Summary Tables
Banten II Study Result

CFW FPH UI & MCSP
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I. Introduction

Background

Indonesia has been working for many decades to reduce maternal mortality. The country has been focusing on maternal and newborn health (MNH) programs, strategies, and priorities since the 1980s, i.e. through the implementation of Making Pregnancy Safer (MPS), village midwives, and many other steps. However, Indonesia is still facing a situation wherein the MMR remains very high and where little reduction has been seen over the last decade (IDHS 1994, 1997, 2002-2203, 2007, and 2012), in spite of a strong commitment to reduce mortality. The IDHS reported that the MMR may have even increased from 228/100,000 live births in the year 2007 to 359 in 2012. No clear conclusions can be made about whether the MMR increased, decreased, or remained stagnant. Information on the characteristics of maternal deaths, including the patterns of causes of maternal deaths is also very limited. Understanding the characteristics of maternal deaths as well as identifying a suitable method to measure it are instrumental to program planning to reduce maternal mortality. While efforts have been made globally to obtain information about the numbers and causes of maternal deaths, many countries, including Indonesia, have had challenges with accurately measuring the MMR, mostly due to the absence of functional civil registration systems for routinely recording vital events including births and deaths

Newborn mortality in Indonesia also remains a significant public health issue. Given the absence of robust civil registration in Indonesia, the only data source that provides an estimate of the newborn mortality rate is the Demographic and Health Survey. The rates, however, are only representative down to province level, and thus, do not capture variations across districts within the same province. However, the district level government has the authority to design and implement health programs according to their local conditions and needs. Thus, it is imperative to have district-level representative mortality rates as a basis to determine health sector priorities. Unfortunately, established methods to measure newborn mortality rates in other countries regionally and globally are also lacking and are even less developed than methods used for estimating maternal mortality rates.

In 2006, the Initiative for Maternal Mortality Programme Assessment (IMMPACT) project at the University of Aberdeen, in collaboration with the University of Indonesia's Center for Family Welfare (PUSKA-UI), conducted a study in Banten Province, Indonesia that used an informant-based method for identifying maternal deaths - Maternal Deaths from Informants/Maternal Death Follow on Review (MADE-IN/MADE-FOR). More than a decade has passed since these estimates were first made so the primary aim of this activity was to replicate the approach to assess whether MMR has decreased and whether there have been any improvements in the quality of routine data related to maternal deaths. The second aim was to assess the feasibility of adapting this method for use in estimating newborn mortality.

Research Questions

1. Has the maternal mortality ratio (MMR) in Banten Province, Indonesia (Serang municipality, Serang district, and Pandeglang district) changed over time?
2. What are the background characteristics of women who die while pregnant or within 42 of termination of pregnancy in Serang municipality, Serang District and Pandeglang District?
3. What are the determinants of maternal deaths (including cause of death, location, and context of death) in Serang municipality, Serang district, and Pandeglang districts?

4. What are the background characteristics of maternal death cases that are missed by the existing health information system?
5. Has official reporting between the health centers and districts health offices (DHO) using the existing health information system of maternal death improved?
6. Has the underreporting of maternal deaths in health facilities s improved in the study districts?
7. Has the coverage of the maternal deaths cases captured through MADE-IN/MADE-FOR method between the Banten I and II studies remained similar?
8. What are the feasibility and sensitivity of adapting the MADE-IN/MADE-FOR methodology (NODE-IN/NODE-FOR) in measuring newborn mortality in a rural and urban setting?

II. Methods

This study employed four data collection procedures: (1) MADE-IN/MADE-FOR method for ascertaining community level maternal deaths; (2) a population-level survey for assessing the number of live births and characteristics of women with recent births; (3) the Rapid Ascertaintment Process of Institutional Death (RAPID) method identify unreported maternal deaths within health facilities; and (4) review of verbal autopsy forms of maternal deaths at health centers and district health offices.

For neonatal deaths, the study employed three data collection procedures: 1) Qualitative data was collected through focus group discussions (FGDs) with village midwives, health volunteers (kaders)[1] and heads of neighborhood unit (head of RT) to explore perceptions on classifications of neonatal death, especially related to stillbirths and to obtain information to improve NODE-IN/NODE-FOR data collection tools; 2) assess the sensitivity and feasibility of using the NODE-IN/NODE-FOR methodology to capture stillbirths and neonatal deaths; and 3) review existing neonatal death and stillbirth recording and reporting health information system documents at all levels (village, health center, DHO and hospital) to provide additional sources of data for capture and re-capture analysis.

Data Analysis

1. Estimating the MMR

Our main objective was to estimate the maternal mortality ratio (MMR), which is defined as the number of maternal deaths per 100,000 live births. MMR is calculated as number of maternal deaths divided by number of live births for the same reference period X 100,000. The number of maternal deaths is derived from the MADE-IN/MADE-FOR data.

A two-level adjustment was used to estimate the numerator (number of maternal deaths). The first adjustment used data from a random sample of villages where the two informant networks (kaders and RT heads) gathered data. Linked data on deaths from the two different informant networks enabled us to use a capture–recapture method to gauge misreporting, estimate the proportion of maternal deaths identified, and re-estimate the true total number of maternal

[1] Kaders are health volunteers who assist health providers in conducting health integrated post activities (known as Posyandu). Kaders are usually females, literate and active members of the community. While head of RTs are also volunteers, they may get some 'benefits' from the government. They are selected by the people to lead the neighborhood unit. They are usually males, respected members of the community and literate. Neighborhood units, or RTs, are the smallest community unit within the village, which consists of approximately 40-100 households. There are usually 10 – 20 RTs in a village.

deaths in the area (Qomariyah et al, 2010). The second adjustment, based on the estimate of total maternal deaths in those areas, calculated the probability of the kader network in capturing cases then used to adjust the number of maternal deaths in areas where only the kader network was involved.

For the denominator, the expected number of births in each of three geographical strata (urban and rural in each district and remote area in Pandeglang) were estimated based on the population in each village (projection from the 2010 national census), and the stratified crude birth rates estimated from the population-based survey.

2. To describe the characteristic of maternal death cases

Descriptive analysis was done to describe the characteristics of maternal death cases gathered through MADE-IN/MADE-FOR. The maternal death cases that were analyzed were those which were confirmed as maternal deaths from the MADE-FOR process (the home visit).

In addition, the RAPID approach was used to obtain information on characteristics of maternal death cases that occurred in hospitals.

3. Maternal death determinants analysis

A case–control analysis was used to examine the determinants of maternal mortality. Cases were defined as all maternal deaths that occurred between July 2015 and June 2017 and were obtained from the MADE-IN/MADE-FOR data, while controls were defined as all recent births in the last 2 years obtained from the population survey, the same time period as MADE-IN/MADE-FOR. Using logistic regression, with allowance for village clustering and stratification, we examined the associations between maternal deaths and wealth quartile (asset ownership), maternal education, type of health insurance, district, urban or rural residence, and the presence of a health professional during birth or near the time of death. We calculated crude and adjusted odds ratios (ORs) with their 95% confidence intervals (CI) and excluding women who died during pregnancy when analyzing delivery history. The cause of maternal death was analyzed using InterVAM (WHO InterVA-4 4.04, issued on 6th June 2017). We used Epi-data for data entry process and statistical analyses were performed using Stata 15 (College Station, TX).

4. To assess the characteristics of maternal deaths that were missed by the routine health information system

The maternal deaths identified in the district health office (DHO) routine reporting system were matched with deaths identified through MADE-IN/MADE-FOR. The criteria used for matching included the woman's name, her husband's name, her address (sub-district, village etc.), date of death, and pregnancy status at the time of death. Matching was done manually by listing the cases in MS Excel and sorting by the criteria.

To measure the coverage of the DHO routine reporting system, the capture re-capture technique (Laska, 2002) was used to estimate the total number of cases including those missed by both MADE-IN/MADE-FOR and DHO routine reporting system.

Descriptive analysis was done to describe cases missed by the DHO routine reporting system. Bivariate and multivariate analyses were also done using logistic regression models, adjusting for clustering at the village level. The analysis was limited to related variables included in the MADE-FOR questionnaire. The variables included were the characteristics of the women (age at death,

their area of residence at death, the district, their wealth quartile at death, and health insurance schemes they had), their history of antenatal care visits (e.g. the frequency, the time of the last ANC visit for their last pregnancy), their place of delivery, their pregnancy status when they died, place of death and cause of death.

5. To assess the completeness of the existing health information system in recording maternal deaths

The Banten I study found that the existing health information system captured only about one third of the maternal deaths identified through MADE-IN/MADE-FOR. The analysis conducted for question number 4 provided a new estimate of the coverage of the existing system. These results were compared to understand whether the quality of maternal death data has changed between the two studies.

6. To assess the improvement in the health facilities maternal death reporting

The total number of maternal deaths reported by the hospitals for the two-year period was collected from each hospital and the district health offices (DHOs). Only two hospitals reported maternal deaths to the DHO. From the two hospitals, one hospital only reported one maternal death. Therefore, we were only able to make a comparison based on this available data from one hospital.

Descriptive analyses were done for all of the data collected. The matching process between hospital reporting data with RAPID used at least two of these four matching criteria: name of the woman, the name of the husband, the address and date of death.

7. To compare the coverage of the maternal death capture through MADE-IN/MADE-FOR method between the Banten I and II studies

We conducted capture-recapture (CRC) analysis to examine the extent of underreporting by the community informants. This technique is a well-established analytical method to estimate total population parameters from two or more data capture methods (Laska, 2002). The technique re-calculates the estimate to include the cases that might be missed collectively by the data capture methods. Specifically in this study, we matched the reporting of maternal deaths between two informants in the same coverage area and analytically determined possible under-reporting (missing cases).

8. To assess the feasibility and sensitivity of adapted MADE-IN/MADE-FOR methodology to measure newborn mortality

We analyzed the number of neonatal deaths and their characteristics. We also obtained the number of maternal deaths from the 3 sub districts from MADE-IN/MADE-FOR study and neonatal deaths from the population survey which was conducted as part of the overall Banten Study 2. To assess the sensitivity of the method to identify neonatal deaths, we compared the proportion of neonatal deaths to maternal deaths in the three subdistricts, and the proportion of neonatal mortality rate and maternal mortality ratio from the population survey and MADE-IN MADE-FOR. We anticipated that neonatal deaths is around 8-10 times higher than maternal deaths for the same period of time.

Similar to MADE-IN/MADE-FOR, capture re-capture (CRC) analysis was applied to estimate of neonatal coverage in those areas rates from two networks, RT and Kader. Cohen's Kappa coefficient was calculated assess agreement between NODE IN and NODE FOR activity. We also compared the number of deaths reported by health centers to the District Health Office. The qualitative data was analyzed using content analysis method. A matrix by themes by informant was developed to assess the feasibility of the method in capturing neonatal deaths and the possibility of informant networks in identifying neonatal death and stillbirths.

We used Stata version 15 (Stata Corporation, College Station, TX, USA) for data management and analyses for quantitatve. Results

Research Question 1

Has the maternal mortality ratio (MMR) in Banten Province, Indonesia (Serang municipality, Serang district, and Pandeglang district) changed over time?

In comparison with the study conducted in the same areas in 2004-2005 (Qomariyah et al 2010), there was a 29% reduction in the total MMR in the 3 districts from 434 (CI: 376, 498) to 311 (CI: 282, 342). Compared by areas, the reduction is the greatest in Pandeglang district (35%), followed by Serang district (23%); there was no change in Serang municipality.

MMR Estimate in Three Districts of Banten Province, 2004-2005 and 2015-2017

	R (CI 95%) per 100.000 live births		
Area	Immpact (2004-2005)	Banten II (July 2015-June 2017)	Difference
Kota Serang	246 *(177, 329)*	248 *(194, 312)*	-1%
Kabupaten Serang	426 *(348, 515)*	327 *(284, 375)*	23%
Serang (all)	379 *(317, 450)*	294 *(261, 332)*	22%
Pandeglang	525 *(435, 629)*	340 *(289, 400)*	35%
Total	434 *(376, 498)*	311 *(282, 342)*	28%

The figure below showed changes in MMR in three districts of Banten Province between 2005 and 2017. The overall reduction of MMR was found to be statistically significant.

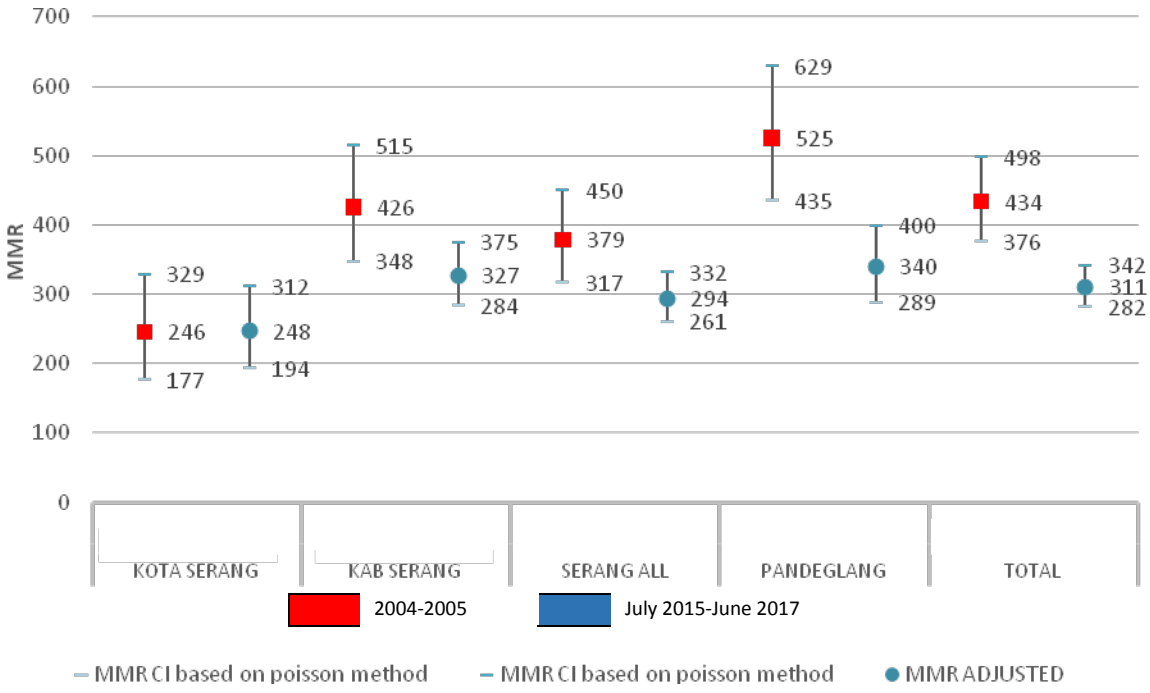


Figure 1. Change in the MMR between 2004-2005 and 2015-2017 in Banten province, Indonesia--Pandeglang district, Serang district and Serang municipality

Research Question 2

What are the background characteristics of women who die while pregnant or within 42 of termination of pregnancy in Serang municipality, Serang District and Pandeglang District?

For the characteristics of women in this study, the median age was 30 years and the highest proportion of women were between 20-35 years (67.8%). Almost half (47.2%) were educated only up to the elementeray school level and most were unemployed (71.6%). Only 29.3% of women were covered by national insurance and almost half of women (44.8%) had to pay for health services from their own pocket. For the wealth quartile, more than half of women were categorized in poorest and lower middle group andonly around 38% of women were in upper group of quartile. In terms of area of residence, most of women who died resided in rural areas (60.8%), and only 7.4% resided in remote areas.

Table 1. Demographic Characteristic of Maternal Death Cases in Three Districts of Banten Province, 2015 – 2017

	District							
	Pandeglang		Serang		Serang Municipality		Total	
	N=117		N=147		N=60		N=324	
	n	%	n	%	n	%	n	%
Age range 3 categories	**n=116**		**n=147**		**n=60**		**n=323**	
Less than 20	13	11.2	11	7.5	4	6.7	28	8.7
20-35	73	62.9	102	69.4	44	73.3	219	67.8
More than 35	30	25.9	34	23.1	12	20.0	76	23.5
Education category	**n=117**		**n=147**		**n=60**		**n=324**	
Senior high school or above	20	17.1	38	25.9	19	31.7	77	23.8
Junior high school	35	29.9	45	30.6	14	23.3	94	29.0
Elementary school completed or not completed	62	53.0	64	43.5	27	45.0	153	47.2
Economic activity status	**n=117**		**n=147**		**n=60**		**n=324**	
Employed	35	29.9	41	27.9	16	26.7	92	28.4
Unemployed	82	70.1	106	72.1	44	73.3	232	71.6
Insurance coverage	**n=117**		**n=147**		**n=60**		**n=324**	
Other insurance	15	12.8	49	33.3	20	33.3	84	25.9
JKN-PBI	42	35.9	32	21.8	21	35.0	95	29.3
Only self paid	60	51.3	66	44.9	19	31.7	145	44.8
Wealth Quartile	**n=117**		**n=146**		**n=60**		**n=323**	
Poorest (Q1)	47	40.2	44	30.1	10	16.7	101	31.3
Lower middle (Q2)	37	31.6	40	27.4	19	31.7	96	29.7
Upper middle (Q3)	16	13.7	25	17.1	20	33.3	61	18.9
Wealthiest (Q4)	17	14.5	37	25.3	11	18.3	65	20.1
Area	**n=117**		**n=147**		**n=60**		**n=324**	
Urban	32	27.4	28	19.0	43	71.7	103	31.8
Rural	73	62.4	107	72.8	17	28.3	197	60.8
Remote	12	10.3	12	8.2	0	0.0	24	7.4
Education category of husband	**n=104**		**n=130**		**n=53**		**n=287**	
Senior high school or above	50	48.1	62	47.7	25	47.2	137	47.7
Junior high school	3	2.9	7	5.4	3	5.7	13	4.5
Elementary school completed or not completed	51	49.0	61	46.9	25	47.2	137	47.7

Table 2 below shows that more than half of women died during the postpartum period (63.6%); more than half of women died during their first day after delivery and quarter of women died during their 8-42 days after delivery. Nearly two thirds of women (61.7%) died more than 24 hours after delivery.

Table 2. Timing of Maternal Deaths in Three Districts of Banten Province, 2015-2017

	District							
	Pandeglang		Serang		Serang Municipality		Total	
	N=117		N=147		N=60		N=324	
	n	%	n	%	n	%	n	%
Pregnacy status during time of death	**n=117**		**n=147**		**n=60**		**n=324**	
Pregnant	25	21.4	36	24.5	16	26.7	77	23.8
At delivery	16	13.7	11	7.5	3	5.0	30	9.3
Postpartum after delivery	72	61.5	95	64.6	39	65.0	206	63.6
Miscarriage or abortion	0	0.0	0	0.0	0	0.0	0	0.0
Postpartum after a miscarriage or abortion	4	3.4	5	3.4	2	3.3	11	3.4
Time of death	**n=117**		**n=147**		**n=60**		**n=324**	
During pregnancy	25	21.4	36	25.0	16	26.7	77	23.8
1 day	45	38.5	51	34.8	15	25	111	34.3
2 days	6	5.1	8	5.4	3	5	17	5.2
3-7 days	13	11.1	18	12.2	6	10	36	11.4
8-42 days	28	23.9	34	23.1	20	33.3	79	25.3
Time of postpartum death	**n=72**		**n=95**		**n=39**		**n=206**	
Within 24 hours after delivery	29	40.3	39	41.1	11	28.2	79	38.3
More than 24 hours	43	59.7	56	58.9	28	71.8	127	61.7
Time of postpartum death	**n=72**		**n=95**		**n=39**		**n=206**	
Within 24 hours	29	40.3	39	41.1	11	28.2	79	38.3
48 hours	5	6.9	7	7.4	2	5.1	14	6.8
More than 48 hours after delivery	38	52.8	49	51.6	26	66.7	113	54.9

Table 3 below shows information about the use of ANC and characteristics of delivery of mothers in this study. Almost all (94.4%) women who died had an antenatal care visit during their last pregnancy. Nearly 70% of women went to health facility for their ANC visit and 70.4% had their first ANC visit in the first trimester. Nearly 70% had more than 4 ANC visits during their last pregnancy.

More than two thirds of deliveries (64.8%) occurred in in a health facility, with 71% in hospitals (81.6% in public and 18.4% in private hospitals) and 29% in health center/clinics, and about 34% at home. Premature births were associated with12% of maternal deaths. Nearly one fourth of women (23%) received a C-section and among those who who received a C-section, 7% died at home and 5% died en-route to a health facility.

Most deliveries (79%) were assisted by a health professional and among those who died in health facility, 87% were assisted by a health professional. Of those died in clinic, 91% were assisted by a health professional. Among those who died at home, 50% were assisted by a health professional.

Table 3. Antenatal Care and Delivery History Among Maternal Death Cases in Three Districts of Banten Province, 2015 – 2017

	District							
	Pandeglang		Serang		Serang Municipality		Total	
	N=117		N=147		N=60		N=324	
	n	%	n	%	n	%	n	%
ANC with health provider	**n=117**		**n=147**		**n=60**		**n=324**	
ANC	110	94.0	139	94.6	57	95.0	306	94.4
Not ANC	7	6.0	8	5.4	3	5.0	18	5.6
Place of ANC	**n=117**		**n=147**		**n=60**		**n=324**	
Health Facility	77	65.8	101	68.7	47	78.3	225	69.4
Other (Posyandu)	30	25.6	26	17.7	9	15.0	65	20.1
Midwife place	2	1.7	11	7.5	1	1.7	14	4.3
Own or relative's home	1	0.9	1	0.7	0	0.0	2	0.6
Not ANC	7	6.0	8	5.4	3	5.0	18	5.6
Gestational age when first visit to ANC	**n=117**		**n=147**		**n=60**		**n=324**	
First Trimester	82	70.1	102	69.4	44	73.3	228	70.4
Second Trimester	14	12.0	21	14.3	7	11.7	42	13.0
>= Third Trimester	3	2.6	2	1.4	1	1.7	6	1.9
Not ANC	7	6.0	8	5.4	3	5.0	18	5.6
Dont Know	11	9.4	14	9.5	5	8.3	30	9.3
Frequency ANC	**n=117**		**n=147**		**n=60**		**n=324**	
>4 times	82	70.1	96	65.3	42	70.0	220	67.9
4 times	8	6.8	6	4.1	3	5.0	17	5.2
<4 times	20	17.1	37	25.2	12	20.0	69	21.3
Not ANC	7	6.0	8	5.4	3	5.0	18	5.6
Gestational age when last visit to ANC	**n=117**		**n=147**		**n=60**		**n=324**	
>= Third Trimester	87	74.4	105	71.4	45	75.0	237	73.1
Second Trimester	12	10.3	15	10.2	9	15.0	36	11.1
First Trimester	7	6.0	11	7.5	3	5.0	21	6.5
Not ANC	7	6.0	8	5.4	3	5.0	18	5.6
Dont Know	4	3.4	8	5.4	0	0.0	12	3.7
Delivery with aterm	**n=88**		**n=106**		**n=42**		**n=236**	
Yes	80	90.9	92	86.8	36	85.7	208	88.1
Less than 8 months	8	9.1	14	13.2	6	14.3	28	11.9
Number of delivery	**n=106**		**n=128**		**n=60**		**n=294**	
Less than 4	80	75.5	102	79.7	53	88.3	235	79.9
>= 4	26	24.5	26	20.3	7	11.7	57	20.1
Delivery with caesarean section	**n=88**		**n=106**		**n=42**		**n=236**	
No	73	83.0	78	73.6	30	71.4	181	76.7
Yes	15	17.0	28	26.4	12	28.6	55	23.3
Delivery with skill birth attendant	**n=88**		**n=106**		**n=42**		**n=236**	
No	20	22.7	25	23.6	5	11.9	50	21.2
Yes	68	77.3	81	76.4	37	88.1	186	78.1

	District							
	Pandeglang		Serang		Serang Municipality		Total	
	N=117		N=147		N=60		N=324	
	n	%	n	%	n	%	n	%
Place of delivery	n=88		n=106		n=42		n=236	
Health Facility	49	55.7	70	66.0	34	81.0	153	64.8
Other place	2	2.3	0	0.0	1	2.4	3	1.3
Own or relative's home	37	42.0	36	34.0	7	16.7	80	33.9
Place of delivery	n=88		n=106		n=42		n=236	
Start and end of delivery inside health facility	20	22.7	23	21.7	11	26.2	54	22.9
Start outside and end of delivery inside health facility	31	35.2	48	45.3	23	54.8	102	43.2
Start and end of delivery outside health facility	37	42.0	35	3 3.0	8	19.0	80	33.9
Referral before delivery	n=88		n=106		n=42		n=236	
Not being referred	50	56.8	42	39.6	10	23.8	102	43.2
1x	34	38.6	57	53.8	28	66.7	119	50.4
2++	4	4.6	7	6.6	4	9.5	15	6.4

Table 4 below shows that place of death in any health facility was about 65%. Of those who died in a health facility, 58% died in hospital (90% in public and 10% in private hospitals), and 42% in health center/clinic). Ten percent of deaths occurred during transit.

Table 4. Place of Maternal Deaths in Three Districts of Banten Province, 2015-2017

	District							
	Pandeglang		Serang		Serang Municipality		Total	
	N=117		N=147		N=60		N=324	
	n	%	n	%	n	%	n	%
Place of death	n=117		n=147		n=60		n=324	
Health Facilities	58	49.6	105	71.4	49	81.7	212	65.4
On the way	12	10.3	15	10.2	4	6.7	31	9.6
Own or relative's home	47	40.2	27	18.4	7	11.7	81	25.0

Place of death in any health facility has shifted from 32% (2004-05) to 65% (2015-2017) (Figure 2). OThere was also a nearly three-fold increase in deaths during transit from 3% to 10%.

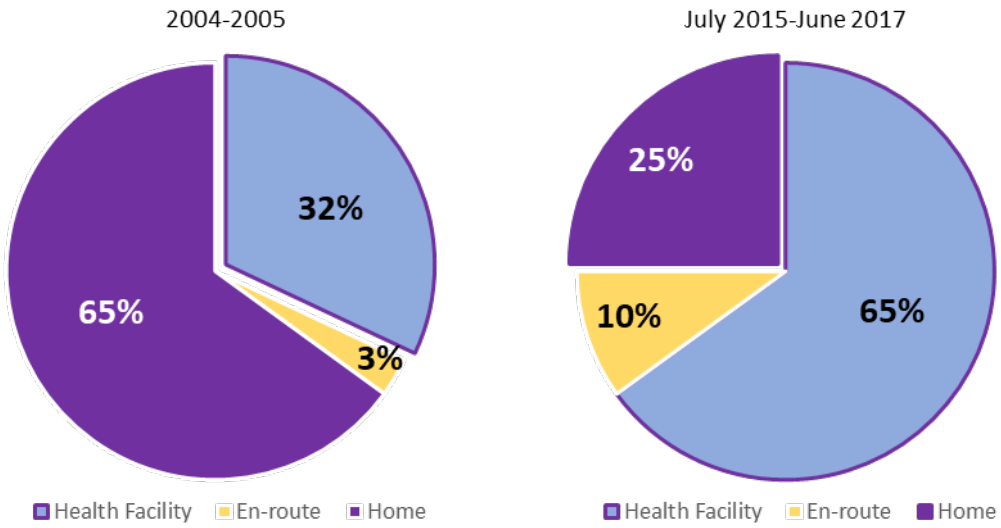


Figure 2. Location of death between Banten I/2004-05 and Banten II/ 2015-17

Using the latest version of the InterVA software, the main causes of death for the current study were: obstetric hemorrhage (38%,) followed by pregnancy-induced hypertension (PIH) (19%). Other causes remained low: pregnancy-related sepsis was 3.3%, while obstructed labour and abortion related were less than 1% each. From this study, the deaths from obstetric hemorrhage and PIH were similar between in facility and at home (40.1% in facilities and 37% at home for obstetric hemorrhage, and 19.8% and 18.5% for PIH, respectively)_. Anemia in pregnancycontributed to 19% of deaths. Indirect causes, together with other remaining direct causes, were responsible for 31% of maternal deaths.

Table 5. Causes of Maternal Deaths in Three Districts of Banten Province, 2015 – 2017*

Causes	District							
	Pandeglang		Serang		Serang Municipality		Total	
	N=117		N=147		N=60		N=324	
	n	%	n	%	n	%	n	%
Obstetric haemorrhage	52	44.40	52	35.40	20	33.30	124	38.30
Pregnancy-induced hypertension	18	15.40	27	18.40	17	28.30	62	19.10
Anaemia of pregnancy	12	10.30	24	16.30	8	13.30	44	13.60
Other and unspecified cardiac	4	3.40	14	9.50	3	5.00	21	6.50
Pregnancy-related sepsis	4	3.40	4	2.70	1	1.70	9	2.80
Other and unspecified maternal	3	2.60	1	0.70	3	5.00	7	2.20
HIV/AIDS related death	4	3.40	2	1.40	0	0.00	6	1.90
Asthma	3	2.60	1	0.70	1	1.70	5	1.50
Digestive neoplasms	3	2.60	1	0.70	1	1.70	5	1.50
Pulmonary tuberculosis	2	1.70	2	1.40	1	1.70	5	1.50
Abortion-related death	2	1.70	2	1.40	0	0.00	4	1.20
Acute resp infect incl pneumon	0	0.00	3	2.00	1	1.70	4	1.20
Diabetes mellitus	3	2.60	1	0.70	0	0.00	4	1.20
Malaria	1	0.90	3	2.00	0	0.00	4	1.20
Obstructed labour	3	2.60	1	0.70	0	0.00	4	1.20
Acute abdomen	0	0.00	2	1.40	1	1.70	3	0.90

Causes	District							
	Pandeglang		Serang		Serang Municipality		Total	
	N=117		N=147		N=60		N=324	
	n	%	n	%	n	%	n	%
Ectopic pregnancy	0	0.00	2	1.40	1	1.70	3	0.90
Liver cirrhosis	0	0.00	1	0.70	1	1.70	2	0.60
Stroke	0	0.00	1	0.70	0	0.00	1	0.30
Haemorrhagic fever	0	0.00	0	0.00	1	1.70	1	0.30
Other and unspecified neoplasm	1	0.90	0	0.00	0	0.00	1	0.30
Respiratory neoplasms	0	0.00	1	0.70	0	0.00	1	0.30
indeterminate	1	0.90	1	0.70	0	0.00	2	0.60
Road traffic acciden	0	0.00	1	0.70	0	0.00	1	0.30
Assault	1	0.90	0	0.00	0	0.00	1	0.30

***Cause of Death Determination using InterVAM**

Research Question 3

What are the determinants of maternal deaths (including cause of death, location, and context of death) in Serang municipality, Serang district, and Pandeglang districts?

For this analysis, we compared the characteristics of maternal death cases with women who survived childbirth and the postpartum period during the same time period. From the demographic characteristic of women in the table below, we found that women who died were mostly between the age of 20-35 years. Almost half of the women who died had a low education level (attended up to elementary school). There were more deaths in quartile 1 and and quartile 2, and less in quartile 3 and 4. More than half of women who died were covered by insurance. With regard to residence of women, most of women who died were resided in rural areas; different pattern with women who survived who has similar pattern between rural, urban and remote.

Table 6. Demographic Characteristics of Maternal Death Cases and a Sample of Women with a Recent Birth in three Districts of Banten Province, 2015 – 2017*

	Women with Recent Birth (POPSURVEY)		Maternal Death (MADE FOR)		TOTAL		P VALUE
	N=1057		N=324		N=1381		
	n	%	n	%	N	%	
Age range 3 categories	**n=1057**		**n=323**		**n=1380**		
Less than 20	43	4.1	28	8.7	71	5.1	0.001
20-35	803	76.0	219	67.8	1022	74.1	1
More than 35	211	20.0	76	23.5	287	20.8	0.071
Education category	**n=1057**		**n=324**		**n=1381**		
Senior high school or above	298	28.2	77	23.8	375	27.2	1
Junior high school	299	28.3	94	29.0	393	28.5	0.260
Elementary school completed or not completed	460	43.5	153	47.2	613	44.4	0.111

	Women with Recent Birth (POPSURVEY)		Maternal Death (MADE FOR)		TOTAL		P VALUE
	N=1057		N=324		N=1381		
	n	%	n	%	N	%	
Insurance coverage	**n=1057**		**n=324**		**n=1381**		
Other insurance	279	26.4	84	25.9	363	26.3	1
JKN-PBI	307	29.0	95	29.3	402	29.1	0.873
Only self paid	471	44.6	145	44.8	616	44.6	0.887
Wealth Quartile	**n=1,057**		**n=323**		**n=1,380**		
Poorest (Q1)	244	23.1	101	31.3	345	25.0	0.002
Lower middle (Q2)	249	23.6	96	29.7	345	25.0	0.007
Upper middle (Q3)	288	27.3	61	18.9	349	25.3	0.591
Wealthiest (Q4)	276	26.1	65	20.1	341	24.7	1
Area	**n=1,057**		**n=324**		**n=1,381**		
Urban	350	33.1	103	31.8	453	32.8	0.000
Rural	357	33.8	197	60.8	554	40.1	0.000
Remote	350	33.1	24	7.4	374	27.1	1
Education category of husband	**n=1,023**		**n=287**		**n=1,310**		
Senior high school or above	621	60.7	137	47.7	758	57.9	1
Junior high school	60	5.9	13	4.5	73	5.6	0.955
Elementary school completed or not completed	342	33.4	137	47.7	479	36.6	0.000

Table 7 below shows that both among women who died and survived, almost all women received antenatal from a health providerIn the group of women who died, a higher proportion received ANC less than 4 times compared with the group of women who survived. For the gestational age at the last ANC visit, a higher proportion of women who died did not have a third trimester ANC visit or no ANC visit at all (22.6%) compared to those who survived (7.3%). Around 12% of women who died were preterm compared to those who survived (1.3%). About 80% of women who died had less than 4 pregnancies, similar with those who survived. A similar pattern was also found for delivery with skilled birth attendant where most women delivered with skilled birth attendant. A higher proportion of women who died were not referred during their delivery (43.2%).

Table 1. Antenatal Care and Delivery History of Maternal Deaths and Women with Recent Births in Three Districts of Banten Province, 2015 – 2017*

	Women with Recent Birth (POPSURVEY)		Maternal Death (MADE FOR)		TOTAL		P VALUE
	N=1057		N=324		N=1381		
	n	%	n	%	n	%	
ANC with health provider	**n=1057**		**n=324**		**n=1381**		
ANC	1,023	96.8	306	94.4	1,329	96.2	1
No ANC	34	3.2	18	5.6	52	3.8	0.056
Place of ANC	**n=1023**		**n=306**		**n=1329**		
Health Facility	886	86.6	225	73.5	1,111	83.6	1
Non Health Facility	137	13.4	81	26.5	218	16.4	0.000
Gestational age when first visit to ANC	**n=1056**		**n=294**		**n=1350**		
First Trimester	876	83.0	228	77.6	1,104	81.8	1
Not First Trimester & No ANC	180	17.1	66	22.5	246	18.2	0.034
Frequency ANC	**n=1023**		**n=306**		**n=1329**		
>=4 times	933	91.2	237	77.5	1,170	88.4	1
<4 times	90	8.8	69	22.6	159	12.0	0.000
Gestational age when last visit to ANC	**n=1057**		**n=312**		**n=1369**		
>= Third Trimester	980	92.7	237	76.0	1,217	88.9	1
Not Third Trimester & No ANC	77	7.3	75	24.0	152	11.1	0.000
Delivery with aterm	**n=1057**		**n=236**		**n=1293**		
Yes	1,043	98.7	208	88.1	1,251	96.8	1
Less than 8 months	14	1.3	28	11.9	42	3.3	0.000
Number of delivery	**n=1057**		**n=294**		**n=1351**		
Less than 4	899	85.1	235	79.9	1,134	83.9	1
>= 4	158	15.0	59	20.1	217	16.1	0.035
Delivery with skill birth attendant	**n=1057**		**n=236**		**n=1293**		
Yes	768	72.7	186	78.8	954	73.8	1
No	289	27.3	50	21.2	339	26.2	0.053
Place of delivery	**n=1057**		**n=236**		**n=1293**		
Start and end of delivery inside health facility	49	4.6	54	22.9	103	8.0	1
Start outside and end of delivery inside health facility	588	55.6	102	43.2	690	53.4	0.000
Start and end of delivery outside health facility	420	39.7	80	33.9	500	38.7	0.000
Referral before delivery	**n=1057**		**n=236**		**n=1293**		
Not being referred	901	85.2	102	43.2	1,003	77.6	1
1x	104	9.8	119	50.4	223	17.2	0.000
2++	52	4.9	15	6.4	67	5.2	0.003

The adjusted multivariate analysis (Table 8) shows that the risk of death was nearly 9 times higher (OR: 8.72, CI: 3.98,19.1) among women who delivered and had a gestational age of less than 8 months as compared to women who delivered at term.

Antenatal care in a non-health facility (Posyandu) and ANC < 4 times were associated with a higher odds of death, 3 and 2 times, respectively. Start of delivery outside of a facility had a lower odds of death by almost 7 times compared with start inside facility. Delivery with unskilled attendance had a lower odds of death. Residence in the urban or rural area was associated with an increased odds of death of 4.9 times (urban) and 8.7 times (rural), while having a husband with only an elementary school education was associated with 2.2 times the odds of death.

Table 2. Case Control Analysis for Determinants of Maternal Deaths in Three Districts of Banten Province, 2015 – 2017*

Determinant Variables	Maternal Death (Case)	Women with Recent Birth (Control)	β	Crude OR				Adjusted OR			
				Crude OR	CI 95		P VALUE	OR Adjusted	CI 95		P VALUE
	N=324	N=1057			Lower	Upper			Lower	Upper	
Delivery with a term	n=236	n=1057									
Yes	88.1	98.7		1				1			
Less than 8 months	11.9	1.3	2.17	13.38	4.82	37.11	0.000	8.72	3.98	19.11	0.000
Place of ANC	n=306	n=1023									
Health Facility	73.5	86.6		1				1			
Not Health Facility	26.5	13.4	1.11	2.28	1.38	3.78	0.001	3.02	1.97	4.64	0.000
Area	n=324	n=1057									
Urban	31.8	33.1	1.58	5.75	2.78	11.90	0.000	4.86	2.57	9.19	0.000
Rural	60.8	33.8	2.17	8.59	4.33	17.03	0.000	8.71	4.79	15.86	0.000
Remote	7.4	33.1		1				1			
Education category of husband	n=287	n=1023									
Junior high school or above	52.3	66.6		1				1			
Elementary school completed or not completed	47.7	33.4	0.78	2.31	1.52	3.50	0.000	2.18	1.53	3.11	0.000
Frekuensi ANC	n=306	n=1023									
>4/4 times	77.5	91.2		1				1			
<4 times	22.6	8.8	0.61	1.65	0.85	3.20	0.136	1.83	1.07	3.12	0.027
Place of delivery	n=236	n=1057									
Start and end of delivery inside health facility	22.8	4.6		1							
Start outside and end of delivery inside health facility	43.2	55.6	-1.91	0.15	0.09	0.27	0.000	0.14	0.09	0.25	0.000
Start and end of delivery outside health facility	33.9	39.7	-2.24	0.13	0.06	0.27	0.000	0.11	0.06	0.19	0.000

Research Question 4

What are the background characteristics of maternal death cases that are missed by the DHO reporting system?

The characteristics of the maternal death cases

Table 9 shows the characteristics of maternal death cases that were missed by the DHO reporting system and those that were captured by same system in the three study districts of Banten Province in 2016. Overall, there were statistically significant differences in the age, urban/rural residence, and

district between the cases captured by the DHO reporting system and the cases that were missed. Of those who were missed, most women were between 20-35 years of age when they died (76.7%). Most deaths occurred in rural/remote areas (72.5% overall) but the DHO information system captured nearly 85% of the cases, implying that more cases from urban areas were missed by the system. By district, a higher proportion of missed cases was found in Pandeglang compared to other districts (37.8% compared to 32.4% and 29.7% for Serang District and Serang City retrospectively) even though Serang District accounted for nearly half of the death cases. In contrast, for cases that were not missed, more than half (55.8%) were in Serang district and a lower proportion in Pandeglang and Serang city (32.6% and 11.6% retrospectively). For the insurance scheme used by the maternal death cases missed by the HIS, a high proportion (47.3%) of cases had no insurance, followed by subsidized insurance by 28.4% and other insurance by 24.3%.

There were no differences in the wealth quartile (as measured by questions related to the ownership of selected household goods) of the cases missed by HIS and captured by HIS.

Table 3. Socio-economic Characteristics of Maternal Deaths Missed by DHO Reporting and Total Maternal Deaths in Three Districts of Banten Province in 2016

Characteristics of maternal deaths	**Missed by DHO**	**Captured by DHO**	**(*p* value)***	**Total**
Age	**n = 73**	**n = 86**		**n = 159**
<20	8 (11.0%)	10 (11.6%)	*ref*	18 (11.3%)
20-35	56 (76.7%)	49 (57.0%)	0.453	105 (66.0%)
>35	9 (12.3%)	27 (31.4%)	0.108	36 (22.6%)
Quartile	**n=73**	**n=86**		**n=159**
Q4 (wealthiest)	13 (17.8%)	17 (19.8%)	0.765	30 (18.9%)
Q3	12 (16.4%)	18 (20.9%)	0.965	30 (18.9%)
Q2	27 (37%)	19 (22.1%)	0.022	46 (28.9%)
Q1	21 (28.8%)	32 (37.2%)	*ref*	53 (33.3%)
District	**n=74**	**n=86**		**n=160**
Serang District	22 (29.7%)	48 (55.8%)	*ref*	70 (43.8%)
Serang City	24 (32.4%)	10 (11.6%)	**<.001**	34 (21.3%)
Pandeglang	28 (37.8%)	28 (32.6%)	**0.003**	56 (35.0%)
Residence	**n=74**	**n=86**		**n=160**
Rural/remote	43 (58.1%)	73 (84.9%)	*ref*	116 (72.5%)
Urban	31 (41.9%)	13 (15.1%)	**<0.001**	44 (27.5%)
Insurance schemes	**n=74**	**n=86**		**n=160**
No insurance	35 (47.3%)	38 (44.2%)	0.877	73 (45.6%)
Subsidized insurance	21 (28.4%)	27 (31.4%)	0.835	48 (30.0%)
Other insurance	18 (24.3%)	21 (24.4%)	*ref*	39 (24.4%)

**Bivariate logistic regression with adjustment for clustering by village*

For the cause of death, of those who were missed by DHO reporting, a quarter of the maternal deaths were caused by an indirect cause (25.7%). More than one third (34.7%) of cases missed by the DHO reporting system had their last ANC visit before the 3rd trimester or had no ANC, and more than half of the missed cases (55.4%) died more than 24 hours postpartum and more than one quarter (27%) died during pregnancy. In addition, nearly 40% of women who were missed delivered in the home (see table 10 below).

Table 4. Antenatal and Delivery Care Characteristics of Maternal Deaths in Three Districts of Banten Province in 2016

Characteristics of maternal deaths	Missed by DHO N= 74	Captured by DHO N = 86	(*p* value)*	Total N=160
Cause of death	**n=74**	**n=86**		**n=160**
Direct	55 (74.3)	74 (86.1)	*ref*	129 (80.6%)
Indirect	19 (25.7)	12 (13.9)	**0.070**	31 (19.4%)
ANC				
Frequency of ANC visits	**n=67**	**n=83**		**n=150**
4+ visits	49 (73.3%)	66 (79.5%)	*ref*	115 (76.7%)
>4 visits	18 (26.9%)	17 (20.5%)	0.409	35 (23.3%)
First ANC	**n=68**	**n=81**		**n=149**
1st trimester	46 (67.7%)	62 (76.5%)	*ref*	108 (72.5%)
Not 1st or no ANC	22 (32.4%)	19 (23.5%)	0.249	41 (27.5%)
Last ANC	**n=72**	**n=83**		**n=155**
3rd trimester	47 (65.3%)	71 (85.5%)	**<.001**	118 (76.1%)
Before 3rd trimester or no ANC	25 (34.7%)	12 (14.5%)	*ref*	37 (23.9%)
Place of delivery end	**n=50**	**n=69**		**n=119**
Home	20 (40.0%)	21 (30.4%)	0.173	41 (34.5%)
Facility	30 (60.0%)	48 (69.6%)	*ref*	78 (65.5%)
Time of death	**n=74**	**n=86**		**n=160**
Intrapartum	6 (8.1%)	12 (13.9%)	*ref*	18 (11.2%)
Antepartum	20 (27.0%)	16 (18.6%)	**0.042**	36 (22.5%)
Immediate postpartum (up to 24 hours after delivery)	13 (17.6%)	30 (34.9%)	0.222	37 (23.3%)
Delayed postpartum (24+ hours to 42 days after delivery)	41 (55.4%)	28 (32.6%)	0.003	69 (43.1%)
Place of death	**n=74**	**n=86**		**n=160**
Home	29 (39.2%)	19 (22.1%)	**0.001**	48 (30.0%)
Facility	45 (60.8%)	67 (77.9%)	*ref*	112 (70.0%)

*Bivariate logistic regression with adjustment for clustering at the village level

Predictors of maternal death cases missed by the District Health Office reporting system

Residence of women who died was found to be related to the odds of being missed by the system. Women who resided in urban areas were four times (OR 4.3, p-value<.001) more likely to be missed by the system compared with women who lived in rural or remote areas. Women who had their last ANC visit before the 3rd trimester or did not have any ANC visits were nearly three times (OR 2.9, p-value=0.030) more likely to be missed by the system. The odds of being missed for women who died during delivery was 70% less (OR 0.304, p value=0.041) than women who died during pregnancy; and for women who died at home, the odds of being missed was 2.1 (p-value=0.023) compared with women who died in facilities. There was no relationship between the frequency of ANC visits with the odds of being missed by the DHO reporting system (OR 0.73, p-value 0.617) (see Table 11).

Table 5. Predictors for probability of cases being missed by the DHO reporting system, maternal death cases in the districts of Banten Province, in 2016

Characteristics	OR (95% CI)	*p* value
Residence in urban area	4.314 (2.082-8.939)	**<0.001**
Last ANC visit before third trimester or no ANC visit	2.935 (1.110-7.761)	**0.030**
0-24 hours after delivery	0.304 (0.096-0.952)	**0.041**
24+ hours after delivery	0.946 (0.437-2.044)	0.887
Died at home	2.163 (1.111-4.211)	**0.023**
ANC visit less than 4 times	0.732 (0.215-2.490)	0.617

Research Question 5

Has official reporting between the health centers and districts health offices (DHO) using the existing health information system of maternal death improved?

From the MADE-IN/MADE-FOR study from the three areas, between July 2015 – June 2017 we found 341 maternal deaths. We attempted to compare the the MADE-IN/MADE-FOR results with the DHO data for the same period of time. However, the DHO data did not include the month of the death, only the total number of deaths each year. Therefore, we could not obtain the total count of maternal deaths in 2015 and 2017 so were only able to use data from the year 2016 for comparison with the results from MADE-IN/MADE-FOR.

First, we compared the number of maternal deaths reported in the routine health information system, which includes information from health centers and DHOs. There were 108 deaths in health centers and 105 deaths in DHOs, but in total there were 122 deaths. We found a discrepancy in the number of deaths and were able to match only 91; 17 deaths were found only in health centers and 14 deaths were found only in DHOs. (table 12). The coverage of deaths in health centers and DHOs was similar.

Table 6. Discrepancies in Reporting Maternal Deaths Between Health Center sand DHO in Three Districts in Banten Province, 2016

	Maternal Death in 2016		
	Only by Health Center	By Both Health Center and DHO	Only by DHO
Number of MD reported	17	91	14
Total cases by both data sources		122	
Total cases by each data source	**108**		**105**
Coverage of each source	**88%**		**86%**

We then used data from DHOs from 2016 and compared it with data from the MADE-IN/MADE-FOR for the same period of time. From 105 maternal deaths from DHO reporting system and 169 deaths from the MADE-IN/MADE-FOR, MADE-IN/MADE-FOR could identify 92% (169) of all 184 deaths, while the DHO system captured 57% (105/184) of the deaths. Maternal death cases from the two data sources were matched and 90 cases were found in both data sources. There were

79 cases missed by the DHO data sources and 15 cases missed by MADE-IN/MADE-FOR method (see figure 3 below).

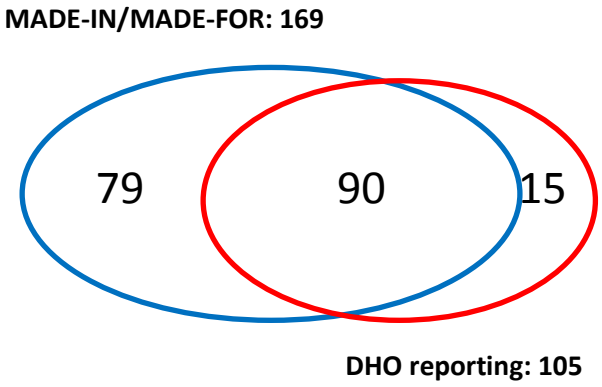


Figure 3. Maternal death data from two data sources: District Health Offices (DHO) Data and MADE-IN/MADE-FOR data, 2016

The capture-recapture technique was then applied to estimate the total number of maternal deaths including those that were missed by the two data sources. Using the capture-recapture formula, the estimated number of cases was 197 (meaning 13 cases were estimated to be missed by both data sources). Based on the total number of cases estimated through capture recapture approach, the coverage of the district health information system in reporting maternal death in 2016 was adjusted and found to be 53% (105/197), while the coverage of MADE-IN/MADE-FOR was 86% (see table 13 below).

Table 7. Total number of maternal death cases based on the two data sources and capture recapture analysis*

		MADE-IN/MADE-FOR		
		Found	Not-found	Total
DHO data set	Found	90	15	105
	Not found	79	13*	
	Total	169		197*

**calculated using capture recapture technique*

Research Question 6

Has the underreporting of maternal deaths in health facilities improved in the study districts?

Comparison of hospital reporting and RAPID 2015/2017 and in 2004/2005

In general, there no significant change was found between the percentage gap reported in the original Immpact study and Banten II study as shown in table 14. The Immpact study found a 57% gap compared to 64% in Banten study II. However, there was a difference in the number of hospitals reported through HIS. In the DHO report on Immpact studies, data were obtained from all existing hospitals (4 hospitals) at that time compared only 2 of 13 hospitals who reported to District health office in the recent study. It means, there were 11 hospitals that did not report numbers of maternal death routinely to the DHO in the current study.

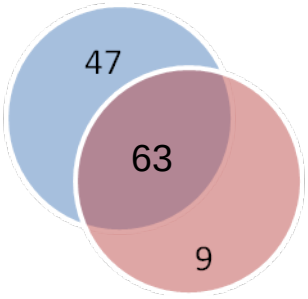
Table 8. Comparison HIS vs RAPID, in Banten Study II and IMMPACT Study

	HIS	RAPID	GAP	% GAP
Immpact	67	155	88	57%
Banten Study 2	73	199	126	64%

Characteristic of cases missed by hospital reporting and total cases found through RAPID

Using the two data sources, there was a total of 119 maternal deaths cases that occurred in Hospital X; 49 cases were missed by the hospital reporting and 63 were cases captured by both. Hospital reporting only captured 60.5% of maternal deaths, while RAPID captured 92.4%.

RAPID in Hospital X: 110 cases



Hospital X reporting: 72 cases

Figure 4. Coverage of Maternal Death Reporting in One Hospital Compare with RAPID in 2015-2017

Table 9. Characteristic of Cases Missed in One Hospital Reporting System, and the Total Cases from 13 Hospitals Found through RAPID

Characteristics of maternal death cases	Total cases captured by RAPID in 13 hospitals n=173	Cases missed by hospital reporting and captured by RAPID	
		Cases missed by hospital reporting in one hospital only (n=35*)	Cases captured by RAPID in one hospital only (n=99**)
Age category			
15 - 20 years	18 (10.4%)	3 (8.6%)	10 (10.1%)
21 - 35 years	114 (65.9%)	23 (65.7%)	66 (66.7%)
36 - 49 years	41 (23.7%)	9 (25.7%)	23 (23.2%)
Pregnancy status related to maternal deaths			
Before delivery	42 (24.3%)	12 (34.3%)	29 (29.3%)
At delivery	11 (6.4%)	0 (0%)	8 (8.1%)
Post-partum	107 (61.8%)	20 (57.1%)	57 (57.6%)
Post abortion	12 (6.9%)	3 (8.6%)	5 (5.1%)
Timing deaths	**N=107**	**N=20**	**N=57**
< 24 hours	32 (29.9%)	1 (5.0%)	17 (29.8%)
24 - 48 hours	4 (3.7%)	2 (10.0%)	2 (3.5%)
> 48 hours	27 (25.2%)	7 (35.0%)	21 (36.8%)
Not recorded	44 (41.1%)	10 (50.0%)	17 (29.8%)
Area			
Urban	67 (38.7%)	18 (51.4%)	45 (45.5%)
Rural	92 (53.2%)	15 (42.9%)	46 (46.5%)
Remote	8 (4.6%)	1 (2.9%)	6 (6.1%)
Other	6 (3.5%)	1 (2.9%)	2 (2.0%)
Length of hospital stay			
0 days	66 (38.2%)	12 (34.3%)	37 (37.4%)
1 – 2 days	54 (31.2%)	10 (28.6%)	34 (34.3%)
3 - 42 days	53 (30.6%)	13 (37.1%)	28 (28.3%)
Cause of deaths: direct or indirect			
Direct	91 (52.6%)	11 (31.4%)	51 (51.5%)
Indirect	65 (37.6%)	17 (48.6%)	36 (36.4%)
Unspecified	17 (9.8%)	7 (20.0%)	12 (12.1%)
Cause of death – individual			
APH	5 (2.9%)	1 (2.9%)	1 (1.0%)
PPH	23 (13.3%)	2 (5.7%)	11 (11.1%)
PE/Eclampsia	50 (28.9%)	6 (17.1)	30 (30.3%)
Sepsis	15 (8.7%)	2 (5.7%)	9 (9.1%)
Unspecified	29 (16.8%)	11 (31.4%)	22 (22.2%)
Abortion	4 (2.3%)	0 (0.0%)	2 (2.0%)
Indirect	61 (35.3%)	15 (42.9%)	31 (31.3%)
Wards			
ICU	71 (41.0%)	7 (20.0%)	33 (33.3%)
ER	31 (17.9%)	13 (37.1%)	20 (20.2%)
Obstetric ward	49 (28.3%)	5 (14.3%)	35 (35.4%)
Internal medicine ward	7 (4.1%)	3 (8.6%)	3 (3.0%)
Operating theatre	1 (0.6%)	0 (0%)	0 (0%)
Mortuary/ not ward	14 (8.1%)	7 (20.0%)	8 (8.1%)

* Data not found in the hospital reporting

** The total number (99) is less then all cases captured by RAPID in the one hospital (110) as for the 11 cases, their medical records were not found

Overall, there were 199 maternal deaths found in the hospital register and medical records. We analyzed 173 of those cases since there were no medical records available for the other 26 cases (table 14). From these cases, we found that most women died between the age of 21 -35 years (65.9%) and died during the postpartum period (61.8%) with timing of postpartum deaths less than 24 hours. Almost half of the deaths (41%) occurred in the ICU ward.

By comparing hospital routine reporting from one hospital only and maternal deaths identified through RAPID for the same period, we found that routine hospital reporting missed 35 maternal death cases. We found that the pattern of misclassification among all hospitals was relatively similar with one hospital who report maternal deaths in the routine system; however, some variables of missed cases in that hospital are different from other hospital. Table 15 presents the characteristics of maternal death cases that were captured by all cases found through RAPID in the 13 hospitals in the three districts, missed by the hospital reporting and cases that were captured by RAPID in one hospital only.

The majority of cases missed by the hospital reporting were for women who died between the age of 21 and 35 years (65.7%) and more than half died during their postpartum period (57.1%). More than one third (37.1%) died in the ER ward.. About half (51.4%) of the women resided in urban areas and 37.1% had received treatment in the hospital for more than 3 days. More than one third (35%) died more than 48 hours after delivery. However, for half of the cases, the time of death during the postpartum period was not recorded. Nearly half of the cases missed by the hospital reporting (48.6%) were deaths due to indirect causes, although 20% of the missed cases had unspecified cause of death.

Data collected through RAPID in one hospital showed that the majority of women died when they were between 21-35 years (66.7%) and more than half died during postpartum period (57.6%). About 37% of the women died more than 48 hours after delivery. However, there was a high proportion of cases with missing information on the time of death (29.8%). The majority of the women died within the first two days of admission (72.7%), with half of them dying on the same day of admission. The proportion of the deceased women who resided in urban areas (45.5%) was similar to those in rural area (46.5%).

Research Question 7

Has the coverage of maternal death cases captured through MADE-IN/MADE-FOR method between the Banten I and II studies remained similar?

Table 10. Coverage of Maternal Deaths between Banten I (Immpact) and II Studies Captured through the MADE-IN/MADE-FOR Method

	Immpact % (CI)	Banten II study % (CI)
Kader	71 (63-79)	72 (65-79)
RT	85 (79-91)	76 (70-82)
MADE-IN/MADE-FOR	96 (92-99)	93 (89-97)

Using the same method, MADE-IN/MADE-FOR to capture all maternal deaths in the study areas, the results showed that the probability of the method in capturing a maternal death case only changed slightly: from 96% in Immpact/Banten I study to 93% in Banten II study with overlapping confidence intervals (CI). However, by informant network, the probability of RT network to capture a death case was lower in the recent study (85% vs. 76%).

Research Question 8

What are the feasibility and sensitivity of adapting the MADE-IN/MADE-FOR (NODE-IN/NODE-FOR) methodology in measuring newborn mortality in a rural and urban setting?

1. Case identification

Unlike in MADE-IN/MADE-FOR, which collects information of maternal deaths in the last 2 years, we used 6 months as the recall period to identify neonatal deaths. This is because the number of neonatal deaths is higher than maternal deaths. To identify neonatal deaths, we used two instruments: the first instrument was used to identify the death of baby 0-28 days in the last 6 months (namely NODE-IN form 1), and the second instrument was used to identify neonatal deaths through the identification of delivery in the last 6 months (NODE-FOR Form 2). With these two instruments, we aimed to assess which approach would be better in identifying neonatal deaths. Below is the comparison table between Form 1 and Form 2.

Table 11. Comparation of Data Collected by Form 1 and Form 2

	Total	
	n	n%
Source of information about neonatal death		
FORM 1	**n=19**	
Kader & RT	8	42.1
Kader only	6	31.6
RT only	5	26.3
FORM 2	**n=19**	
Kader & RT	1	5.3
Kader only	2	10.5
RT only	4	21.1
Not Kader or RT	12	63.2

Note: There were no eligible neonatal deaths were found in Pandeglang and Serang District (team only found case of stillbirth there)

Number of Deaths

Form 1 identified more deaths than Form 2. From NODE-IN form 1, kaders identified 31 deaths and RTs identified 22 deaths (Figure 5). From NODE-IN Form 2, kaders identified 9 deaths and RTs identified 5 deaths. After screening, we finally found 25 from NODE-IN Form 1 and 6 of them are stillbirth, so in total we found 19 neonatal deaths (table 17). From NODE-IN Form 2, we only found 12 neonatal deaths. Therefore, we used data from NODE-IN Form 1 for further analysis.

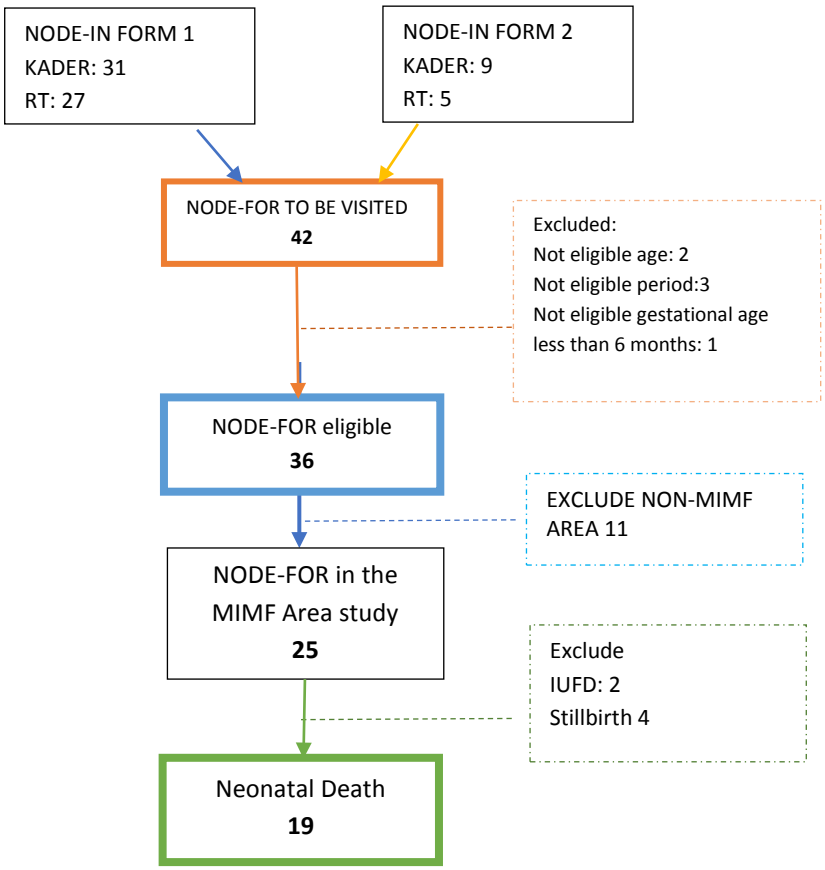


Figure 5. Flow Chart of Death Identification

Characteristics of neonatal deaths identified through NODE-FOR

Out of the 19 deaths identified through NODE-FOR, more than two thirds occurred within the first seven days after birth. More than half of the neonates (58%) had been pre-term deliveries and most of these deaths (78%) occurred in a health facility.

Table 12. Characteristic of Neonatal Deaths Identified through NODE-FOR

	Neonatal Death	
	n	%
Age of neonatal death	**n=19**	
0-7 days	13	68
8-28 days	6	32
Pre-term birth	**n=18**	
Premature	11	58
Age of neonatal death	**n=19**	
0-7 days	13	68
8-28 days	6	32
Sex of neonatal death	**n=18**	
Male	9	50
Female	9	50
Place of neonatal death	**n=18**	
Health facility	14	78
Home	2	11
Other/On the way to health facility	2	11

2. Sensitivity

To assess the sensitivity of NODE-IN/NODE-FOR in identifying neonatal death, we compared the number of neonatal deaths identified by NODE-IN/NODE-FOR with data reported from health centers to District Health Offices; we also compared neonatal deaths over maternal death (Table 19). From NODE-IN/NODE-FOR study in the 3 sub districts, the number of neonatal deaths was3.45 times that of maternal deaths. From population survey and MADE-IN/MADE-FOR, we found that the NMR was 14 per 1000 live births while the MMR is 311/100,000 live births in the same time period. From these two figure the NMR/MMR was 4.5.

The NMR was calculated based on the number of neonatal deaths found through the population survey. The population survey found 22 neonatal deaths during study period. The MMR was calculated based on number of maternal deaths found by MADE-IN/MADE-FOR study from three districts during study period. MADE-IN/MADE-FOR found 341 maternal deaths and 1057 live births. MMR was calculated from capture and recapture analysis and adjusted of live births.

Table 13. Proportion of Number of Neonatal to Maternal Deaths fromNODE-IN/NODE-FOR, and NMR to MMR from MADE-IN/MADE-FOR and from Population Survey

NODE-IN/NODE-FOR & MADE-IN/MADE-FOR (from 3 sub districts)		**Population Survey & MADE-IN/MADE-FOR (from 2 districts & 1 municipality)**	
Number of Neonatal Deaths: 19 in the last 6 months after extrapolation times 4 (2 years)	76	Neonatal Mortality Rate in the last 2 years from population survey*	14 per 1000 live births
Number of Maternal deaths in the 3 subdistricts in the last 2 years from MADE-IN/MADE-FOR as reported by family	22	Maternal Mortality Ratio in the last 2 years from MADE-IN/MADE-FOR	311/100.000 live births
Number of ND/ MD	**3.45**	**NMR/ MMR**	**4.5**

*Calculated from a total of 15 neonatal death (died between 0-28 days) and 1057 live birth

About two thirds of 19 neonatal deaths occurred in the first week (table 6). In this case it is quite similar with what has been evidenced globally (4).

Correct classification of neonatal deaths through NODE-IN by village informant type

Out of 19 neonatal death cases, kaders captured 14 cases and RTs captured 13 cases. Eight cases were captured by both. Applying the capture recapture technique, we estimated that the total number of neonatal deaths in the area was 23. Based on the adjusted estimate, NODE-IN/NODE-FOR was able to capture 83% of neonatal deaths (Table 20). The ability of kaders to recall neonatal deaths was 61% while it was 56% among RTs.

Table 14. Recall of neonatal deaths by village informants (CRC)

	Numerator	Denominator (adjusted)	%
	n	N	
Kader	14	23	60.9
RT	13	23	56.5
Total	19	23	82.6

Accuracy of Village Informant in identifying Neonatal Death

Table 21 and the kappa analysis showed strong agreement (kappa 0.85) between NODE-IN and NODE-FOR data. This suggests that village informants are able to accurately identify neonatal deaths when compared to the information collected from the families of neonatal death cases.

Table 15. Agreement of Village Informants in Identifying and Differentiating Neonatal Deaths and non neonatal death from Form 1 (including outside area)

		NODEFOR					
		Neonatal		Not Neonatal		Total	
		n	%	N	%	N	%
NODE-IN	Neonatal	24	100	2	20	26	76
	Not Neonatal	0	0	8	80	8	24
	Total	24	100	10	100	34	100

Match between NODE-FOR and NODE-IN

Different information between NODE-FOR and NODE-IN

		NODE FOR	
NODE IN		+	-
	+	24 (a)	2 (b)
	-	0 (c)	8 (d)

Observed proportionate agreement=a + d / (a + b+ c+ d)= (24+8)/(24+2+0+8)= ***0.94***
Probability of yes= [(a+b)/ (a + b+ c+ d)] x [(a+c)/ (a + b+ c+ d)]= ***0.54***
Probability of no=[(c+D)/ (a + b+ c+ d)] x [(b+d)/ (a + b+ c+ d)]= ***0.069***
Probability of random agreement=P_{yes} + P_{no} = .54 + .069= ***0.61***
Kappa=($p_0 - p_e$) / (1- p_e)= (.94-.61)/(1-.61)= ***0.85***

Cause of Neonatal Death by Inter-VA

Among the identified deaths in this study, most neonatal death were caused by prematurity (38.9%) followed by meningitis and encephalitis and congenital malformation.

Table 16. Main Cause of Neonatal Death

Main cause of death	n	%
Prematurity	7	38.9
Meningitis and encephalitis	5	27.8
Congenital malformation	4	22.2
Neonatal pneumonia	1	5.6
Indeterminate	1	5.6
Total	18	

III. Conclusion and Further Exploration Needed

This study found that there has been an overall reduction in MMR in three districts in Banten Province between 2006 and 2017. The greatest reduction was seen in Pandeglang District followed by Serang District, while there was no change in Serang Municipality. The place of death also significantly changed between the two study periods from women mostly dying at home ten years ago to mostly dying in health facilities in the present study. The time of death during deliveries and the first 24 hour postpartum was quite similar; however the frequency of deaths that occurred 8-42 days postpartum almost doubled from a decade ago. By geographical area, this recent study showed that the proportion of maternal death in urban area is higher.

The adjusted multivariate analysis showed that the risk of death was nearly 9 times higher among women who delivered and had a gestational age of less than 8 months as compared to women who delivered at term. Higher risk of maternal deaths was also associated with less contact with health professional and facility, as shown by 3 times higher risk among those who had ANC in non-health facility and 2 times higher risk among those with ANC < 4times.

Although it is not easy to interpret, the start of delivery outside of a facility and delivery with unskilled attendance were associated with lower risk of death. On the other hand, residence in the urban or rural area was associated with an increased risk of death as compared with remote area. Having a husband with only an elementary school education was associated with 2.2 times the risk of death.

There has been no significant improvement in the coverage of maternal death recording/reporting through both Health Center (HC)-District Health Office (DHO) system and hospital reporting system. Results from this study showed that women who died in urban areas more likely to be missed by the HC-DHO. Women who died during post partum period and during pregnancy were more likely to be missed by the DHO reporting system as compared to women who died during delivery.

The coverage of the MADE-IN/MADE-FOR method in capturing the maternal deaths remains as high as its implementation ten years ago. However, the probability of RT netwrok in capturing a case is lower then ten years ago. This might be caused by the changing in the community setting which have more urban areas with dense population.

This also the case for the implementation of the RAPID method which found about 40% higher than hospital reporting to DHO, although there are some challenges in the implementation due to problems in the hospital recording/reporting. In the future, adaptation of this method might be needed to accommodate the possible changing in the health facility information system, e.g changing to electronic based system information.

The pilot study to capture neonatal deaths using adapted MADE-IN/MADE-FOR method (called NODE-IN/NODE-FOR) showed that it is feasible to implement as it uses existing network and the data collection burden is similar to MADE-IN/MADE-FOR. The accuracy of village informant in identifying the neonatal deaths is quite high when compared to the information from the family of the neonatal death. As the study was only conducted in three sub-districts, it is difficult to confidently asses the sensitivity of the method. However, the calculation using the information gathered through all methods used in Banten II Study (Population survey, MADE-IN/MADE-FOR, and DHO reporting, health center reporting), and comparing the proportion of death during early and later period of neonatal deaths, and the ratio between number of neonatal to maternal deaths and NMR to MMR, indicated that the method is promising but demand for a larger scale study to ensure that it can capture significant number of neonatal death as in maternal death.

Issues for further exploration

The determination of cause of maternal deaths in the study uses InterVA software. It was found that the main cause of maternal death in the study population was obstetric hemorrhage. This is also the pattern of cause of deaths among those who died during 8-42 days post-partum period. Further exploration is needed to explain this result. In addition, the cause of death pattern from the community data based is different with the facility based data. Assessing the quality of care as well as referral history may also need to be included as part of the RAPID method to gather more comprehensive data on cause of death.

To confidently measure the sensitivity of NODE-IN/NODE-FOR, its implementation on a wider scale (e.g. in a district with larger population) is needed.

For the implementation of MADE-IN/MADE-FOR/NINF in different area as in Banten II study (e.g in eastern Indonesia) additional informant networks may need to be included in order to explore which networks best captures maternal/neonatal death. This additional information e.g. about the best informant to be involved in capturing the cases can be collected qualitatively. Cultural and social background might be different in different areas. In addition, more exploration on the existing data collected through the Banten II Study and other secondary data is needed to inform policy makers in developing strategic planning for routine measurement of maternal/neonatal death.