measurement of the impact of recently implemented interventions difficult if not impossible; 4) Demographic and Health Surveys (DHS) and other large surveys provide useful national estimates, but they offer limited insight about regional diversity; 5) Large confidence intervals and wide margins of error reduce precision and often lead to an inappropriate interpretation of results (Stanton et al, 2000).

Sentinel Surveillance**:** District-level sentinel surveillance (DSS) has been used in low-resource settings with much success (Setel et al, 2006). The two main features of DSS are: (i) systematic data collection, consolidation, and tabulation of data, and (ii) prompt analysis and dissemination of data to key stakeholders (Teutsch and Thacker, 1995). One study in Vietnam compared four different methods of mortality estimation and found that quarterly household follow-up was superior to re-census, vital registration, and neighborhood surveys as this method was able to detect 99.8% of deaths (Huy, 2003). The limitations of such systems, however, include 1) High cost of training and maintaining a large research staff; 2) Lack of permanent registry and thus limited utility for measuring long-term trends; 3) No nationally representative data produced,;4) Due to unmeasured migration, and demographic changes, DSS estimates

produced from the same region at different time points are not comparable. As Byass et al. (2002) notes, DSS are most useful where existing data are scarce, yet these are the same countries and regions that are least able to afford a well-designed DSS(Graham and Hussein, 2003). Thus, while DSS can provide important insights into mortality, it is not an approach that can be brought to scale, nor is it sustainable in resource-poor settings.

       <u>Verbal Autopsy:</u> Verbal autopsy methodology has been use extensively to measure cause of death mortality around the globe. VA employs a structured questionnaire, and may include an open-ended narrative to ascertain the sequence of events around, and contributing factors to, a death. Reviewers can determine probable cause of death by a process of diagnostic elimination. Four sequential actions are generally used in VA methodology: 1) Death identification; 2) Interview of relatives of the deceased; 3) COD attribution; and 4) Validation of findings (if testing methodology). Following a VA interview, the data are reviewed by either a panel of expert physicians or a computer-based algorithm. The latter method provides two major advantages: a) standardization of COD attribution and b) reduced reliance on skilled medical personnel. Computer-based systems, however, require the appropriate technological infrastructure and skilled personnel to input data from the VA and open-ended narrative—which itself requires human interpretation. Although it can be a resource-intensive process, current literature indicates that VA is a highly effective method of assessing maternal, neonatal and child deaths. Studies validating VA findings with hospital diagnoses reveal relatively high sensitivity and specificity for the instrument (Kahn et al, 2000; Setel et al, 2006; Chandramohan et al, 1998).

Employing A Mixed Methods Approach

With such a diverse range of tools and varying levels of feasibility, there currently exists a compelling case for a mixed methods approach to measuring maternal mortality. While alone none of the aforementioned approaches can provide accurate or complete estimates of maternal mortality at the national or regional levels, a strategic combination of methods presents important opportunities. Previous studies have demonstrated that data collection using different combinations of SS, VR, and/or VA can be extremely effective. A study in rural South Africa successfully demonstrated that a team of community-based field workers could collect complete VR data from their communities (Kahn et al, 2000). These findings are supported by large mortality studies that used VA (including validation by blind reviewers and re-interview of informants) and found no systematic defects in field worker technique (Gajalakshmi et al, 2002; Fantahun et al, 2006). In Tanzania, a SS system was implemented in 2003 using a network of community leaders complemented by VA questionnaires assessed by a panel of physicians. The study demonstrated the inadequacy of the official statistics on maternal death, which were limited

to data from health facilities where less than half of local maternal deaths occurred. Maternal mortality in all three study areas exceeded official estimates and the study was able to determine that post partum hemorrhage (PPH) was responsible for 29% of maternal deaths (Mswia et al, 2003). This information has had significant effect on safe motherhood policies in Tanzania.

Reproductive Age Mortality Studies (RAMOS):

The introduction of Reproductive Age Mortality Studies (RAMOS), also a mixed methods approach, was a milestone in the measurement of maternal mortality. When it was first introduced, RAMOS provided the first reliable data on maternal mortality in low resource settings, demonstrating for the first time that 20% to 25% of all deaths among women in the fertile age group were pregnancy-related. (Potts, 1986). RAMOS is an in-depth review of reproductive-age female deaths, using VR to identify deaths and VA to ascertain COD. The success of this method, however, is contingent upon the existence of complete or near-complete registry of female deaths. It is most advantageous in contexts where vital registration data are complete but COD data are missing or inaccurate.

A New, Community-Based, Mixed-Methods Approach to Maternal Mortality Measurement: a pilot study in Tigray, Ethiopia

Study Design and Study Sites:

The current study in Tigray, Ethiopia is an external pilot project, that aims to assess the feasibility of a low-cost, sustainable method of accurately measuring maternal mortality at the community and facility level, with cause of death attribution. The study, which is ongoing, takes place in the northern-most region of Ethiopia, Tigray. Tigray has a population of over 4 million, of whom 81% are rural inhabitants. Almost 95% of the population is ethnically Tigray, and Tigrigna is the predominant language. Three village sites (*tabias*) were included in the study; Ataklti, West Amba, and Bega, for a total catchment area of approximately 15,000 people. Each tabia has one health post (basic-level health facility) which reports to the district (*woreda*) of Abi Addi where the regional health center (intermediate-level health facility) is based.

Methods

Hypotheses

We hypothesize that attribution of probable cause of maternal death by mid-level providers will not significantly differ (In public health relevance or statistical significance ($p<.05$)) from a panel of expert physicians and obstetricians/gynecologists, and that the proposed system will register $\geq$

95% of births and deaths in the study sites as compared to demographic data from the 2007
Ethiopian Population and Housing Census.

Objectives

The pilot project has five objectives, two primary and 3 secondary:

- Objective 1: Establish an accurate civil vital registration system at the health post
  level, supported by a sustainable community-based sentinel surveillance system
  for births and deaths.

- Objective 2: Train mid-level providers to use Verbal Autopsy to identify
  maternal deaths, attribute probable cause of death, and describe circumstances
  surrounding the deaths. Mid-level providers will conduct VA for all deaths
  among females 12 to 49 years and will attribute probable cause of death using a
  list of single direct/obstetric causes (or any combination of causes).

- Objective 3(secondary): Analyze contributing factors to maternal deaths and
  engage community in dialogue. Data collected in the verbal autopsies, will be
  analyzed, and each maternal death classified each as "non-avoidable" or
  "avoidable" based upon cause of death and factors contributing the death.
  Encouraging dialogue between local communities and health care providers
  around maternal death will generate innovative solutions with the potential to
  improve conditions for women of reproductive age and their families.

- Objective 4 (secondary): Generate demographic indicators. We will produce
  demographic indicators that require complete vital registration, including crude
  birth/death rates, stillbirth rate, infant mortality rate, mortality rate of women of
  reproductive age, maternal mortality rate and ratio, distribution of deaths by age
  and sex, and other key indicators.

- Objective 5 (secondary): Conduct cost analyses. We will conduct a cost-benefit
  analysis to analyze the system's level of efficiency, its strengths, and its
  weaknesses. Results will be used to generate solutions for system limitations. We
  will also conduct a cost-effectiveness analysis to compare our system to other
  approaches currently being utilized to enumerate births and deaths and identify
  causes of maternal death.

Hypothesis Testing

In order to test our first hypothesis: *Attribution of probable cause of maternal death by mid-level providers will not significantly differ from panel of expert reviewers,* we will compare the decisions about COD made by the members of the Audit Committee as "agreement", "majority agreement" or "no agreement." If there is "no agreement" at the AC level, that case will not be compared to the midlevel providers' assessment. If there is "agreement" or majority "agreement" then this result will be compared to the COD attribution by the midlevel provider. The result of this comparison will be tabulated as "agreement between midlevel provider and AC" or "no agreement between midlevel provider and AC." We expect that the level of disagreement between the mid-level providers and the AC will not be statistically significant. To compare the two proportions, we will use Student t-test, assigning significance at a p-value of <0.05. In addition, we will employ Cohen's Kappa coefficient to assess the level of inter-rater agreement. We expect a 20-25% level of disagreement within the AC, and we will test if the disagreement between the AC and midlevel providers is within this range.

In order to test the second hypothesis: *The proposed system will register ≥95% of births and deaths in the study sites.* To test the second hypothesis we will use the 2007 Ethiopian Census to project the expected age-structure of the population for both project years so that we can estimate the expected number of births and deaths in our study sites. To accomplish this, we will do the following:

Step 1: **Adjust the 2007 census population age distribution for missing data** using an approach recommended by Hill et al (2001). For example, the adjusted number of females in the quinquennial age group 20 to 24 years (5Nadj20) is obtained as:

> *Adjusted number of females aged 20-24 = Observed number of females aged 20-24* Total observed female population / (Total observed female population – Number of females missing age information)*
> **5Nadj20 = 5Nobs20 * Nobstotal / (Nobstotal - Nobsmissing)**

The same step will be repeated for each age group and for both sexes.

Step 2: **Adjust the age distribution of deaths, if required.** We will repeat the same method used in Step 1. For example, the adjusted number of female deaths (ages 20 to 24) (5Dadj20), for example, is calculated as:

Adjusted number of female deaths (ages 20-24)= Observed number of female deaths (ages 20-24)

* Total observed female deaths/ (Total observed female deaths – Number of female deaths missing age information) **5Dadj20 = 5Dobs20 * Dobstotal / (Dobstotal - Dobsmissing)**

This step will be repeated for each age group and for both sexes.

<u>*Step 3*</u>: **Analyze the completeness of death recording in the census.** This will determine whether the numbers of deaths recorded in the census accurately reflects the true death rate in the population. If it is not complete, additional adjustments will be required to transform the reported death rate into a more complete measure of mortality conditions. Most methods to do this rely on mathematical calculations between the age distribution of deaths and the age distribution in the population, and make simplifying assumptions about error patterns. We will apply the *Brass Growth Balance Equation*, and extensions of it, which compares age-specific death rates based on the number of deaths reported in a census with the death rates implied by the population age distribution. It can be used to estimate the completeness of death recording relative to population recording. The completeness estimate may then be applied as an adjustment factor against the reported deaths of women of reproductive age. This straightforward way of evaluating completeness of death recording(c), based on the assumption that the population is characterized by a constant growth rate (r). If deaths are incompletely reported, the true death rate (ba+) will equal the observed death rate (da+) multiplied by an unknown factor (the inverse of the completeness of death recording, constant 'c'). This relationship can be expressed using the following equation (Hill et al, 2001): $ba+ = r + (1 / c) * da+$

<u>*Step 4*</u>: **Analyze the completeness of birth recording in the census.** This will be evaluated using Brass P/F Ratios, a method that examines the completeness of birth recording for a given reference period preceding the census. These ratios reflect the consistency between information on lifetime fertility and current fertility across women's age groups. Average parity *(P)* is calculated simply by dividing the number of children ever born alive to women of a given age group *(CEBi)* by the total number of women in the same age category *(Ni)*. Thus, for the age group 25-29 *(i=3)*:

*Average parity for the age group 25-29 = Children ever born to women aged 25-29 / Number of women aged 25-29   **P3 = CEB3 / N3***

This measure reflects the cumulative number of children born during the women's reproductive span. Information on current fertility can also be cumulated to arrive at an indicator comparable to average parity, or "lifetime-equivalent" fertility *(F)*. This is measured by summing current age specific fertility rates from the beginning of the childbearing years. In particular, age-specific fertility rates *(fi)* are calculated by dividing the number of births in the past 12-month period to women of the given age group *(Ti)* by the number of women in the same age category *(Ni)*. Thus, for the age group 25-29:

*Fertility rate for the age group 25-29 = Births in the past year to women aged 25-29 / Number of women aged 25-29 **f3 = T3 / N3***

From the age-specific fertility rates, '*F' is* calculated by interpolation using a quadratic formula which involves, for each age group *i*, summing the rates for all younger age groups, and then adding an appropriate adjustment for fertility within the age group itself. This latter adjustment is based on the pattern of fertility in the given age group and the next group. For example:

*Lifetime fertility equivalent at ages 25-29 = 5 * (Sum of fertility rates at ages under 25) + 3.392 * Fertility rate at ages 25-29 - 0.392 * Fertility rate at ages 30-34*
F3 = 5 * (f1 + f2) + 3.392 * f3 - 0.392 * f4

The P/F ratio can now be calculated for each age group. For example:

P/F ratio for the age group 25-29 = Average parity at ages 25-29 / Lifetime fertility equivalent at ages 25-29

After estimating the P/F ratio we can then estimate the completeness of the recorded births:

Completeness of recorded births = P/F ratio at ages 20-24 - (P/F ratio at ages 25-29 - P/F ratio at ages 20-24) P/F adjusted = P2/F2 - (P3/F3 - P2/F2)

Step 5: **Estimate the expected number of births and deaths for both project years**, given the population age structure and the mortality and fertility patterns of each study site.

Meeting Study Objectives

Generating Demographic Statistics:

We will estimate other important maternal mortality measures besides maternal mortality ratio, such as maternal mortality rate, adult female mortality, and lifetime risk of maternal death. In addition, we will also estimate crude death rates by age and sex, crude birth rates, and stillbirth rates.

Cost Analyses:

We will carry out cost analyses of the proposed system at the end of the project. We will: (i) Track costs from project onset; (ii) Quantify activities and human resources involved at every step and at every level of proposed system; (iii) Assess incremental economic costs of each step in each level of the proposed system; (iv) Assess costs of training for various levels of healthcare workers including (voluntary) community-based reproductive health agents and TBAs (v) Estimate Ministry of Health budgetary costs for scale-up in districts of pilot study sites, as well as for the entire region of Tigray.

Project Implementation

At the beginning of the study, in June-July 2010, in order to raise community awareness about the project plan and rationale, meetings with communities were held before project initiation, and will be held monthly for the one-year duration of the study. All levels of the research team, from medical staff to TBAs and representatives from religious organizations or other community-based groups, were invited to participate. As a result of the initial community meetings, it was determined that, as important community leaders, and as those who unofficially register all births and deaths in the communities, all 26 priests (all orthodox Christians as the communities are 95%) in the catchment area should be trained in the specifics of the project, and, as the traditional registrars of births and deaths in the community. All 26 priests willingly agreed to participate and cooperate in VR data collection.

Training

Over a period of two weeks, seven mid-level providers (1 Health Officer and 6 nurse-midwives) and twenty community-based providers (TBAs and CBRHAs) from 3 communities, 3 health

posts, and 1 health center were trained in SS, VR, and VA. 26 priests from all surrounding villages were trained in SS.

Community-Based Sentinel Surveillance:
All priests, TBAs and CBRHAs were trained to locate and report all births and deaths in their designated areas. These providers were given explicit training on how to educate and motivate families to report births and deaths in their homes. To date, they have been assisting mid-level providers in locating key informants for VA and for the verification of births and stillbirths.

Complete Vital Registration at the Health Post Level:
To ensure that all vital events are captured, community based health providers were trained to report all births and deaths to the local health post (one in each village) where vital registries will be kept up-to-date in order to ensure that *all* births and deaths reported during outreach work are also listed into the vital registry log books at the health post. Once per month, each of the three health posts compiles a list of all births, possible stillbirths and deaths of females (aged 12 to 49) for verbal autopsy and verification by mid-level providers.

Complete Vital Registration & Verbal Autopsy at the Health Center Level:
The seven mid-level providers were given 5-days of intensive training in conducting verbal autopsy, in-depth interview technique, and interviewing around sensitive topics. For all deaths of females aged 12-49 that occur in the community, one trained mid-level provider is assigned by the health officer to conduct verbal autopsy interviews. The mid-level provider privately interviews 2 different adults related to the deceased (the closest living male relative and the closest living female relative). These interviews occur after the traditional 14-day mourning period, and after informed consent is obtained. Upon completion of the VA interviews, the mid-level provider carefully reviews the answers given by both respondents and determine: a) if the death was a maternal death b) if the cause of death was any combination of the five main obstetric causes or "other" and c) the circumstances and contributing factors to death. If the two interviews yield conflicting stories, the mid-level provider arranges an interview with a third key informant, and consults with fellow trained providers to come to consensus about the cause of death are given to the Site Coordinator. Mid-level providers continue to register all deaths and births that occur in the facility, as per normal operations. All records of maternal deaths in facilities undergo maternal death audit and are additionally registered in the vital registration logs at the appropriate health-post.

Classification of Cause of Death

For the purposes of the pilot study, the mid-level providers were trained to follow the WHO recommendation of "classification of single causes of death and any of the combinations of the single causes" (Campbell and Ronsmans, 1994). The minimum list of single causes includes: (i) induced abortion and sepsis; (ii) induced abortion and hemorrhage; (iii) ectopic pregnancy; (iv) spontaneous abortion; (v) antepartum hemorrhage; (vi) postpartum hemorrhage; (vii) sepsis; (viii) eclampsia; and (ix) prolonged labor. We also use the International Classification of Diseases (ICD-10) definition of an indirect obstetric death as deaths "*resulting from previous existing disease that developed during pregnancy and which was not due to direct obstetric causes, but was aggravated by physiologic effects of pregnancy.*"(Campbell and Ronsmans, 1994). Indirect maternal deaths are relatively rare and meaningful sub-categories are difficult to establish. However, separate categories were created for the classification for diseases of local importance, which represent relatively large proportions of maternal deaths, such as hepatitis, malaria, TB, anemia, heart disease, AIDS, tetanus, and injuries (intentional and unintentional).

Mid-level providers were trained to analyze the data collected in the verbal autopsies, and classify each maternal death as "non-avoidable" or "avoidable" based upon cause of death and factors contributing the death.

Preliminary Results

Data collection began on August 1st, 2010, and, while data will not be analyzed until termination of the pilot project in July, 2010, based on preliminary results we are optimistic about the feasibility of the methodology. Study protocol continues to be followed by all members of the study team, and data collected reflect reasonable estimates of demographic indicators.

In early January of 2011 a monitoring visit to the health post in Bega tabia reviewed the existing records. 71 births, and 18 deaths had been recorded. 1 death of a female age 12-49 was recorded, but was determined not to be a death of maternal causes. Given that 4 months of data collection have occurred to date, these statistics indicate a birth rate of 42.6, a death rate of 10.8, and thus far, no maternal mortality recorded. Compared to a national birth rate of 38 and death rate of 12, we feel confident that our data accurately reflect the births and deaths occurring at the community level. Further, more detailed analyses will be conducted when data from all sites are available in July, 2011.

Limitations

We have anticipated some potential limitations and difficulties that might arise during implementation. For one, our first hypothesis predicts that midlevel providers will be capable of determining cause of maternal death. The training, however, may not be successful, or the midlevel providers' level of medical expertise may not enable them to successfully pinpoint the cause of maternal death. We carefully developed our training based on previous successful trainings conducted by ourselves or others, and to ensure the greatest success possible, requested and received feeback from project advisors, as well as other expert MCH trainers on our materials and proposed methodology.

Additionally, We have attempted to reduce the likelihood of missing abortion-related deaths by carefully structuring the order and content of the VA questionnaire. We used role-play when training midlevel providers to conduct VA interviews, especially on strategies to sensitively probe key informants in a non-judgmental fashion. At the end of the study, triangulation of data will assist in determining whether specific key informants may have omitted pieces of information. Our decision to use a medical provider who will be trained to emphasize provider-patient confidentiality to conduct the VA interview (rather than a community member) key informants may be more willing to disclose sensitive information.

Finally, we have two other interventions currently underway in the study areas, one attempting to decrease maternal mortality by using misoprostol to prevent PPH, and the other attempting to reduce unmet need for family planning by community-based distribution of injectables, which could also impact MMR over time. We may have to adjust our estimates of vital events to account for potential declines in birth and/or death rates during the project period. This will enable us to accurately test our second hypothesis. However, since the first intervention began in 2003 and the second in 2007, the potential impact of these interventions on fertility and mortality will most likely take years to observe in our study sites.

Implications for Programming

This research has the potential to make a significant impact on the study of vital events and on methodologies to measure maternal mortality at the community level with more accuracy and reliability. While over 40% of urban Ethiopian women deliver in a health facility, only 2.4% of rural women do the same. In a country where 85% of the population lives in rural areas, facility based deliveries will not become universal anytime soon. Establishing a community-based SS system has the potential to be an efficient way to obtain accurate, up-to-date information that has never been collected systematically. Training mid-level providers to establish cause and

circumstances surrounding maternal deaths (including abortion-related deaths) and to verify stillbirths will result in the generation of accurate statistics that will inform MCH policy and funding prioritization. It will also free up the limited number of qualified doctors to do higher level clinical work. The proposed system will also provide COD certification for deaths occurring outside health facilities, which is currently non-existent. Participatory analysis of contributing factors to maternal deaths will increase the currently low levels of communication between rural communities and health facility staff. Identifying avoidable causes of maternal death will empower communities to take action and generate ideas about what can be done by ordinary families to reduce maternal mortality. Finally, generating accurate indicators such as MMR or neonatal mortality rate help to inform key policy makers and ministries who set financial priorities based on the magnitude of specific MCH problems.

        In addition to a redoubled global commitment to reducing maternal mortality, data collection systems for measuring maternal mortality must be re-envisioned in order to track progress accurately and efficiently. Especially in resource-poor settings, reliable morbidity and mortality data are difficult to come by, but are key to developing evidence-based policies in health. Data generated by some of the measurement systems currently in use (specifically Vital Registry, Sentinel Surveillance, and Verbal Autopsy) on their own can provide reliable estimates of the levels and differentials of important indicators such as maternal morbidity and mortality, but often put an extraordinary burden on already feeble systems. The system set into action through the pilot project in Ethiopia aims to model a new methodology for measurement of maternal mortality. This model builds upon existing health infrastructures, trains current health care providers, and has the potential to create a sustainable system for reliable and accurate maternal mortality data collection with cause of death attribution that can offer local and national governments a low-cost, practical method of measuring vital events, as well as community-based solutions to improve maternal health.

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