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UNDERSTANDING THE CAUSES OF MATERNAL MORTALITY IN INDONESIA

A Review of Research on the Determinants and Trends in Maternal Mortality in the Asia-Pacific Region

By MAMPU

Understanding the Causes of Maternal Mortality in Indonesia

A Review of Research on the Determinants and Trends in Maternal Mortality in the Asia-Pacific Region

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ABBREVIATIONS, ACRONYMS, AND INDONESIAN TERMS

Antenatal Care	Routine health screening for pregnant women to diagnose diseases or complicating obstetric conditions without symptoms, and to provide information about lifestyle, pregnancy and delivery
BEONC	Basic Emergency Obstetric and Neonatal Care (in Bahasa Indonesia known as PONED—*Perawatan Obstetri Neonatus Esensial Dasar*)
BPS	*Badan Pusat Statistik* (Statistics Indonesia)
CEONC	Comprehensive Emergency Obstetric and Neonatal Care (in Bahasa Indonesia known as PONEK—*Perawatan Obstetri Neonatus Emergensi Komprehensif*)
DHS	Demographic Health Survey
GDP	Gross Domestic Product
GP	General Physician
FIGO	International Federation of Gynecology and Obstetrics
Gerakan Sayang Ibu	(Safe Motherhood Program) A former program of Indonesia Ministry of Health which then extended by the adoption of WHO's Making Pregnancy Safer and placed greater focus on complication prevention and birth preparedness
HDI	Human Development Index
ICD-10	International Statistical Classification of Diseases and Related Health Problems 10th Revision
ICM	International Confederation of Midwives
IHME	Institute for Health Metrics and Evaluation
IMMPACT	Initiative for Maternal Mortality Programme Assessment in Clinical Trials
Jamkesda	*Jaminan Kesehatan Daerah* (Local Health Coverage)
Jamkesmas	*Jaminan Kesehatan Masyarakat* (Public Health Coverage)
Jampersal	*Jaminan Persalinan* (Maternity Coverage)
JKN	*Jaminan Kesehatan Nasional* (National Health Coverage)
Kader	Also known as village health promotor who are chosen by the local community and are able to work voluntarily to serve the community specifically regarding their health
MCH	Maternal and Child Health
MDG	Millennium Development Goal
MDG5	A specific goal of Millenium Development Goals, which put in a place to: • Target 5A: Reduce by three quarters the maternal mortality ratio between 1990 and 2015; and • Target 5B: Achieve universal access to reproductive health.
MICS	Multiple Indicator Cluster Survey; a UNICEF-supported series of nationally representative health surveys
MMEIG	Maternal Mortality Estimation Inter-Agency Group
MMR	Maternal Mortality Ratio; a standardized calculation of deaths of women which are related to the pregnancy or its management aside

	from accidental causes denominated by 100,000 live births in a certain area/country. (WHO)
MoH	Indonesia Ministry of Health
NAoS	National Academy of Sciences
PODES	*Pendataan Potensial Desa* (Village Potential Logging)
Polindes	*Pondok Bersalin Desa* (Village Birth Facility)
Postpartum Haemorrhage	Abnormal bleeding or blood loss of 500 ml or more from the genital tract, within 24 hours of delivery (primary) or between after 24 hours of delivery until 6 weeks postpartum (secondary).
Puskesmas	*Pusat Kesehatan Masyarakat* (Local Health Center)
Riskesdas	*Riset Kesehatan Dasar* (Basic Health Survey)
SBAs	Skilled Birth Attendants
SUPAS	*Survey Penduduk Antar Sensus* (Intercensal Survey)
TBAs	Traditional Birth Attendants
UNAIDS	The Joint United Nations Program on HIV/AIDS
UNFPA	United Nations Population Fund
UNICEF	United Nations Children Fund
UNPD	United Nations Procurement Division
WHO	World Health Organization

ABSTRACT

Indonesia has seen improvement in its maternal mortality rate in recent years, however, it only achieved 56% reduction rate from the 75% targeted in the Millennium Development Goals. The study examines available evidence on determinants and trends in maternal mortality in the Asia Pacific region to understand determinants of maternal mortality in Indonesia. The study finds that Indonesia performs better than its neighbouring countries in the rate of births accompanied by skilled birth attendants, but its referral system and emergency level care coverage require improvements. The study also highlights the issue of inconsistent measurement of Indonesia's maternal mortality rate and the importance of examining socio-economic and education background as possible determinants of maternal mortality. The review proposes further analysis on recalculation of Indonesia's maternal mortality rate and identification of possible determinants.

Keywords: maternal mortality ratio (MMR), statistic measurement, determinants of maternal mortality

EXECUTIVE SUMMARY

"Understanding the Causes of Maternal Mortality in Indonesia: a review of research on the determinants and trends in maternal mortality in the Asia-Pacific Region" is a literature review that aims to analyse the underlying factors for maternal deathin Indonesia in comparison with other countries in the same developmental stage.

"In the context of Indonesia in particular, the difficulties of measuring maternal mortality lead to very diverse estimates of the magnitude of the problem; there remains a significant challenge of achieving the desired improvement in maternal health."

Based on the WHO report on 2013, Indonesia has seen improvement in its maternal mortality rate (MMR) through the period of MDGs (1990—2013), however, it managed to reduce the rate by only 56% from the targeted of 75% under MDGs and the progress is considerably slower compared to other South East Asian countries. The review also highlights inconsistent method in Indonesia's MMR measurement over recent years, which raises concern on validity of the current MMR in reflecting the situation of maternal death in Indonesia. The review analyses available evidence to understand determinants and trends in maternal mortality in Indonesia.

KEY FINDINGS

INCONSISTENT METHODS FOR MEASURING MATERNAL MORTALITY IN INDONESIA

All of the model-based estimates conclude that the latest DHS (2012) estimate (359 per 100,000 live births) was not completely reliable. There is a possibility that the actual rate may not be as low, although Indonesia is still falling short from the MDGs target of 75% improvement by 2015.

This study[2] found that there are two main differences which leads to the high degree of imprecision in the DHS estimates, namely:

a. The use of terms and structures in the questionnaire

b. The sampling design (the 2007 survey covers ever married women aged 15–49 years, while the 2012 survey samples both ever and never married women in this age range)

Thus, we suggest that Indonesia needs an accurate vital registration system to perform an effective efforts evaluation in reducing maternal death as well as planning the strategy to fulfil both national and international target, such as MDGs.

[2] *Complete discussion in Technical Note: Is the increase in Indonesia's 2012 maternal mortality ratio due to methodological differences? (Cameron, Suarez, and Cornwell, 2015)*

INSUFFICIENT MATERNAL HEALTH INFRASTRUCTURES AND SERVICE DELIVERY

Indonesia's current situation of antenatal coverage (96% for minimum of 1 visit with skilled provider and 88% for the minimum of four visits with any provider) and proportion of births assisted by a skilled birth attendant (83%) are better compared to other Southeast Asian countries despite inadequacies in quality and access to services. The review identified several areas where Indonesia is falling short of the goal of universal access to health services. These are listed several key points identified:

1. Inadequate practical clinical skills of SBAs (only 6% considered "competent");
2. Insufficient key infrastructure in health centres, including necessary drugs and equipment (only 21% of Basic Emergency Obstetric and Neonatal Care (BEONC) had the required inputs to treat postpartum haemorrhage);
3. Insufficient integration and coordination in the health care system, specifically in managing the referral systems that potentially cause delays in emergency treatment. This is mainly showed in rural areas where most births are assisted by traditional birth attendants and skilled birth attendants are only contacted when complications develop during labour;
4. Low rates of coverage of emergency-level care, as indicated by the number of available nation-wide obstetricians (only 2,600 compared to the national target of 35,000) and aggravated by uneven distribution (most work in the urban centres in Java, especially Jakarta capital region);
5. Lack of sufficient infrastructure (e.g. roads access to health facilities) and transportation available for emergencies;
6. Dual public-private contract system of employment for midwives tends to draw them to a wealthier client base in urban areas, despite the incentives offered for rural work. Thus, it tends to leaves the rural areas remain unserved where is often delivery carried out at home without or with poorly resourced SBA.

SUPPLY AND DEMAND SIDE AS DETERMINANTS OF MATERNAL MORTALITY

Improved access to and use of health facilities has been attributed to the decline of maternal deaths, along with reduction in high-risk births, improvements in women's education, and decrease in fertility. Other possible contributing factors include improvements in overall income and infrastructure development.

a. Supply side factors: 'the absence of qualified healthcare service provider and of ease of access in rural and geographically-isolated areas'

It is also found on the study (Ronsmans et al., 2009) that wealth and location have significant impacts on the maternal outcomes, shown in the magnitudes range between the poorest quartile (shows highest maternal mortality and lowest births with health professionals), and the richest quartile (shows the opposite). Another finding revealed that the highest mortality rates are found amongst those who gave birth with a SBA—especially when compared to an unskilled provider (Titaley, 2012)—which then Ronsmans et al. (2009) suggest is due partly to adverse selection, and partly due to lack of training

of emergency care—in contrast with Heywood and Choi (2010) who argue that the main issue with low utilisation rates of SBAs has to do with health system performance.

b. Demand side factors: 'the tendency of not seeking for a medical services due to the hardships in accessing the services itself'

Despite the onerous effort done by the government of Indonesia, there insist several reason for the low utilities or demand for the services of health care professionals and facilities. Studies found some factors affecting as follows: obstacles of access and distance to health facilities, a belief that complications are unlikely (specifically for those who chose TBAs instead of SBAs), and that midwives are frequently being 'out of town', and some factors related to the accountability/quality of midwives also take some important parts on the services demand—people tend to seek traditional assistance because in general, they used to face difficulties in reaching the health facilities or provider in the first place and it makes a massive continuity under such circumstance.

RECOMMENDATIONS

1. Quantify the relevant factors affecting maternal mortality using multivariate model to estimate marginal effects. For example, using the regional literature to examine demographic factors

2. To overcome the difficulty of collecting data, we suggest to use case-control data which identifies all maternal deaths in the targeted region and then appending these data with a random sample of live births, and using the estimation by logistic regression

3. Research Agenda

   We suggest an examination the 2012 DHS data to re-estimate the MMR so it will be consistent with the previous years' calculations. This aims to conclude what degree of confidence maternal mortality has recently increased in Indonesia.

   a. The primary data source will be taken from the 2010 Indonesian Census, enlarged with the 2011 PODES and 2005 Intercensal Survey (SUPAS)

   b. The study will estimate multivariate models of maternal death with affecting aspects (such as: socio-economic conditions; the availability of health services regarding geographical variation across Indonesia)

   The analysis will thus provide new information on the key determinants of maternal mortality in Indonesia.

1 INTRODUCTION

Pregnancy and childbirth are phases in a woman's life that involve significant health risks both for the unborn and newborn child and for the mother. Reflecting this, the health-related Millennium Development Goals (MDGs) prioritise infant and maternal health, by including a goal for reduction (by two-thirds) in infant mortality rates, and a further goal to reduce the maternal mortality ratio (MMR)[3] by three-quarters.[4]

Maternal mortality has a huge social cost, in terms of the tragedy of a loss of the mother's life, and compounded by the loss occurring at a time when the mother would normally be assuming a critical role as primary carer of a vulnerable newborn child. The widespread and persistent disparity in maternal mortality rates between those in rich, developed countries and poor, developing countries, is indicative of long periods where inadequate attention has been paid to addressing the systemic causes of these recurring tragedies. For example, the World Health Organisation (WHO, 2013) note that even in 2013, after a period of sizeable reductions in MMRs globally, "*the MMR in developing regions (230) was 14 times higher than in developed regions (16)*" (WHO, 2013, p.21).

A further dimension to the crisis of maternal mortality is that the vast majority of difficulties that are experienced during pregnancy and birth are relatively easily avoided with current levels of medical knowledge and appropriate targeting of resources (Goldenberg and McClure, 2015; WHO, 2006), although geographic isolation does pose particular challenges in some cases. WHO (2006) observes that:

"Approximately 15% of women experience a complication during pregnancy or birth – little of which can be predicted but almost all of which can be managed."

—WHO, 2006, p.3

Building on this observation, WHO (2006) advocates for significant upscaling of the presence of midwives at births, a relatively inexpensive step forward that ought to produce substantial improvements in maternal and child health outcomes.

Since 2008, the WHO has produced reports on global progress towards the fifth MDG related to maternal health – the target to reduce the MMR by 75% between 1990 and 2015 (WHO, 2013; WHO 2012, WHO, 2010). In its latest report, WHO (2013) calculates that the number of maternal deaths has declined by 45% globally between 1990 and 2013: a MMR of 380 maternal deaths per 100 000 live births in 1990 down to 210 in 2013. Based on this global picture, it is very unlikely that the 75% reduction in the target will be achieved globally by 2015. Consistent with this, a number of countries appear to be well short of achieving anything close to the 75% reduction.

Regionally, the MMR is at its worst in sub-Saharan Africa, with a ratio of 510. Southern Asia and Oceania are the next highest with rates of around 190, followed by South-East Asia (140), Latin America and the Caribbean (85), Western Asia (74), Northern Africa (69), Caucasus and Central Asia (39), and Eastern Asia (33) (WHO, 2013).

[3] *MMR: maternal mortality ratio: the number of maternal deaths per 100,000 live births.*
[4] *http://www.unmillenniumproject.org/goals/gti.htm#goal5*

Indonesia has seen improvement in its MMR through the period of the MDGs; the WHO's (2013) set of internationally comparable estimates suggest the MMR has fallen from 430 in 1990 to closer to 190 in 2013, a 56% improvement. However, there are several reasons for concern: first, even if this improvement is taken at face value, it is still well short of the MDG target of 75%. Secondly, the rate of improvement for Indonesia has been relatively slow, compared to many neighbours in South-East Asia, even though Indonesia has been ahead of most of its neighbours in many other indicators of economic and social development. Thirdly, there is some uncertainty about the level of the MMR. Some evidence actually suggests a worsening in the rate in recent years (BPS, 2013), but results are not consistent across methods. There is a need to reconcile the different approaches and gain greater clarity about the extent of improvement or otherwise. Finally, regardless of the measure used, the "at best" slow progress in reducing the MMR sits alongside a significant investment in a number of the areas thought likely to have the greatest impact on the MMR – things like a substantial increase in the supply of midwives, and associated improvements in the proportion of births supervised by a skilled birth attendant.

This report, giving an overview of the current evidence and recent literature, will seek to bring some clarity and focus to the issues we have raised here. Section 2 reports on the various estimates that have been produced for Indonesia and South-East Asia by reviewing the literature on approaches to measuring and estimating the MMR. We will show the most recent estimates (around 2010-2013) vary significantly, from as low as 190 to as high as 359. The discussion in Section 2 makes some attempt to explain this disparity, but in the end, concludes that whatever the level, it is well short of the MDG target, and leaves plenty of room for improvement.

Section 3 summarises the significant milestones in policy development and design of major interventions aimed at improving maternal health care internationally and in Indonesia. This section also compares Indonesia's performance on the "inputs" side – increased supply of midwives, supervised births, access to specialist support, pre-natal visits, etc. relative to its neighbours in South-East Asia.

Discussion in the literature of maternal mortality and how to address shortfalls in the relevant inputs that are likely to affect maternal health, is predicated on a common understanding of the causal drivers of maternal health (or maternal mortality). Section 4 of this review will highlight the key empirical literature that has been used to build an evidence base around the drivers of maternal mortality. The review will highlight several obvious and well known factors, as well as showing the potential importance of a number of other potential drivers. But most of all, it will show that there is much we do not understand about maternal mortality and the means by which it can be reduced, particularly in Indonesia. These knowledge gaps will point to a research agenda for future stages of this research program; Section 5 contains some observations about the best methodologies to adopt in the ongoing program of research.

2 MEASURING MATERNAL MORTALITY FOR INDONESIA

What precisely is a maternal death? The ICD-10[5] defines maternal death as:

"the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes"

—WHO 2012, p.9.

It is clear from this definition that identifying a death as maternal requires some knowledge of the circumstances surrounding the death. This is one factor that makes the issue of measurement difficult, as while identifying deaths may be relatively easy, often the cause of death is not adequately documented to provide clarity about how to categorise a particular death. Hence there is a need for some discussion of measurement, given that in developing countries, measurement requires working with incomplete information: the WHO (2013) reports that "*less than 40% of countries have a complete civil registration system with good attribution of cause of death, which is necessary for the accurate measurement of maternal mortality*" (WHO, 2013, p. 2). In the context of Indonesia in particular, the difficulties of measuring maternal mortality lead to very diverse estimates of the magnitude of the problem.

2.1 DEMOGRAPHIC AND HEALTH SURVEY DATA

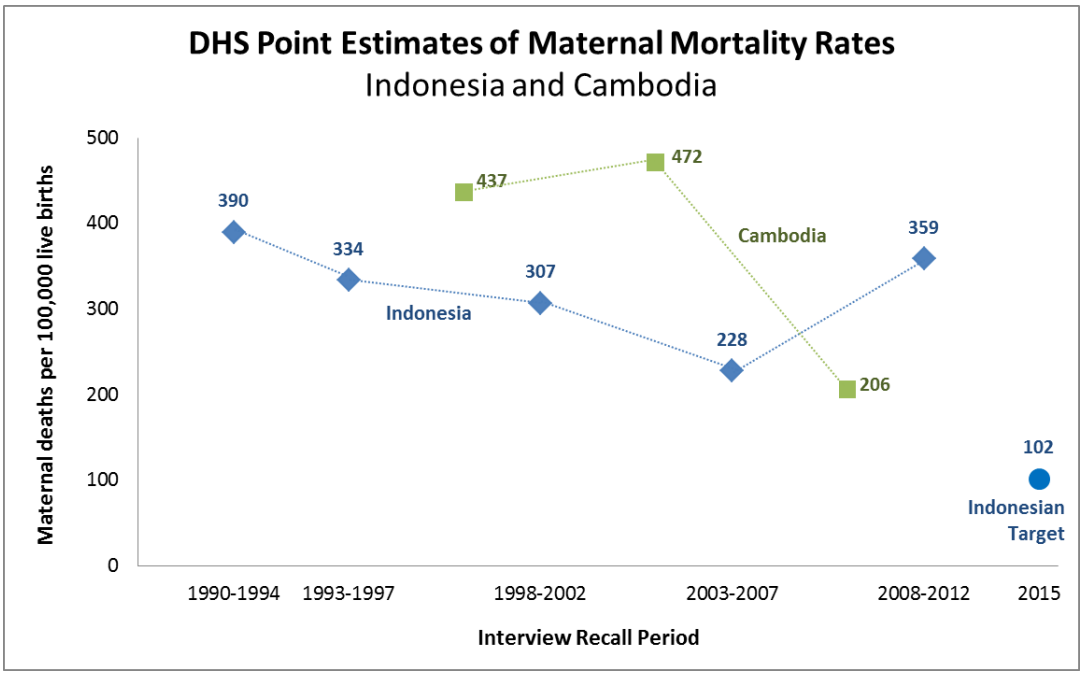
In the absence of accurate civil registration and death reporting, household surveys are commonly used to estimate the maternal mortality rate in a developing country context. In planning and measuring the achievements towards MDG5, the government of Indonesia has nominated results from the Indonesian Demographic and Health Survey as the official measure (NAoS, 2013).

Figure 1 plots point estimates of Indonesia's maternal mortality ratio between 1990 and 2012 from the official Demographic and Health Survey (DHS) reports, alongside the MDG target for 2015. The Demographic and Health Survey allows for calculation of estimates over the five-year period prior to and including the survey year. Results for Cambodia are also presented for comparison, being the only country in the region with a similar number and timing of data collection for their own national DHS. Prior to the latest 2012 Indonesian DHS, these estimates indicate Indonesia was making moderate progress towards the goal, but would be unlikely to meet it by 2015. The latest results, however, produce an alarming point estimate

[5] http://www.who.int/classifications/icd/en/

of 359 deaths per 100,000 live births, suggesting very little overall progress towards the goal since 1990, and shifting Indonesia back into the "high" maternal mortality category.[6]

Figure 1. DHC Point Estimates of MMRate



Source: DHS 1994-2012 Final Reports, Indonesia and Cambodia
95% Confidence Intervals reported:
Indonesia 2007: 228 (132-323); 2012: 359 (239-478)
Cambodia 2005: 472 (338-605); 2010: 206 (124-288)

There are a number of issues with measurement of MMRs using the DHS data sets that cause us to qualify the message apparent in Figure 1. The most crucial step in estimating the MMR is identifying maternal deaths. Household surveys such as DHS and Multiple Indicator Cluster Survey (MICS)[7] generally rely on the 'sisterhood method'. The DHS women's questionnaire asks each woman in the household about the survivorship of all the live-born children of her mother, that is, her maternal siblings. For any female siblings who died at age 10 or older, further questions determine whether the death was pregnancy-related (pregnant when died, died during childbirth or died within 2 months after the end of a pregnancy). This sisterhood method allows data to be collected on pregnancy-related deaths for a larger sample of women – not just those in the immediate household being surveyed, but also the sisters of those women in the surveyed household. Here the term "pregnancy-related" is used, as since the DHS questions do not ascertain whether the death was caused or aggravated by the pregnancy, it does not meet the ICD-10 definition of a maternal death. Typically, the MMR is

[6] *WHO 2012 (p.1): MMR Extremely High >=1000, High >=300, Moderate >=100-299, Low <100*
[7] *MICS surveys are a UNICEF-supported series of nationally representative health surveys that cover very similar material to the DHS surveys.*

estimated for a somewhat lengthy 5-year period prior to and including the DHS survey year (BPS, 2013).

Maternal mortality is considered to be underreported (Shahidullah, 1995), and even with these approaches to broadening the sampling frame in which to identify maternal deaths (using pregnancy related deaths and a 5-year recall period), it still remains that because maternal deaths are a relatively infrequent event, even with a good-sized household survey the estimated ratio is based on a small number of deaths. For example, the 2012 DHS figure for Indonesia was based on only 92 maternal deaths (BPS, 2013). As a result, these point estimates of the MMR carry such large sampling errors that it is inconclusive whether Indonesia's maternal mortality rate has indeed taken a dramatic turn for the worse. In fact, even the improvement from 390 in 1990-94 to 228 in 2003-07 is not a statistically significant decline (BPS, 2008).

A further issue reflects a change in methodology for the 2012 DHS. The denominator of the 2012 DHS MMR figure relates to a fertility rate calculated amongst all women of childbearing age (75 births per 1000 women aged 15-49), whereas previous figures relate only to ever-married women (89 for 2007 DHS) (BPS, 2013; 2008). The 2012 MMR figure may be higher because fertility rates amongst the female population aged 15-49 are likely to be lower than those amongst ever-married women of the same age range. It is not clear how much of a problem this imposes for comparability of the MMR estimates across the different surveys, but it is a potential concern. It would be feasible to use additional information in the surveys to reconcile the figures; this will be the subject of future work.

BPS (2013) also note that the female adult mortality rate increased substantially in 2012. It is possible that the maternal mortality rate calculated from the 2012 DHS simply reflects this overall higher female mortality rate. This is likely to be the case if some of the female adult mortality is incorrectly classified as maternal mortality. Future work will look into why this is happening, and to what extent this may be affecting the estimates of the MMR.

To summarise, while on the surface the DHS surveys paint a very bleak picture of progress towards the MDG target for maternal mortality, there are a number of questions around how the data is collected and the precision of estimated ratios. This motivates consideration of alternative approaches to measurement, in an attempt to resolve some of this uncertainty.

2.2 CENSUS DATA

One useful alternative is to rely on census data. Census data can be used to directly estimate MMRs without the small-sample and uncertainty related issues of the DHS, when there are suitable DHS-like questions of maternal status of recently deceased women. Again, while this would only identify "pregnancy-related" deaths, which while not exactly maternal mortality, would be a good guide to MMRs.

The 2010 (but not 1990) Indonesian census includes the following questions:

Question 301: Has there been a death in this household since 1 January 2009?

If female over 10 years old:

Question 307: Did [name] die while pregnant, during delivery or the 2 months after birth?

Direct estimates of the maternal mortality rate have been calculated from the 2010 census by Hartanto (2012) and Soemantri (2012). Because the critical questions are not used in

previous censuses, there is no capacity to compare the same measure across time. However, the large "sample" size has the advantage of allowing calculation of MMR estimates by geographical region, adjusted to correct for underreported pregnancy-related deaths (Soemantri, 2012), although there is some information loss compared to the DHS because the survey asks only about deaths in the past year, while DHS covers the past 5 years. The results in Table 1 below show that Java/Bali has a much lower rate, while Sulawesi and islands in eastern Indonesia have much higher rates. Even still, the rates fall well short of the 2015 target in all regions. These regional disparities provide some clue as to the potential causes of Indonesia's slow progress: factors such as variations in access to health services / degree of geographic isolation, and spatial inequities in expenditure on health care services.

Table 1. Indonesian MMR by Region Corrected for underreported pregnancy-related deaths 2010 Population Census

Region	MMR
Java-Bali	222
Sumatra	251
Kalimantan	290
Eastern Indonesia	382
Sulawesi	430
National	263

Source: Soemantri (2012), cited in: NAoS (2013)

Neither Hartanto (2012) nor Soemantri (2012) appear to have used the census data to investigate the determinants of these variations in rates. Part of this project will involve investigating these determinants, by first combining the 2010 census data (and data from the 2005 intercensal survey, SUPAS, which also has the requisite mortality questions) with a number of data sources that give measures of key characteristics of the different regions, and then developing models that use these characteristics to explain maternal mortality.

2.3 MODELS

While census data offers one possible solution to the imprecise estimates of MMRs coming from household surveys, there are deficiencies. Not all censuses ask the relevant questions to give the required information about maternal deaths (for Indonesia, only the 2010 census is adequate), and census sampling is relatively infrequent (once every 10 years in Indonesia). Consequently, alternative model-based approaches have been developed, drawing on a variety of data sources and combining these in a coherent way. This produces MMR estimates that are intended to be as accurate as possible, given available data, and that can be legitimately compared across time and across countries.

Such internationally-comparable estimates of MMRs are what is published in the WHO (2010; 2012; 2013) reports documenting progress towards MDG5, calculated by the "Maternal

Mortality Estimation Inter-Agency Group" (MMEIG), a group comprised of representatives from the WHO, UNICEF, UNFPA, UNPD, World Bank, National University of Singapore and the University of California at Berkeley (WHO, 2013).

Table 2 presents the MMEIG estimates for the 1990 and 2013 MMRs of South-East Asian countries reported in WHO (2013), and Figure 2 highlights the trend in country estimates, with figures for 1990, 1995, 2000, 2005 and 2013.

Table 2. MMEIG estimates for the 1990 and 2013 MMRs of South-East Asian countries

	MMR 1990	MMR 2013	% change in MMR 1990-2013 (target 75%)	Progress Category
Brunei	26	27	+1%	–
Cambodia	1200	170	-86%	on track
Indonesia	430	190	-56%	making progress
Lao	1100	220	-80%	on track
Malaysia	56	29	-48%	–
Myanmar	580	200	-65%	making progress
Philippines	110	120	+15%	no progress
Singapore	8	6	-30%	–
Thailand	42	26	-37%	–
Timor-Leste	1200	270	-78%	on track
Vietnam	140	49	-64%	making progress
South-East Asia	**320**	**140**	**-57%**	
World	**380**	**210**	**-45%**	

Source: MMEIG estimates reported in WHO (2013)

While conceding that globally, the 5th MDG target of reducing MMR by 75% by 2015 is unlikely to be achieved (current estimate is a reduction of 45% globally between 1990-2013), WHO (2013) commends South-eastern Asia for being among the better-performing regions, with a reduction of 57% over the 23 years, and only the Philippines falling short of progress towards the goal.[8] By 2010, Vietnam had joined Thailand, Malaysia and Singapore with a low MMR, while Cambodia, Lao, and Timor-Leste have already exceeded the 75% target.[9]

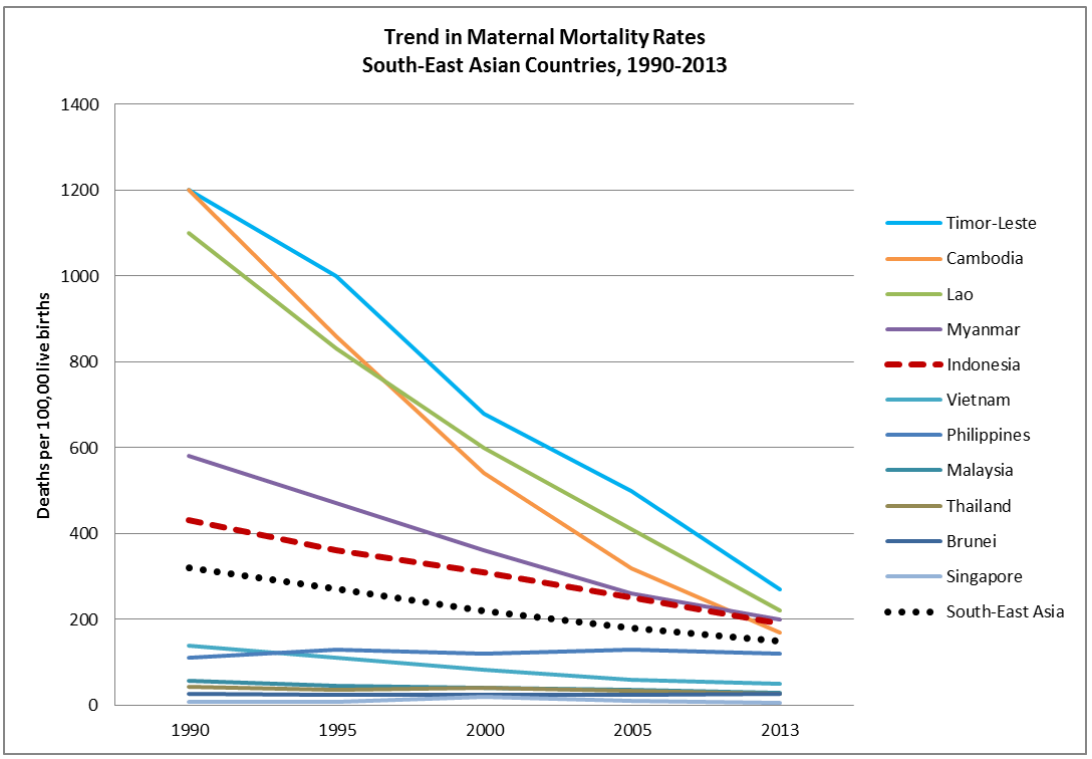
Among those countries whose MMR did not classify as "low" in 1990, Indonesia's MMR of 430 in 1990 ranks in the midrange of values. However, these estimates suggest that progress since

[8] Among South-East Asian countries whose maternal mortality rate was 100 or more in 1990: Cambodia, Indonesia, Lao PDR, Myanmar, Philippines, Timor-Leste and Vietnam.

[9] Rates for Philippines and Singapore use first-best data sources (civil registrations, etc.), while those for the remaining countries use the second-best multi-level estimation. There are large differences in rates, degree of improvement and rankings from those published in the 2010 report, including amongst those based on first-best data.

then has been fairly unimpressive. The 56% reduction is the slowest improvement among these nations, with the exception of the Philippines, and it suggests that the MDG target of 75% reduction is unlikely to be achieved. Having said that, it has to be acknowledged that an improvement of 56% is a sign of insignificant progress.

Figure 2. Trend in Maternal Mortality Rates South-East Asian Countries, 1990-2013



Source: MMEIG estimates reported in WHO (2013)

While estimates of MMR by the MMEIG are similar to the DHS values for 1990 (DHS of 390, MMEIG value 430) and most other years, the MMEIG-estimated MMR of 190 for 2013 is very different to the 2012 DHS figure of 359. These two most recent MMR estimates are so vastly different that they cannot be ignored. They tell a conflicting story of progress: the DHS value suggests poor progress and recent sharp deterioration in maternal outcomes, while the MMEIG estimate suggests reasonable progress, if somewhat short of the MDG and inferior to most South-East Asian neighbours.

So how do we resolve these differences? It is not possible to give a definitive answer to this question, but further understanding of the construction of the estimates may shed some light. First, given the DHS value goes so against the trend of previous DHS estimates, it is tempting to dismiss this value as some anomaly and to go with the MMEIG estimate of 190, which does appear consistent with the pattern of previous DHS values. However, understanding the construction of the model-based estimates, and comparing with other attempts at the same exercise, leads us to question the validity of the more positive MMEIG estimate.

The MMEIG estimates are compiled with the objective of estimating maternal mortality rates that are comparable across countries, and that alleviate misclassification of cause-of-death and the small sample issues with household surveys. In doing this, the MMEIG (WHO, 2013) estimates use a combination of data obtained through country consultations, agency databases (e.g. UNAIDS, UNICEF, UNPD, WHO), DHS, MICS, and censuses, and then rank data sources for countries according to data quality and completeness. Highest-ranking data sources based on civil registration data are generally used in raw form, with some adjustment for misclassification of cause of death (67 countries). For countries and years where data was considered less than adequate in quality, maternal mortality is estimated using a multi-level regression model: country GDP, general fertility rates and rates of skilled attendants at birth are used to predict the proportion of deaths among women of reproductive age that are due to maternal causes (96 countries with a composite of incomplete civil registration data, and 20 countries with no national maternal mortality data). This figure is then converted to a MMR by incorporating data on population estimates and live births.

The MMEIG estimates published in WHO (2013) provide comparable values for 183 countries, a monumental task of painstaking data trawling and modelling. No detail is given as to how specific calculations are made for a particular country, apart from a 3-category ranking of mortality data sources. As a result, any comments we make here in relation to the estimates for Indonesia are necessarily speculative. What we do know is that Indonesia is among the 96 countries with incomplete civil registration data, and so Indonesia's estimates were based at least in part on the "multi-level regression model" described above. As noted, such a model uses aggregate measures like GDP, fertility rates and number of skilled birth attendants to essentially predict what the maternal mortality rate would be, given the measurable values of these inputs.

So the estimate for 2013 of 190 is best thought of as a model projection of what ought to have occurred, given the values of these inputs. It takes no account of the myriad other factors that would cause variation from the model. For example, with Indonesia's very large and geographically spread population, predicting an improvement in the MMR based on increased numbers of birth attendants will fail to capture the potential variation in spatial distribution of these attendants, or the variable quality of their training, or their access to the required equipment or medical supplies in the health centres where they work. As we will highlight later, there are a number of serious deficiencies in many of these areas, none of which would be captured in the predictive model used by the MMEIG and published in WHO (2013). Being a model based on slowly evolving input variables, the MMEIG model is likely to predict a continuation of the trend evident in past data, which is exactly what we observe.

For these reasons, we would argue that the relatively optimistic estimates presented in WHO (2013) is no reason for complacency. Even this number is well short of the MDG target, and represents a slower improvement than most neighbouring countries, and there are good reasons to believe this estimate is more optimistic than the actual situation.

Some support for this scepticism of the MMEIG estimate is found in considering earlier estimates by the MMEIG in WHO (2010) and WHO (2012), alongside estimates originating out of the Seattle Institute for Health Metrics and Evaluation (IHME), and documented in Hogan et al. (2010), Lozano et al. (2011) and Kassebaum et al. (2014). These studies produce country-level estimates of MMRs over time, each with successive updates to available data and analytical methods.

Kassebaum et al. (2014) estimate Cause of Death Ensemble Models for 188 countries over the MDG period 1990-2013 using the Global Burden of Disease 2013 Cause of Death database,

alongside civil registration data, DHSs, Reproductive Health Surveys and censuses. They use an algorithm to re-classify deaths as maternal and non-maternal. Covariates include fertility rates, HIV and neonatal death rates, GDP per capita, proportion of deliveries in health facilities and assisted by a skilled health professional, antenatal care coverage and rates of child-under-five malnutrition.

Table 3 presents a comparison of these various model-based estimates for Indonesia by the MMEIG and IHME in each successive publication. The first striking observation is the huge differences in starting estimates for 1990: from 253 in Hogan et al. (2010) to 620 in WHO (2010). While the MMEIG revised their starting estimate down from 620 (WHO, 2010) to 430 (WHO, 2013), IHME revised theirs up, from 253 (Hogan et al., 2010) to 368 (Kassebaum et al., 2014). The revisions would necessarily be due to a change in modelling approach, or to availability of new data affecting the 1990 time period. Nonetheless, the revised starting estimates of 430 and 368 are reasonably in line with the DHS figure of 390.

Table 3. DHS and Model-Based Estimates of MMRs for Indonesia

	Starting Estimate 1990	Latest Estimate 2008-2013	Implied % Change	Year of Latest Estimate
DHS Estimate (Sisterhood Method)	390*	359 (239-478)	-8%	2012
MMEIG in WHO (2013)	430	190 (130-300)	-56%	2013
MMEIG in WHO (2012)	600	220 (130-350)	-63%	2010
MMEIG in WHO (2010)	620	240 (140-380)	-61%	2008
IHME in Kassebaum et al. (2014)	368 (312-433)	199 (149-257)	-46%	2013
IHME in Lozano et al. (2011)	404 (365-446)	245 (189-311)	-39%	2011
IHME in Hogan et al. (2010)	253 (148-411)	229 (133-379)	-9%	2008

95% confidence intervals in parentheses, where reported
* DHS figure relates to the five-year period 1990-1994

In contrast, the model-based estimates for 2008-2013 by MMEIG and IHME are somewhat consistent with each other, but vastly more optimistic than the DHS figure of 359. Because they rely on slow-moving explanatory variables, all of these model-based methods produce estimates that evolve according to a smooth trend, and almost by construction could not have predicted the sharp increase in MMR for Indonesia in 2012 estimated from the DHS. Nonetheless, different models produce different results, and importantly, different conclusions about progress towards the MDG.

To summarise, all of the model-based estimates tell a story that is not as pessimistic as the latest DHS estimate. There is no definitive answer to the question of why the DHS estimate varies so much from its previous trend and from the model-based estimates, but similarly, the value ought not to be easily dismissed. If we were to "average out" these various estimates, a reasonably balanced estimate of around value of 250, say, would represent improvement of less than 40%, well short of 75%: there remains a significant challenge of achieving the desired improvement in maternal health.

3 MATERNAL HEALTH POLICY AND DEVELOPMENTS

3.1 BROADER HISTORICAL CONTEXT

The 20th century has seen a rapid improvement in MMRs in high and middle income countries, largely due to significant steps forward in key preventative and curative interventions. For example, in the USA, the MMR hovered around 800 up to the 1920s (almost 1% of live births resulting in maternal mortality), and now sits at around 10, a phenomenal 98.75% improvement (NAoS, 2013).

In this context, the ambitious MDG goal of a 75% reduction in MMR by 2015 ought not be seen as unrealistically aspirational. We have the benefit of recent history to help understand the key drivers of the rapid improvements, and in most cases the required improvements to health services are not unachievable. It is in this context a great deal of momentum has been built up seeking to roll out these interventions in the developing world.

It is widely recognised that the major contributors to the improvements in the high-income countries have been based on a relatively small number of medical innovations and improvements in maternal care, and not necessarily due to improvements in standards of living (Loudon, 2000). Key factors were prenatal care that allowed for early identification of potential complications; more deliveries were supervised by trained midwives and obstetricians; antibiotics became available to manage infection, as well as other specific drugs and use of blood transfusions (NAoS, 2013; Goldenberg and McClure, 2011; Loudon, 2000).

In this context, a number of major initiatives have taken place over the past 40 years that pursued more widespread adoption of these new approaches and interventions in the developing world. Here we briefly summarise some of the major interventions with a timeline of key global initiatives.

In recognition of the importance of supervised births, initial efforts in the 1970s promoted by the WHO and others were focused on technical training of traditional birth attendants (TBAs). This strategy aimed to provide a link between traditional practice and modern maternal health care, however technical training of TBAs alone was later proven to be uneconomical and more importantly, ineffective, in improving maternal and child health (Liljestrand, 2000; WHO, 1999). The emphasis then shifted to building a wide network of skilled birth attendants (SBAs).

A very influential contribution came in the form of a 1985 Lancet article titled "*Maternal Mortality—a neglected tragedy. Where is the M in MCH?*" (Rosenfield & Maine, 1985). This article strongly called for the World Bank to provide loans for developing countries to build, staff and equip rural maternal health centres in line with a system of comprehensive maternity care outlined in Taylor and Berelson (1971).[10] This was followed in 1987 by the Global Safe Motherhood Initiative, launched at a joint WHO-World Bank-UNFPA conference in

[10] *Specifically, establishing a maternity centre with midwife per population of 4,000, and a referral centre with obstetrician per 100,000 population.*

Nairobi. The objective of the initiative was to raise awareness of maternal deaths and initiate change to reduce levels by half by 2000. However, there remained a continued lack of consensus on the "right" interventions to follow.

A consensus in priority interventions developed at the tenth anniversary of the Nairobi conference, the 1997 Global Safe Motherhood Technical conference in Colombo. One of the key action messages states:

"The single most critical intervention for safe motherhood is to ensure that a health worker with midwifery skills is present at every birth, and transportation is available in case of an emergency."

(Starrs, 1997, p.77)

This clear focus became one of the building blocks of national goals and plans for improving provision of maternal and child health services.

A joint statement by the WHO, World Bank, UNFPA and UNICEF in 1999 (WHO, 1999) names three factors as determinants of maternal mortality: low social and economic status of women; delivery without a skilled birth attendant (with adequate drugs and equipment); and poor nutrition. Policy recommendations in the statement included: increased support for family planning and abortion counselling; greater access to antenatal and postpartum care, and skilled attendants; provision of quality obstetric services at accessible referral centres. The statement also proposed monitoring progress using process indicators (such as increased access to antenatal care, supply of SBAs, etc) rather than using household surveys to simply measure the MMR outcome.

Following on from this statement was renewed focus on programs designed to implement these recommendations, including Columbia University's Averting Maternal Death and Disability Program funded by Gates Foundation, which advocates specifically for improving emergency obstetric care (Tita & Ehiri, 2009).

A World Bank report (Pathmanathan et al., 2003) analysed the success of Malaysia and Sri Lanka in reducing maternal mortality in the 1980s. Success was attributed to investment in maternal health services through the removal of user fees and establishing an integrated system of care, the backbone of which was SBAs. The success of Malaysia and Sri Lanka through professional midwives became an anchor point for the promotion of SBAs (for example: Ronsmans et al., 2009; WHO, 2006; WHO, 2004). Others have recognised success as attributed to a combination of SBAs integrated into a strong health system of referrals and accountability (see, for example: Shankar et al., 2008; Bullough et al., 2005; Van Lerberghe & De Brouwere, 2001; Koblinsky et al., 1999).

The focus on skilled birth attendants was reinforced again in 2004 with a joint statement by the WHO, ICM and FIGO advocating for universal coverage of SBAs – that is, an accredited health professional trained to manage normal pregnancies and to identify referral cases (WHO, 2004). The statement also describes skilled care in the context of the overall health system, in particular the availability of equipment and transportation to emergency care:

"Skilled care refers to the care provided to a woman and her newborn during pregnancy, childbirth and immediately after birth by an accredited and competent health care provider who has at her/his disposal the necessary equipment and the support of a functioning health system, including transport and referral facilities for emergency obstetric care."

(WHO, 2004. p.1)

The planning process towards achieving the MDG goal of 90% SBA coverage by 2015 has highlighted effective referral amid geographical diversity and weak infrastructure as a critical factor (WHO, 2004).

A series of Lancet articles on maternal survival in 2006 (Ronsmans & Graham, 2006; Campbell, et al., 2006; Koblinsky, et al., 2006; and Borghi et al., 2006) recommended the standard for safe delivery ought to be deliveries in health facilities supervised by a midwife. To boost supply and demand for these services, Borghi et al. (2006) call for larger investment in maternal health by government and donors to abolish user fees, while Koblinsky (2006) recommends teams of midwives and midwife assistants working in facilities as the most efficient way to scale-up coverage.

Marking the 20th anniversary of the Safe Motherhood Initiative, the first Women Deliver conference was held in London in 2007. Running global conferences every three years since then, the Women Deliver organisation aims to keep the health and well-being of women and girls in the forefront of the international policy agenda.

A further series of collaborative Lancet articles in 2014 demonstrated a pivotal role of midwives in providing quality maternal and child health, and continued the call for universal coverage of skilled care at births. Homer (2014) modelled scenarios with various scale-up rates of midwifery practice, estimating that up to 83% of maternal, fetal and neonatal deaths could be averted in low-HDI countries. Van Lerberghe (2014) reviews the strategy of rapid deployment of midwives in Burkina Faso, Cambodia, Indonesia and Morocco, concluding that improving maternal and child health outcomes depends crucially on the overall network of service delivery, while Renfrew et al. (2014) highlights effective integration of health systems with communities.

Recent research and programs have addressed behavioural and cultural issues, as research has identified that simply providing services is often not enough. The issue is not only about the supply of services, but about educating people to demand such services. This can occur in part via a participatory approach through women's groups. This is reflected in a 2014 WHO recommendation (WHO, 2014) for a new emphasis on programs that promote community mobilisation through facilitated participatory learning in women's groups (see the review in Cameron & Schaner, 2013). These groups also allow women to address issues around pre-conception care in a culturally sensitive way.

In summary, the current general consensus in the international community is that, since maternal death is a fairly rare and largely unpredictable event, in most cases an adequately skilled and resourced birth attendant is sufficient to ensure a safe, normal birth, and to identify cases requiring referral. This referral needs to happen quickly and seamlessly, with quality basic and comprehensive emergency care available as required. In delivering this strategy, the message of need for near-universal use of SBAs has been heard and largely followed, but it would seem that in many developing countries the rest of the message has been lost, or presented even greater implementation challenges. This could be due to several

possible reasons, including competing priorities, inadequate financing, and lack of staffing, infrastructure or direction.

3.2 INDONESIAN CONTEXT

This section covers the recent history of maternal health care in Indonesia, emphasising how the environment has changed in recent years, in part reflecting the various phases of the broader global push towards improved maternal and child health outcomes.

3.2.1 MATERNAL HEALTH POLICIES AND STRATEGIES

Following the 1987 Safe Motherhood conference, maternal health became a priority item on Indonesia's health policy agenda (Shiffman, 2003). The village midwife program (*bidan desa*), introduced in 1989, envisaged that a trained midwife and birth facility (*polindes*) would be placed in every village, alongside engagement of volunteers within the village (*kaders*) to promote health service utilisation (NAoS, 2013). In order to staff the requisite supply of midwives, initially nursing graduates who completed an additional year of midwifery training were deemed skilled birth attendants, but this training was later increased to 3 years (NAoS, 2013; World Bank, 2010). Under the pre-2001 centralised system, the goal of a midwife in every village was largely achieved (NAoS, 2013; Shiffman, 2003). However, in this period, concerns about quality quickly surfaced - the midwife training falls short of the WHO training requirements for a skilled birth attendant (NAoS, 2013), and graduates have been found to score inadequately in skills tests (Rokx, 2010; Koblinsky, 2003).

A number of initiatives were undertaken in the late 1990s with a focus on educating mothers and communities. This included the 1996 *gerakan sayang ibu* (literally "dear mother movement"; Indonesian custom name for Safe Motherhood program), which was initiated to mobilise pregnant women and their families to seek antenatal care and assistance with the birth. The movement focussed on risk profiling and community efforts to reduce the risks (World Bank, 2010). Similarly, the 1999 Maternal and Newborn Health Program and SIAGA media campaigns socialised communities about warning signs of postpartum haemorrhage, encouraged utilisation of SBAs, delivery in a health facility and providing transport (Hill et al., 2013).

Decentralisation saw responsibility for health education shift to the Ministry of Education, and led to a large scale expansion in midwifery training institutions (NAoS, 2013). By 2012 there were over 200,000 midwives in Indonesia (NAoS, 2013). Despite this, retention of midwives in rural areas post-contract has become particularly problematic, to the point that recent data suggests only 40% of villages currently have a midwife (NAoS, 2013; World Bank, 2010; Makowiecka et al., 2008).

A new health paradigm emerged in 2001 as the Ministry of Health adopted the WHO's Making Pregnancy Safer approach as their national strategy (Nayoan, 2011; JHPIEGO, 2004). The new direction for Indonesia built on an earlier program (*gerakan sayang ibu*), but placed greater focus on complication prevention and birth preparedness (World Bank, 2010). Also following decentralisation was the gradual adoption of a set of universal minimum service standards for care, aimed at ensuring quality and accountability in primary health care service provision across the districts and municipalities (Hayes & Harahap, 2011). This evolved into a Ministry of Health Decree (Decree 741/2008) that by 2015 the following goals would be met:

- 95% antenatal care coverage
- 80% of obstetric complications attended
- 90% of deliveries attended by skilled health providers with obstetric competencies
- 90% post-partum visit coverage
- 100% coverage of basic health care and referral services for the poor

A further Ministry of Health Decree (Decree 515/2011) launched the *Jampersal* maternity coverage scheme. The scheme was directed at the poorest 33% of the population, providing free basic maternal health care at local health centres (*Puskesmas*) and referral centres, effectively closing the coverage gap left by the existing social health insurance schemes (*Askes*, *Jamsostek* and *Jamkesmas*/*Jamkesda*) (Achadi et al., 2014). This scheme was shown to be effective in increasing deliveries in facilities, and was amalgamated into the National Health Insurance Scheme (*Jaminan Kesehatan Nasional*—JKN) in 2014 (Achadi et al., 2014).

3.2.2 INDONESIA'S CURRENT SITUATION

The WHO and UNICEF recognise four indicators associated with MDG5.B: antenatal care coverage (at least one visit with a skilled provider and at least four visits with any provider), proportion of births assisted by a skilled birth attendant, and proportion of deliveries in health facilities.[11] Indonesia scores quite well in the first three of these indicators relative to its South-East Asian neighbours – see Table 4.

Table 4. MDG5.B Indicators for South-East Asian Countries

	Antenatal Care (at least 1 visit) %	Antenatal Care (at least 4 visits) %	Skilled Attendant at Birth %	Health Facility Deliveries %
Brunei	99	-	100	100
Cambodia	89	59	72	61
Indonesia	96	88	83	63
Lao	54	37	42	38
Malaysia	97	-	99	99
Myanmar	83	-	71	36
Philippines	95	78	72	55
Singapore	-	-	100	100
Thailand	98	93	100	100
Timor-Leste	84	55	29	22
Vietnam	94	60	93	92

Source: UNICEF global databases based on latest available data (2009-2012)

[11] http://data.unicef.org/maternal-health/maternal-mortality

N.B. The definition of a health facility includes a birthing hut, often the home of midwife, which would only be equipped for normal births (World Bank, 2014).

However, Indonesia's national-level figures on antenatal care and skilled birth supervision hide a number of inadequacies in quality and access to services, despite the various iterations of national strategies, setting of targets, introduction of schemes, and large scale investments in expanded service provision. This suggests that the current reality for Indonesia is well short of the goal of universal access to health services that meet minimum standards. We document the key points of concern below.

1. **SBAs are not adequately trained**

   Rokx et al. (2010) express concern for the credentialing process amid rapid growth in midwifery training institutions, particularly with respect to opportunities to gain practical clinical skills. In a case study of one province, Makowiecka et al. (2008) find that 79% of midwifery providers serving villages in Banten province graduated under the one-year diploma system; even the improved three-year diploma system falls short of the WHO training requirements for a skilled birth attendant (NAoS, 2013). In skills tests, the average score for Indonesian village midwives was 51%, and only 6% of midwives met the minimum score of 70% to be considered "competent" (Koblinsky, 2003). Maintaining skills competency is also an issue post-graduation, with the median number of births attended by midwives in Indonesia much lower than the optimal levels (Makowiecka et al., 2008).

2. **Lack of necessary drugs and equipment**

   A World Bank (2014) report assesses the 'readiness' of Indonesian public health care facilities to provide universal maternal health care. The report finds a number of deficiencies in coverage and large disparities in quality of services by region. For example, they find that while an adequate network of health centres largely exists, a large proportion of health centres in some provinces lack basic infrastructure such as water supply, referral transportation and communication. Nationally only 21% of BEONC (basic emergency obstetric and neonatal care) health centres had the required inputs to treat postpartum haemorrhage, the most common cause of maternal death.

3. **Referral systems impose delays in emergency treatment**

   Labour may start with the support of a traditional birth attendant, and is then referred to a midwife late in labour if complications develop (Scott et al., 2013; Makowiecka et al., 2008). This call for more skilled assistance often arrives too late for interventions to be effective (Scott et al., 2013). Moreover, Makowiecka et al. (2008) claim that the system of community-based midwifery provision promotes home-based care, which can be basic even with attendance by a SBA.

4. **Rates of coverage of emergency-level care are low**

   The NAoS (2013) report highlights that while numbers of skilled birth attendants have improved substantially, Indonesia has the lowest doctor-population ratio in South-East Asia (NAoS, 2013). The situation is even worse with specialists, with only 2,600 obstetricians nationally, compared to a goal of 35,000, and the report suggests that the majority of these work in Jakarta or other large urban centres in Java.

5. **Lack of integration and coordination in the health care system**

Indonesia has a hierarchical referral system for maternal complications which creates great complexity and potentially costly delays. The TBA refers to the village midwife, who in turn refers to Puskesmas (BEONC), with referrals then going to the district hospital (CEONC – comprehensive emergency obstetric and neonatal care.

Alongside the deficiencies with quality of care at each of these stages, studies highlight a web of procedural, logistical, informational as well as socio-cultural impediments to accessing appropriate care, for example: lack of preparedness for complications, absence of and delays in calling a midwife, delays and refusals in making the referral, delays in progressing through multiple or incorrect referrals, needing to organise a poverty certificate, cost and perceived costs of care, fear of modern medicine and stigma (see, for example, Nasir et al., 2014; D'Ambruoso et al., 2010, World Bank, 2010).

6. **Lack of adequate roads and transportation**

   This contrasts with the high quality and coverage of ambulance services in Malaysia, including an Obstetric Flying Squad (Kowalewski & Jahn, 2001).

7. **There are geographical and income-related differences in all these aspects**

   Despite Indonesia's national midwife-to-population ratio being similar to Malaysia and Sri Lanka, rural areas remain underserved (Makowiecka et al., 2008). The dual public-private contract system of employment for midwives means that midwives are drawn to a wealthier client base in urban areas, despite the incentives offered for rural work (Makowiecka et al., 2008). Thus, it tends to be the rural and geographically-isolated poor who suffer from multiple disadvantages, often delivering at home and/or without a (poorly-resourced) SBA.

It appears that while Indonesia has invested heavily in some key areas of need, such as rapid expansion in the number of midwives, there are other important dimensions where there has been little progress. To illustrate, Acuin et al. (2011) fit a quadratic equation to MMRs in South-East Asian countries to determine whether changes in the MMRs can be attributed to changes in country-level maternal health policy. They find improvements in MMRs for Malaysia and Thailand to be linked to general socioeconomic progress and coordinated components of the maternal and child health systems. The Indonesian experience is contrasted with that of Thailand in two aspects: first, while both had a significant deployment of SBAs, in Thailand this was accompanied by increased access to obstetric and emergency care. Little progress has been made in these aspects in Indonesia as is clear from the inadequacies in the system identified above. Secondly, with a much less geographically dispersed population in Thailand, the expanded workforce resulted in reasonably good geographical coverage. This is far from the case in Indonesia, where its archipelagic nature poses much greater challenges.

Both the World Bank (2014) and the NAoS (2013) reports place a great deal of emphasis on the geographical inequities in access to health care services, including and especially higher level care. The World Bank (2014) report particularly recommends a focus on eastern provinces, which are geographically isolated from more densely populated Java, and the NAoS (2013) recommends developing a specific strategy for reaching the outer islands (non-Java).

To summarise, while a great deal of attention has been given to expanding maternal care nationally, the best that can be said is that broadly, it is only the "basics" that have been covered. For example, while the proportion of births supervised by a skilled birth attendant

has improved greatly, questions remain about the quality of their skills, and their access to more specialist equipment or expertise when the need arises, and regarding the many geographical areas where such skilled attendants are still all too scarce.

We categorise in three broad areas the ongoing challenges that have been identified:

Table 5. Ongoing Challenges

Quality	This includes improving the training, expertise and experience of the health workforce; improving the quality of health facilities and other ancillary services to ensure needs are met to acceptable standards.
Co-ordination	Looking at the needs of women and children through a prism of treatment guidelines, and addressing the gaps in services (e.g. the lack of obstetric services) that mean all dimensions are adequately covered in a timely manner.
Coverage	Taking a closer look at the spatial variations in access to services and the quality of those services, and addressing regions of significant disadvantage.

4 DETERMINANTS OF MATERNAL MORTALITY

The historical development of policy and programs around maternal mortality described in Section 3 has provided some consistent messages about critical factors that need to be addressed in reducing maternal mortality. Underpinning much of this policy development is, in most cases, a solid body of research that provides an evidence base for priority setting. This section will give an overview of this research, including highlighting places of notable knowledge gaps, particularly with reference to the Indonesian context. The research will also show that there are complexities and subtleties to what might seem like obvious directions for program development. Ignoring the complexities may result in significant investment in areas with little return.

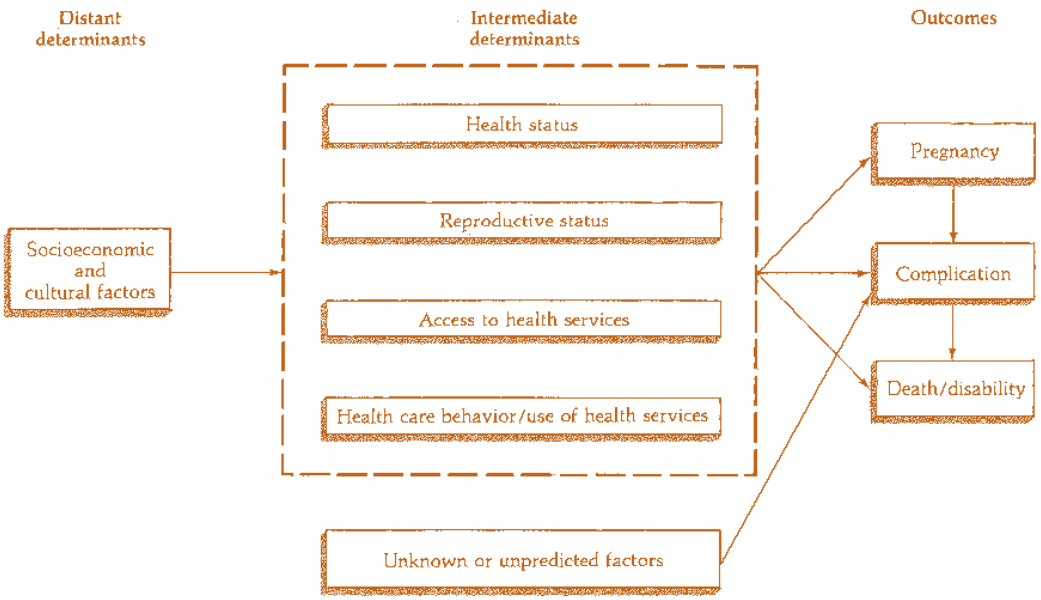
We start with an overview of potential frameworks for determinants of maternal mortality, and with these in mind, present our own framework (section 4.1). Subsequent sections present key empirical literature following our framework.

4.1 FRAMEWORKS FOR UNDERSTANDING THE DETERMINANTS OF MATERNAL MORTALITY

A number of authors have defined a schematic representation/framework to capture the key factors contributing to maternal health outcomes. Each representation is designed to capture the major contributing factors, although there is quite some variation in how the factors are combined and highlighted.

McCarthy and Maine (1992) develop a framework based on a sequence of events (pregnancy, complications thereof, and death), to which efforts to reduce maternal mortality must respond. The outcomes associated with these events are each determined by distant factors (socio-economic and cultural factors), intermediate factors (health status, reproductive status, access to health services, health care behaviour and utilisation) and unknown or unpredicted factors (McCarthy and Maine, 1992). The inherent sequential nature of these events calls for careful attention to be paid to the issue of selection in modelling the determinants of maternal mortality. McCarthy and Maine's model is presented below.

Figure 3. McCarthy and Maine (1992)



Tinker and Koblinsky (1993) adapt this framework to include health system aspects. Thaddeus and Maine (1994) frame maternal mortality as a result of "3 delays": delay in the decision to seek care, delay in the arrival of/to care, and delay in receipt of quality care. Meanwhile Koblinsky et al. (1994) set out criteria for safe motherhood settings, built around "access" to services through all stages. Their framework also provides some helpful indicators of progress in each of these areas.

Below we present a framework we have developed, that borrows from previous versions, but also draws from the focus of the various empirical research papers, with a view to providing a coherent classification of these papers. We note the framework articulates demand side issues more strongly than others.

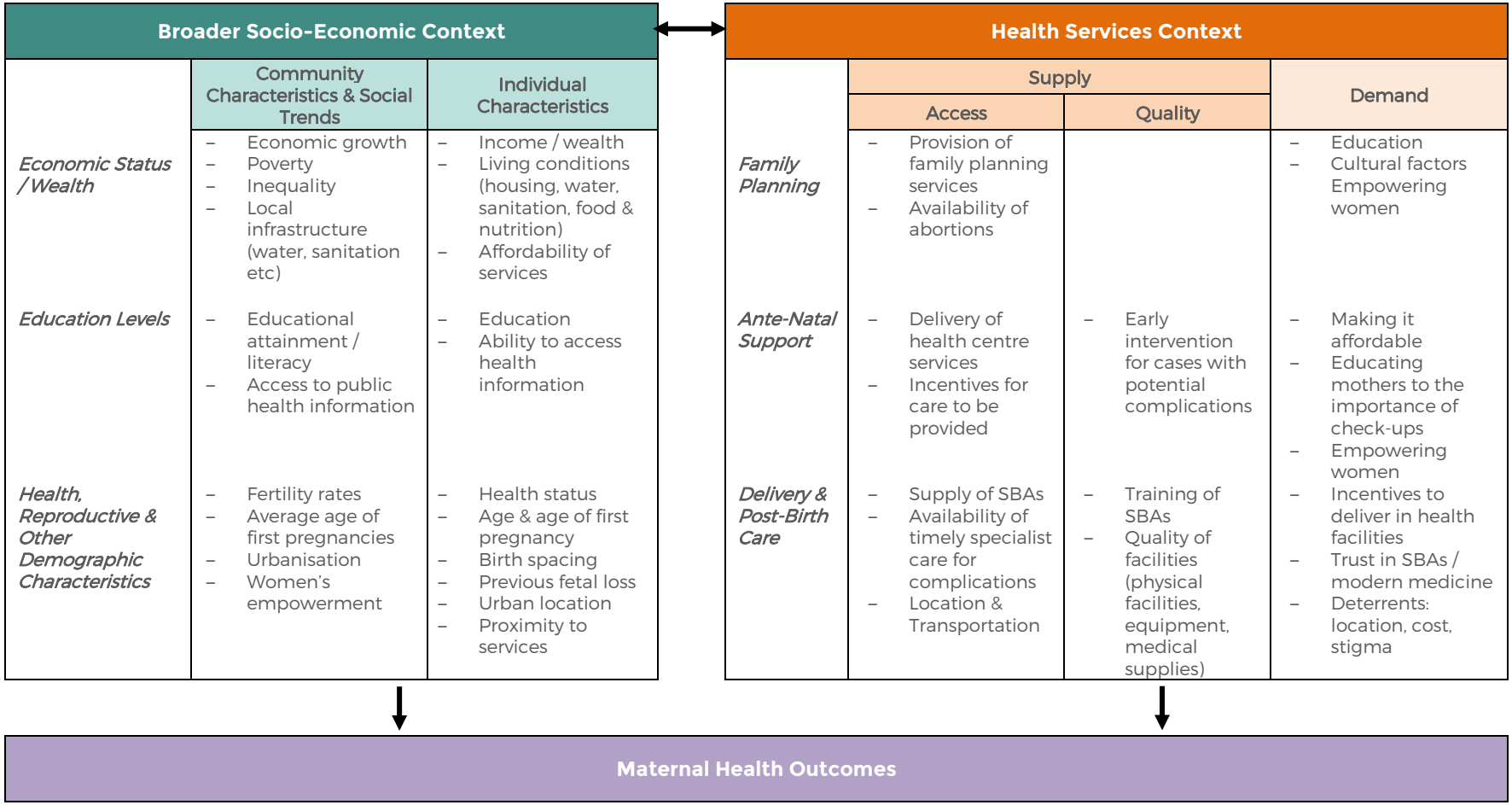


Figure 4. A Framework for Determinants of Maternal Health Outcomes

In the section to follow we present an overview of literature that focuses directly on determinants of maternal mortality, including key findings on the drivers of intermediate determinants. The overview is structured around the framework presented in Figure 5 above: determinants in the broader socio-economic context and then in the context of supply and demand for health services.

4.2 THE BROADER SOCIO-ECONOMIC CONTEXT

In the socio-economic context, factors such as economic status, levels of education and other demographic characteristics may influence maternal health outcomes at both an individual and broader (national/community) level. While evidence of the link between reductions in maternal mortality and general economic progress across time and countries is not clear (Loudon, 2000; Shiffman, 2000), large differentials in maternal mortality by income class exist within countries (see, for example: a comparison of rates within income quintiles in Tanzania, Peru and Indonesia in Ronsmans et al., 2006).

A clearer relationship is observed between measures of social progress such as educational attainment, fertility rates and women's empowerment and reductions in maternal mortality. For example, Chowdhury et al. (2009) find fertility rates and women's education to be strong predictors of maternal mortality in Bangladesh. Arifeen et al. (2014) use two rounds of the specific Bangladesh Maternal Mortality Survey, alongside six rounds of the national DHS, to decompose factors attributable to the decline in maternal mortality in Bangladesh between 2001 and 2010. While improved access to and use of health facilities were named as key contributors to the improvement, important socio-economic factors were also identified, including a reduction in high-risk births, improvements in women's education and decreases in fertility. Improvements with respect to overall income and poverty also occurred during this time, alongside major improvements in infrastructure (roads, bridges and communications).

Similar conclusions were drawn using recent evidence from Nepal. Shrestha et al. (2014) find socioeconomic and demographic factors played an important role, alongside improvements in the availability of maternal health care services. Fewer births in high-risk age groups and lower fertility rates were important factors in explaining the decline in Nepal's maternal mortality rate, as well as increased uptake of maternal health care services that came with higher levels of education of women and higher urbanisation rates. The effect of the role of declining fertility for Nepal was corroborated by Hussein (2011), as well as improvements in general health (anemia), wealth and education.While these factors would not directly affect the pregnancy, they set the socioeconomic context for a woman's pregnancy and birth experience.

Empirical studies of determinants of maternal mortality at the individual (woman) level are necessarily either prospective cohort studies following a large sample of pregnant women, some of whom are later observed as maternal deaths, or case-control studies, whereby "cases" of maternal mortality and "controls" of surviving mothers are identified within a defined population, often combined from composite data sources, to then retrospectively determine the causes of mortality amongst the "cases". Due to the onerous nature of collecting representative data in developing countries, many of these studies are restricted to cases-and-controls admitted to hospitals or health centres, observations of which are likely to be biased to particular demographics. As an alternative approach, "case" observations can be broadened to include pregnancy-related near-misses and maternal morbidities which could

potentially have led to mortality. This gives a much more frequently-occurring set of cases from which to sample

Dimensions of reproductive status – such as age, birth spacing and number of births (parity) – and aspects of health service access and use tend to dominate as important factors in studies identifying determinants of maternal mortality at the individual level. For example, in a large population-based case-control study of women across 16 rural districts in Pakistan, Midhet *et al.* (1998) find the age of the mother, first-births and pregnancies following a previous fetal loss are all important risk factors for mothers, and these risk factors are exacerbated in areas under-served by health facilities. Across three districts of India, Ganatra et al. (1998) match maternal deaths with survivors of similar pregnancy complications to identify socio-economic and health system factors attributable to deaths. While they also identified age of the mother and birth parity as factors, their results highlighted delays in seeking and reaching care as critical factors. Distance to obstetric care was also highlighted in a study by Scott et al. (2013) for Bangladesh and Indonesia. Importantly, distance was a factor for mortality amongst women who were assisted by health professionals, highlighting time to seek and access care is critical when complications arise.

4.3 HEALTH SERVICES CONTEXT

The vast amount of attention in public policy development and program development has been directed at strengthening child and maternal health services, as a 'continuum of care'. As noted in Section 3, it is the transformation of maternal health services that is given credit for the dramatic improvements in maternal mortality in much of the developed world in the first part of the 20th Century, hence the focus on expansion of services in recent decades.

Much of the empirical literature related to maternal mortality is focussed on factors affecting the uptake of health services (such as ante-natal care, SBAs and births in a health facility), under the assumption that use of such services reduces maternal mortality risk. This would, in part, be due to the limitations of obtaining an adequate sample of maternal deaths.

In this subsection we examine the evidence base related to maternal mortality and aspects of health services. Following the framework presented in Figure 5, attention will first be paid to research on "supply side" factors, before we look at some of the push factors that increase utilisation of the various services.

4.3.1 FAMILY PLANNING

It has already been observed that lowering fertility rates and improving the timing of births are significant contributors to improved maternal health. The health system can play a role in this by the provision of family planning and pregnancy support services. Anecdotally, there are examples of policy interventions or progams that can have dramatic effect on fertility rates, the most obvious being the one-child policy in China. However, a 1997 review of research into the link from family planning programs to reductions in fertility found surprisingly few cases of significant impact (Freedman, 1997). In trying to explain the decline in fertility in Indonesia in the 1980's, Gertler and Molyneaux (1994) found 75% of the fertility decline resulted from increased contraceptive use. While some of this increased use was due to greater education and empowerment of women, the existence of an effective supply chain for contraceptives was essential.

The availability of safe abortion services has been highlighted as another important factor in reducing maternal mortality. Around half of all abortions worldwide would classify as "unsafe", and these are a major cause of maternal mortality (Haddad & Nour, 2009). In a recent study based in the Matlab province of Bangladesh, Chowdhury, et al. (2007) exploit a natural experiment, in the form of non-random differences in service providers by geographical area. They found that access to safe abortion was an important factor for maternal health (along with better access to emergency care).

4.3.2 ANTE-NATAL CARE

WHO standards highlight the importance of care for women during pregnancy (Kerber et al., 2007). Care during this period can be invaluable in improving health through education and health promotion, and by providing an opportunity for detecting and managing complications. One would also expect that an effective antenatal package will also improve the chances of a supervised birth in a suitable birth facility, although we are not aware of evidence to support this. Evidence suggests that antenatal care needs to involve a minimum of four visits, appropriately timed, and with a set of areas that need to be covered, including measurement of height, weight and blood pressure, and testing of blood and urine (Villar et al., 2001).

A US-based study by Conway and Kutinova (2006) shows that antenatal care can significantly improve the health of the mother, but a study in Nigeria of women who received antenatal care but then delivered outside a health facility puts the importance of antenatal care for maternal health in question: the study shows the location of birth is a far more critical factor than access to antenatal care (Etuk et al., 2000).

4.3.3 BIRTH LOCATION AND SKILLED ATTENDANTS

The importance of skilled birth attendants for improving maternal and child health outcomes has been well recognised and promoted in the international community. Scott and Ronsmans (2009) review the evidence on the relationship between use of SBAs and maternal mortality. They first consider 10 cross-country studies, and nine of these conclude a decrease in the MMR associated with higher rates of SBAs. The tenth study by McClure et al. (2007) suggests there is a threshold of uptake of skilled attendants (40%) before a reduction in the MMR is seen – in most of the studies considered, less than one-third of births were attended by a SBA.

Scott and Ronsmans (2009) note the definition of SBA often includes a nurse and one study included TBAs, and location of birth varies across studies. Next they review a further 10 individual-level studies, some of which followed the outcomes of pregnant women, and others which were case-control studies. Again, there were variations in definitions of a SBA and birth location. The majority pointed to no effect or a significant *positive* relationship between *the* use of a SBA and death – that is, women who used SBAs were more likely to die than those who did not use a SBA. Scott and Ronsmans (2009) suggest this could be an issue of selection, or symptomatic of low rates of uptake of SBA.

There are important aspects of the provision of SBAs that impact on their effectiveness, including quality of training, proximity to clients, access to the necessary drugs and equipment, and coordination in the overall health system (NAoS, 2013; Ronsmans et al., 2009; Harvey et al., 2007). Research also highlights that location of birth is important to the

effectiveness of SBAs. For example, results in Badriah et al. (2014) suggest traditional birth attendants actually have fewer adverse outcomes than skilled attendants for births that take place outside health facilities, suggesting the benefits of SBAs cannot be experienced unless both the delivery takes place in a well-resourced health facility, and reaching such care is not too late. As mentioned earlier, Arifeen et al. (2014) suggest that the most important factor is improved access and use of facilities, and find improved access was facilitated at least in part by factors outside the health sector, such as development of roads and transportation.

The barrier of distance for uptake of health services such as use of SBAs (e.g. Scott et al., 2013; Chowdhury et al., 2006) and deliveries in facilities (e.g. Kumar et al., 2014; Masters et al., 2013) is well-evidenced. Relatedly, Hanlon et al. (2012) investigates the role of population density on maternal health coverage at a cross-country level, providing evidence to show that more dispersed populations experience greater financial burden in meeting multinational targets such as the MDGs.

4.3.4 INCENTIVES FOR QUALITY SERVICE DELIVERY

Continuing to address the complexities of service delivery, evidence suggests that simply providing the midwives and health facilities does not appear to lead to increases in take up of the services. In part this is to do with creating a demand for such services among women – we will discuss this further in the next sub-section. On the supply side, there remains issues of providing incentives for SBAs to provide the services for which they are trained. With the many obstacles associated with service delivery in a developing country setting, often additional incentives are required. Recent work has focused on using financial incentives that reward delivery of outcomes, over and above simply paying a midwife's salary. Recent studies examine the effectiveness of these financial incentives find some positive effect on the incidence of deliveries in health facilities – see Chaterjee (2005) for an example of a pilot program with for pay-per-delivery and referral bonus for midwives in Cambodia.

4.3.5 EMERGENCY CARE

A 2013 World Health Organisation systematic review of global causes of maternal deaths estimates that around 83% of maternal deaths in South-East Asia were a result of direct obstetric causes, while 17% were due to indirect causes, such as pre-existing medical conditions (Say et al., 2014). Among the direct obstetric causes, haemorrhage was most common (36% of direct causes), followed by hypertensive disorders such as eclampsia (17%) (Say et al., 2014). Interventions to prevent and treat these leading direct causes of maternal death are well-established, highlighting that the issue is with inadequacies in the availability, timeliness and quality of care (Goldenberg and McClure, 2015). The importance of emergency care for maternal mortality is illustrated in 100-fold higher mortality rates observed amongst a group of women in Indiana, USA, who received no maternal health care for religious reasons (see Kaunitz et al., 1984).

Mortality rates are highest at the time of birth and the 24 hours postpartum (Li et al., 1996), suggesting that interventions most effective at saving lives ought to ensure emergency care at the time of birth. In line with these observations, the United Nations promotes strategies to increase the presence of skilled attendants at births, and improve timely access to emergency obstetric care (NAoS 2013). Goldenberg and McClure (2015) insist that timely access to such care is crucial, and suggest that quality, basic emergency obstetric care be staffed with "*at least two skilled birth attendants available 24 hours a day, seven days a week*

assisted by trained staff" (Goldenberg and McClure, 2015, p. 6). Campbell and Graham (2006) argue that birthing location, and in particular, proximity to referral-level care, is also of paramount importance. Jowett (2000) argues that 48% of maternal deaths are preventable with access to essential obstetric care. Chowdhury et al.'s (2007) study on Matlab, Bangladesh found better access to emergency care to be a very important determinant of maternal health, even in the context of low numbers of SBAs.

4.3.6 DEMAND-SIDE FACTORS

While uptake of health services would normally be considered a demand-side factor, much of the evidence has been presented as a supply (access) constraint, so we will not repeat it here. Cultural issues and traditional practices can often serve as a hindrance to women taking advantage of health services even when they are available. For example, in some contexts, many mothers still prefer traditional birth attendants or home births, even when more qualified support and better facilities are available (see, for example, Titaley et al., 2010). A range of empirical studies have sought to understand these dynamics, and also to evaluate approaches to overcoming these behavioural obstacles. For example:

- Indicators of improvement in the empowerment of women have been shown to be a strong push factor for deliveries in health facilities (e.g. Nguyen et al., 2014) and the subsequent decline in the mortality rate (e.g. Hussein, 2011).
- Financial incentives have also been used in programs in Cambodia: voucher subsidies for health facility services led to a substantial increase in facility deliveries for poor women (Van de Poel et al., 2014). As well as improving maternal health outcomes, this is also associated with a decline in neonatal mortality.
- In 2005 the government of Nepal introduced financial incentives to women giving birth in public health facilities and health workers attending deliveries. Using propensity score matching methods to evaluate the program, Powell-Jackson and Hanson (2012) find a positive impact on program utilisation. They did not, however, investigate the role of the program in avoiding maternal deaths.
- McQuestion and Velasquez (2006) study the choice to deliver in "women-friendly" public emergency care facilities in Peru. Their study includes a program evaluation of community mobilisation through media, and an accompanying insurance scheme to address financial constraints to accessing care. Results show increased utilisation of emergency care facilities amongst the poor due to the insurance scheme, and an improvement in institutional quality measures among facilities in the treatment area.
- Since 2005 India has been undertaking a large scale Safe Motherhood program (Janani Suraksha Yojana), aimed at increasing the number of poor women who give birth in public or private health facilities. Like similar schemes in other countries, payments are made to pregnant women to cover transport and other expenses, and village health workers are paid a bonus for each woman they assist to attend a health facility. Evaluations (e.g. Joshi and Sivaram, 2014; Mazumdar et al., 2011) show sizeable, but varied, increases in the percentage of uneducated, rural and poor women who give birth in health facilities. It is not yet clear whether the program has had an effect on maternal mortality.

4.4 INDONESIA-SPECIFIC STUDIES AND ANALYSIS

In this subsection we highlight a few studies that have touched on determinants of maternal mortality in Indonesia. The messages align with the broader literature outlined so far, but there are some issues that emerge as particularly important in the Indonesian context, ranging from family planning through to quality of care and the need to stimulate demand.

4.4.1 FAMILY PLANNING

As noted in section 4.3, early work by Gertler and Molyneaux (1994) have found declines in fertility through the 1980s due to increased contraceptive use, and as a result of greater education and empowerment of women, and an effective supply chain for contraceptives. Later qualitative studies highlight the continuing need for involving women in their reproductive choices, especially at the community level (see Cameron and Schaner, 2013).

Abortion is a critical issue in Indonesia. It is estimated that in 2000, there were approximately 2 million abortions (Sedgh and Ball, 2008), many of which would be classified as unsafe, especially since abortion is illegal, with the exception of a few particular conditions. Based on the international evidence, this reality alone could be a significant contributor to maternal mortality. Apart from a few specific case studies, though, this is an area where there has been little rigorous research, and it appears only slow progress in achieving changes in policy or attitudes.

4.4.2 ANTE-NATAL CARE

The Indonesian Ministry of Health follows the WHO guidelines in recommending four antenatal visits during pregnancy (MoH, 2012). While a fairly large proportion (88%) of pregnant women receive the full quota, only 74% meet the recommended schedule of visits (1 in the first trimester, 1 in the second trimester and 2 in the final trimester) (BPS, 2013). Cross-tabs of variables related to antenatal visits against socio-economic and geographic characteristics of the woman highlight a substantial rural-urban divide in utilisation rates, as well as differences by wealth, age, education and signs of complications (see BPS, 2013).

Titaley, Dibley and Roberts (2010) use 2002/3 and 2007 DHS data to investigate the underutilisation of antenatal care in Indonesia. The empirical models are built on a behavioural framework adapted from Andersen (1995), whereby factors affecting utilisation of antenatal care are grouped into four categories: external environment (location), predisposing factors (socio-demographics and health knowledge), enabling factors (e.g. distance to health services, availability of money and transport) and need factors (e.g. signs of complications). A hierarchical modelling strategy with backwards elimination was then employed to identify significant factors within the four categories and estimate a logistic model for the odds of underutilisation of antenatal care. The findings corroborate those of the cross-tabs in BPS (2013): higher odds of underutilisation were found for mothers living in rural areas, particularly those outside of Java-Bali, those with low wealth and low education. Other significant factors include birth order and spacing, degree of media exposure, and enabling factors including availability of money, transport and distance to services. This suggests that antenatal care coverage could be improved through education campaigns targeted at low income households and by improving access to services.

Frankenberg et al. (2009) use three waves of the Indonesian Family Life Survey (1993, 1997 and 2000) to examine how improved access to health care services (through roll-out of the

Indonesian village midwife program) affected uptake of antenatal and delivery care. Since around one-third of sampled villages gained a midwife between the 1993 and 1997 surveys, Frankenberg et al. (2009) exploit the variation in availability of the village midwife program and the panel nature of the data to examine maternal health service utilisation of pregnant women before and after the arrival of a midwife to the village. In logistic regressions they find positive effects of the village midwife program on receipt of antenatal care and delivery with a health professional, but these effects wash out in models that allow for individual (woman) fixed effects i.e. models that compare the behaviour of the same woman over time (before and after the program).

4.4.3 SKILLED BIRTH ATTENDANTS

With the village midwife program a cornerstone of Indonesia's maternal health program, there are several studies examining the uptake and success of the program, in particular exploring why the MMR is still high, even in the presence of such a major investment in expanded services. The core goal of the village midwife program was to reduce the MMR, to be achieved through increasing the uptake of SBAs, particularly for the rural poor. A hallmark of the program was that the midwives would be locally based, within villages, and be seen as part of the community (Makowieka et al., 2007). Births would, in many cases, continue to take place in the pregnant woman's home, or the home of the village midwife. This approach would allow women to continue to give birth in a familiar environment, and help overcome potential distrust of modern approaches to deliveries.

Did the village midwife program increase uptake of SBAs (coverage)?

Hatt et al. (2007) pool four waves of DHS data, covering births over the period 1986-2002, to assess the targeting accuracy of the village midwife program, that is, whether the program increased uptake of SBAs for the poor. Since the pooled data spans 17 years, the data shows a great deal of change in the socio-demographic profile of Indonesia: more areas were classified as 'urban', the average levels of education and wealth increased, and the country was hit by the 1997 Asian financial crisis. While rates of SBA utilisation and births in health facilities also increased, changes in the economic and demographic profile were found to explain part of the trend. Most notably, the highest rates of change in SBA utilisation were experienced by women in the lowest wealth quintiles and those giving birth in rural areas, suggesting that the push for use of SBAs did indeed reach the rural poor. Nonetheless, Hatt et al. (2007) point out that such observed increases in use of SBAs does not infer that these SBAs were adequately trained or equipped.

The analysis by Hatt et al. (2007) also considered changes in the rates of birth by caesarean section. These rates almost exclusively increased among women in the richest quintile and the highly educated, and were dampened by the financial crisis. This highlights the inequities that persist in access to emergency obstetric care.

Baird et al. (2011) evaluate the safe motherhood program rolled out in Indonesia's Central Java and East Java provinces between 1998 and 2003. The program aimed to improve quality of maternal and child health care services and to stimulate demand for such care through educational awareness. Based on DHS data from 1990-2005 aggregated to province level, combined with data collected through the UNICEF Maternal and Child Survival Development and Protection program for the intervening years, their evaluation utilised a Difference-in-difference approach, with other provinces in Java serving as controls. Outcomes of interest were: unmet contraceptive need, deliveries with a trained health professional (nurse, midwife,

GP etc.), the fertility rate, teenage pregnancy rates, and rates of infant and child mortality. Covariates included year-and-province-level economic and demographic data and well as an indicator for program participation and amount of funding received through the program. The results of Baird et al. (2011)'s analysis show that while rates of deliveries with trained professionals improved during the sample period, these provincial level improvements were found in both the treatment and control provinces. This suggests overall economic and demographic changes played a majority role in the improvements. According to the results, the only significant impact of the safe motherhood program was an improvement in the under-five mortality rate. Considering two districts in Banten province, Java, as part of an Initiative for Maternal Mortality Programme Assessment (IMMPACT) study, Ronsmans et al. (2009) identify determinants of maternal mortality and assess the efficacy of the midwife program in increasing uptake of SBAs. The study uses the same data as Scott et al. (2013): a population-based survey of women from 150 villages who had given birth in 2004-2006, combined with maternal death data for these villages collected through informants, thus forming a case-control study.

The results show an alarming difference in maternal health access, use and outcomes by wealth. At the time of the study, Indonesia's national DHS-based MMR was 307 deaths per 100,000 live births. In the sample, the overall rate was 436, and this differed substantially by wealth quartile: from 706 among the poorest, 417 and 423 and among the middle quartiles respectively, and only 232 among the richest quartile. A similar pattern of magnitudes are seen by location: remote 633, rural 446 and urban 270. Births with a health professional ranged from 10% in the poorest quartile to 71% in the richest quartile. Overall there were very few births with the assistance of doctors (10%), and even fewer births by caesarean section (1.2%). Mortality rates were higher amongst those who gave birth with a SBA, which Ronsmans et al. (2009) suggest is due partly to adverse selection, and partly due to lack of training in emergency care. Between the two districts there were 4 hospitals and 66 health centres for 1.1 million residents, yet the vast majority of births (83%) took place at home. While the number of births occurring outside the home increased with wealth, the majority of these were taking place in the midwife's home rather than a health centre, clinic or hospital. In the wealthiest quartile, close to 50% of births occurred outside the home, of which around 70% took place in the midwife's home. In light of the disparities by wealth, Ronsmans et al. (2009) argue that it is cost and access that form the greatest barrier to professional care, rather than attachment to traditions.

Heywood and Choi (2010) argue that the main issue with low utilisation rates of SBAs has to do with health system performance, or quality. They assess district level health system performance after decentralisation by looking at DHS 2002/3 and 2007 data on 10 districts in Central and East Java provinces (safe motherhood project areas). Comparing differential rates of utilisation of antenatal and delivery care in each district, they argue an increase in availability of private facilities led to increased births in health facilities, but little change in use of public facilities. They conclude that there has been little improvement in health system performance, characterising Indonesia's health system as fractured, which results in a system that is difficult to manage, lacking in quality and accountability.

A related study by Badriah et al. (2014) looks at differences in outcomes for skilled vs unskilled delivery in home deliveries, using the 2007 DHS data. Using a logistic regression approach they found inferior outcomes for skilled attendants, and argue on this basis that skilled attendants need more training. However, there some complicating factors in this conclusion: first, the benefits of an SBA may largely be lost in a home delivery environment where little additional equipment is available to the skilled professional. Secondly, the study takes no

account of adverse selection, whereby skilled attendants may well be called in for a home delivery when difficulties arise, so the statistics may suggest more adverse outcomes, this could not be attributed to the difference between SBA and TBAs.

Titaley et al. (2012) pool 1994-2007 waves of DHS data to also show birth outcomes are no better for home-births assisted by a SBA compared to an unskilled provider. Their focus is on early neonatal mortality, but highlight the same shortfalls around the quality and skills of village midwives. They also highlight the geographical differences in rates of facility-births and access to emergency care, and call for improvements in the referral system and greater coordination between midwives, TBAs and community health workers.

As part of an IMMPACT project, Makowiecka et al. (2008) assesses the distribution of midwives in two districts of Banten province on Java. The study interviewed 98% of registered midwifery practitioners in the districts (737 midwives and nurses with midwifery responsibility) concerning their training, employment contract and workload. This data was combined with information on the population, location and health facilities of the 708 villages in the two districts. While overall the midwife-to-population ratio in these districts is consistent with the national level, only 27% of villages classified as rural or remote had a resident assigned midwifery provider, compared to 44% for urban villages. Resident midwives reported a median of 20 days per month on clinical work in their village, while non-resident assigned midwives worked 4-10 days in rural and remote locations. Furthermore, the length of tenure of a midwife in rural and remote villages was far less than that of midwives in urban areas. Overall, 79% of midwives had qualified under only the 1-year diploma course, and in some villages nurses held the position of midwifery provider due to an absence of any assigned midwife. In their recommendations, Makowiecka et al. (2008) argue for facility-based births as a more efficient, effective and sustainable policy to pursue. Further, Chowdhury et al. (2006) demonstrate that a shift towards facility-based births can be achieved even when there is a cultural attachment to home-births, however the shift may create short-term equity issues that need to be addressed.

Also as part of an IMMPACT project, Scott et al. (2013) considers the link between distance to a health facility, consulting a health professional and maternal mortality in Indonesia (Banten, Java) and Bangladesh (Matlab). The Indonesian data involved (as described earlier) a population-based survey of women from 150 villages who had given birth in 2004-2006, combined with maternal death data for these villages. The Bangladeshi data was taken from a population-based cohort study that recorded all pregnancies and deaths within a defined service area between 1987 and 2005. Results from a logistic model showed that distance to a health facility is an important factor in whether a birth is supervised by a SBA. To consider the effect of distance on the odds of dying, models were stratified according to whether or not a SBA assisted with the birth. Results show that among women who chose to utilise a SBA, those living further away from the health centre were actually more likely to die. No effect of distance was seen for those who did not utilise a SBA. Scott et al. (2013) relate these findings to the '3 delays' concept of Thaddeus and Maine (1994): delay in deciding to use care, delay in care arriving/reaching care, and delay in receiving adequate care. We note that this study only includes Java, and a study of genuine geographic isolation would need to consider the outer islands, where the story could be even worse. Once again, the study points to issues of midwife quality and the lack of professional support for village midwives.

In support of this finding, Shankar et al. (2008) provide evidence for the failure of the midwife program to deliver the anticipated improvements in MMR. Their conclusions are very similar to Scott et al. (2013): reasons rest primarily on inadequate quality training and lack of

experience of SBAs, together with a lack of access (transport and financial) to emergency care and other referral facilities.

4.4.4 CO-ORDINATION OF CARE

A couple of recent international comparisons highlight important gaps in service delivery in Indonesia, relative to comparable neighbours, especially in hospital and emergency care. A 2006 study by Ronsmans and Graham highlights that Thailand, Malaysia and Sri Lanka all achieved large reductions in their maternal mortality rates through long-term investment in midwifery training and referral hospitals alongside free care and supportive systems. They contrast this with Indonesia, which while strong in numbers of SBAs, have weak training, and access to very limited referral services.

Van Lerberghe et al. (2014) provide an overview of the experience of countries which had deployment of midwives as their core strategy - Burkina Faso, Cambodia, Indonesia, Morocco. They note that all were late to pay attention to quality of care. The research also points out the need to focus on an overall network of facilities, not just midwives. Their analysis presents a very convincing criticism of Indonesia situation, and a prescription for strengthening and coordination of health systems, in particular, the need for high coverage of midwifery to be supported by timely and competent hospital care.

4.4.5 DEMAND SIDE FACTORS

There is a range of qualitative evidence exploring aspects of the demand side of maternal health care. For example, Titaley et al. (2010), in a qualitative study among rural women from West Java, found many still had a preference for traditional birth attendants. Reasons given included the obstacles of distance to health facilities or lack of access to health facilities generally, and a belief that complications are unlikely. A number of participants also mentioned that the village midwife was frequently 'out of town'.

Hay (1999)'s qualitative study in Lombok found services were not well received among many women, in part because of issues of lack of trust and communication, and lack of awareness of local cultural sensitivities. Along similar lines, Achadi et al. (2007) studied the willingness of women to use SBAs for their births, based on surveys of midwives in West Java. They found variation in women's willingness to rely on SBAs. The level of education and wealth of the mother had a significant effect on uptake, as did the midwife's duration of service in the village, and professional status, highlighting again the importance of building trust in the services being provided.

It appears that while there has been a significant expansion of midwives through the various government programs, it is not clear that they were sufficiently trained or resourced to bring much improvement in quality of service, over and above what was already in place through TBAs. It is not surprising, therefore, that women are unpersuaded about the benefits of such services. Demand is likely to grow once there are perceived to be real benefits. In addition, international evidence (Cameron and Schaner, 2013) suggests that there are a number of important initiatives that could be undertaken at the community level to improve maternal health and to build confidence in the health system.

In summary, notwithstanding significant investments by the Indonesian government in the provision of village midwives and other initiatives, Indonesia's maternal mortality rate has not fallen to the extent hoped. Existing studies suggest that this is due to a combination of

factors, including insufficient training of midwives, poor coordination of care and an unwieldy referral system, lack of investment in health facilities and a lack of access in more remote areas. The observed relatively low quality of village midwives skills may have served to weaken the demand for their services.

The research that is to be completed as part of this project will seek to quantify the role of key determinants of maternal death. The next section summarises the methodologies used in the above discussion and sets directions for the project's research.

5 METHODOLOGY FOR DETERMINING MAIN DRIVERS OF MATERNAL MORTALITY

A very important aspect of the research agenda around MMR is identifying the relative importance of different factors. This is critical to priority setting for investing in further development of the health sector, yet a surprisingly small number of studies have quantified the role of the key determinants of maternal health. This likely reflects that maternal deaths, although occurring at much higher rates in developing countries than developed countries, are still relatively rare events – for example, an estimated 0.21% of live births resulted in maternal death in Indonesia in 2013. This results in very small numbers of maternal deaths being observed in even large random samples of the population. This presents challenges for analysis of determinants. Further, much of the work in this area is conducted by public health or medical researchers. The resulting papers thus tend to focus on the immediate medical causes of death – e.g. obstructed labour, postpartum haemorrhage – rather than the more indirect causes such as socio-economic disadvantage and the availability of infrastructure such as health clinics, hospitals and the transport infrastructure required to make these accessible. Further, given the need to track progress against the Millennium Development Goals, a great deal of scholarly effort has been focused on identifying and verifying trends and changes in maternal mortality rates over time, as opposed to identifying the drivers of such change.[12]

The obvious approach to consider in quantifying the relevant factors influencing maternal mortality is some kind of multivariate model, exploiting regional variations in health inputs and other socio-demographic factors to estimate marginal effects. The existing literature that seeks to examine such drivers most commonly estimates logistic regressions with, given the scarcity of observing maternal deaths in random sample data sets, the dependent variable often being a measure of utilisation of health services, rather than maternal deaths per se. Titaley et al. (2010) for example, examines underutilisation of antenatal care services in Indonesia using the 2002 and 2007 DHS data. They relate underutilisation to factors including broad geographic regions (Java/Bali/Sumatra/Eastern Indonesia; rural/urban), maternal age, marital status, household wealth and parental education and a number of variables reflecting health knowledge and pregnancy complications. They find that socio-economic variables explain more than half the variation in underutilisation.

[12] *Cross-country and cross-regional studies are helpful at highlighting regional differences, but it is difficult to draw definitive conclusions from these studies because there is a large amount of unobserved heterogeneity that makes it difficult to clearly identify the determinants of change. Here we focus on studies that utilise individual level data.*

An alternative approach to dealing with the small number of observations of maternal death is to use case-control data. As explained above, this involves identifying all maternal deaths in the targeted region and then appending these data with a random sample of births that have not resulted in death. The logistic regression is then estimated over this combined sample. This overcomes the difficulty of observing maternal deaths in the data but collection of the case data is costly and time-consuming and so only logistically feasible over a limited geographic range. These studies provide an important source of information on the causes of maternal death but are unable to provide a nationally representative analysis of the issue. In Indonesia, case-control data has been assembled for the province of Banten in West Java. Achedi et al. (2013) estimate logistic regressions using these data with maternal death as the dependent variable and distance to a health facility as an explanatory variable and find that the probability of dying increased with distance from a health centre for those who were assisted by a health professional, but not for those who were not.[13]

Having overcome the small sample problem, approaches to modelling maternal mortality such as those described above face a number of further challenges. The challenges chiefly reflect the endogeneity of a number of the potential explanators. That is, in addition to affecting the probability of maternal death, the explanators may also be determined by the riskiness of the birth. For example, women facing a more risky birth (as a result of their age or unobserved pre-existing health conditions) are more likely to seek the care of a health professional. Such an association makes it difficult to identify the true effect of seeking such health care. Similarly, program placement can be endogenous with health services being more readily available in high risk areas because of higher prevalence of complications in the past. [14]

Having data at two points in time and examining changes across time can help overcome this problem. We are aware of only one study that examines determinants of changes in maternal mortality over time. Arifeen et al. (2014) combine two waves of the Bangladesh Maternal Mortality Survey with six waves of the Bangladesh DHS to examine factors associated with changes in maternal mortality over time. They use multivariate Poisson regression to examine the key determinants of the risk of maternal death. They conclude that the observed drop in mortality risk was mainly due to improved access to and use of health facilities. They however go a step further and decompose the improvement in Bangladesh's MMR over time and estimate that 52% of maternal deaths that would have occurred in 2010 were averted because of decreases in fertility and risk of maternal mortality. By looking at the change in maternal mortality over time and the use of municipality-level averages for service use by maternal survivors, they deal with the potential endogeneity of both individual health service utilisation and health service placement. This is the most methodologically sophisticated and, in our view, useful analysis of the drivers of maternal mortality to date.

[13] It is difficult to interpret the findings of Achedi et al. (2013) as they are conditional on seeking health care which is itself a function of the risk of the birth. This circularity, or endogeneity, is discussed further below.

[14] The endogeneity of health care will bias the coefficient on health care downwards so understating the benefits of such care.

In some cases a "natural experiment" allows causal factors to be identified. For example, Chowdhury et al. (2007) exploit a (non-random) natural experiment in Bangladesh's Matlab district to assess the efficacy of strategies to increase access to skilled birth attendants and emergency obstetric care. The natural experiment occurred because of varied health service providers, and therefore varied maternal health interventions, by geographical area within the district. While increased access to emergency care did contribute to the decline in MMR, factors outside the health sector such as improvements in female education made a major contribution.[15]

[15] *In other examples of multivariate modelling approaches, Hussein (2011) tests the robustness of Nepal's improvement in MMR and estimates district level MMRs as a function of the fertility rate, human development index, a gender empowerment index as well as average rates of anaemia. Shrestha (2014) then predicts the probability of a mother delivering in a health facility and having a professional in attendance as a function of socio-economic characteristics.*

6 RESEARCH AGENDA

The existing evidence points towards a number of important determinants of maternal health in Indonesia – physical and financial access to health facilities, quality of health services, attitudes to seeking professional care – but so far evidence is patchy and conclusions somewhat speculative. The steep gradient for the impact of socioeconomic status (even when the woman's geographic location is controlled for) suggests that cost and/or attitudes and education play a role. Systematic investigation of the evidence is needed to confirm the indicative findings. We propose such an investigation. This research will consist of two main steps:

6.1 MEASUREMENT

Prior to an examination of the determinants of maternal mortality in Indonesia, we will first seek to better understand recent changes in the maternal mortality rate calculated for Indonesia, building on the analysis presented in this paper. As noted in Section 2, there are several approaches to estimating MMR using available data. These give widely varying estimates, and can have large standard errors associated with them. While estimates based on sample proportions in a DHS-type survey may be the simplest to understand and compute, they are not always the most reliable. At the same time, the model-based approaches produce estimates that cannot be replicated with the information provided. This means there is no opportunity to reconcile differences in the measures, and for decision makers to assess the relative merits of the different estimates. Given the wide disparity in the most recent estimates of Indonesian MMR, from 190 to 359, it is important to the ongoing debate to make sense of these differences and to obtain some consensus as to how best to measure progress.

We will begin with a close examination of the DHS data. Policy-makers relying on estimates from these data need to better understand how few observations of maternal death the calculated maternal mortality rates rely on. We will clearly document this. We will also re-estimate the MMR with the 2012 DHS using the fertility rate of ever-married women in the denominator so as to be completely consistent with the calculations from previous years. From these two exercises we will be able to conclude with what degree of confidence maternal mortality has actually recently increased in Indonesia.

6.2 DETERMINANTS

We will then begin a systematic investigation of the drivers of maternal mortality in Indonesia, with a focus on socio-economic and geographic, rather than health-related, determinants. To overcome the research challenges outlined above we propose the following:

6.2.1 MEASUREMENT AND DATA SOURCES

The DHS has been the source used to date to calculate maternal mortality rates in Indonesia. As discussed above, this means relying on a relatively small number of observed deaths in the data to draw conclusions. We instead propose using:

2010 INDONESIAN CENSUS

We will explore using the 2010 Indonesian census as the primary data source. The Indonesian census aims to provide information on every household and individual in Indonesia. In 2010 it included a question on whether there were any deaths in the household in the previous 12 months and for deaths of females over the age of 10, asked whether the woman died either while pregnant, during delivery or in the two months post-delivery. It thus enables the identification of pregnancy-related deaths. Our ability to use these data for the analysis will depend on whether the number of deaths reported appears reasonable in comparison to other sources.

2011 PODES

The PODES is a census of every village in Indonesia and is conducted every 3 years. It provides detailed information on health services within the village as well as distance to a wide range of health facilities when there is no such facility within the village and ease of access to such a facility. It also provides information on availability of medical professionals (including mid-wives) and the range of services provided. The PODES 2011 also collected information on how many women died in the village in the previous year while pregnant, during delivery or in the 40 days after delivery. Preliminary calculations suggest that the total number of deaths reported in this source is broadly consistent with the nation's maternal mortality rate. To our knowledge, the PODES has not previously been used to examine maternal mortality. The maternal mortality question was only asked in the 2011 round of the data (it does not appear in the 2014 questionnaire) and it may present a valuable opportunity for understanding the relationship between maternal death and proximity to health services and other factors. Further, a comparison of the PODES data, the DHS and the census data will enable an assessment of the reliability of the data sources. We plan to merge the PODES to the census data using village identifiers.

2005 INTERCENSAL SURVEY (SUPAS)

The intercensal survey is conducted every 10 years, between census years. It surveys approximately one million households and is designed to be representative of the nation. In 2005 it asked the same question of pregnancy-related deaths as in the Census. An initial tabulation of the data however reveals only 140 maternal deaths are reported. We may use this as an additional supplementary source of data.

6.2.2 METHODOLOGY

We propose using the 2010 census data to estimate multivariate (logistic or probit) models of the risk of maternal death on the sample of all women who were pregnant in the 12 months prior to the census. We will control for the observed socio-economic characteristics of the household. We will merge the PODES data to the census data and so will be able to use the information on distance and availability of health services and health professionals as additional explanatory variables. If the SUPAS data and census data appear relatively consistent, we may try estimating regressions looking at changes over time. It is more likely however, that we will be working with the census as a cross-section. In this context, our focus will be on explaining geographic variation in maternal mortality across Indonesia. We will seek to decompose the differences in maternal mortality between Java and other island

groupings into components, including those associated with socio-economic conditions and those associated with availability of health services. That is, we will use a methodology similar to Arifeen et al. (2014) but instead of seeking to explain changes across time, we will be seeking to explain geographic variation across Indonesia. In doing this we will be able to answer questions such as: Is maternal mortality high in Indonesia as a result of its unique disparate geography? What percentage of the difference in maternal mortality between Java and the Outer Islands is due to greater distances to clinics off Java? If access to health clinics was the same in Papua as in Java, what would Papua's maternal mortality rate be? If levels of education amongst women in the Outer Islands were the same as in urban Java what would the maternal mortality rate be? The analysis will thus provide information not before available on which are the most important determinants of maternal mortality in Indonesia. This should be of interest to researchers and those designing policies aimed at reducing maternal mortality in Indonesia and elsewhere.

6.2.3 PROVISO

The ability to follow the research plan as outlined above will to some degree depend on what we find once we start working with the data. We already have access to the PODES and the SUPAS and have recently been granted access to the Census. We may also apply to use the Ministry of Health's Riskesdas data for 2007, 2010 and 2013. While not collecting information on maternal death, this data set collects a wide array of information on births, utilisation of maternal health services and maternal health more generally, and so may be of use as a supplementary data source.

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