POPULATION BASED ESTIMATES OF MATERNAL MORTALITY IN MOJOKERTO, EAST JAVA.

(The application of indirect technique : Sisterhood Method).

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ABSTRAK

Mendapatkan angka kematian maternal secara langsung merupakan kendala bagi berbagai negara berkembang. Oleh sebab itu mendapatkannya secara tidak langsung merupakan alternatif untuk dikembangkan. "Sisterhood method", pendekatan tidak langsung yang dikembangkan oleh Wendy Graham dkk., adalah salah satu alternatif untuk dipertimbangkan. Penerapan metode tersebut dalam survei rumah tangga di Mojokerto memberikan hasil yang konsisten dengan penerapan di negara lain (Gambia dan Peru). Maternal mortality ratio (MMR) dari metode tersebut di Mojokerto (397 per 100.000) juga dapat dibandingkan dengan hasil penelitian MMR cara langsung di Indonesia setelah dipertimbangkan kekurangan cara langsung.

INTRODUCTION

One of the widest health disparities between rich and poor is in maternal mortality.[1] There are, for example, more maternal deaths in India in the space of a week than there are in all Europe in a whole year. More than 99% of the estimated half million such deaths that occur every year take place developing countries, with ratios to 100.000 live births ranging from 700 in West Africa to 55 in East Asia.[2]

Although it has been considered as an important health indicator, deriving population-based estimates of maternal mortality is not easy. Currently, three main sources of information are available on maternal deaths : vital registration, health service statistics, and community–based surveys. Birth-death record linkage and investigation of all deaths of women aged 15–49 from vital statistics, and prospective monitoring of pregnant women up to 6 weeks after end of pregnancy from the community studies are considered the most suitable for obtaining maternal mortality rates! Unfortunately, vital registration is nonexistent in many parts of the developing countries and, even where it does exist, is often only complete for a small , usually urban proportion of the population. Value to large sample size needed to produce statistically reliable estimate of rate events like maternal death, and prospective studies are expensive in term of both time and resources, deriving maternal mortality from the community studies is also a constraint for most developing countries. Health service statistics may serve as alternative data sources, however they suffer serious biases owing to selectivity and may lead to over or underestimates of the level of maternal mortality in the community.

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If the call for usable population-based estimates of maternal mortality by 1995 is to be met by all member states of WHO, alternative and complementary approach to data collection (suitable for developing countries) need to be developed.[2] Wendy Graham, William Brass and Robert W. Snow have initiated in developing a new approach called sisterhood method.[3,4,5] Sisterhood method is an indirect technique to derive population –based estimates of maternal mortality from the proportions of sisters dying of pregnancy–related causes reported by adult respondents during a census or survey. This paper describes their method and presents findings of applying this method in Mojokerto, East Java.

THE SISTERHOOD METHOD.

This section is abstracted from papers by Wendy Graham et. al. [3,4,5]. Those who are interested to know the methodology in more detail should consult to these papers.

The sisterhood method is a new, indirect technique for deriving population –based estimates of maternal mortality. It uses the proportions of adult sisters dying during pregnancy, childbirth, or the puerperium reported by adults during a census or survey, to derive a variety of indicators of maternal mortality.

Basically the method is adapted from the sibling survivorship method developed by Hill and Trussell[6]. The sibling survivorship method is based on questions asked of adults on the survival of all their brothers and sisters ever born, and is generally regarded as the indirect technique that is most suitable for obtaining estimates of non–cause specific mortality among young adults.

Drawing on the knowledge of model fertility and mortality distributions,[7] a simple procedure has been developed for deriving indicators of maternal mortality based on the reported proportion of sisters who reached the age of exposure to the risk i of pregnancy–related death, and who are either alive or have died during pregnancy, childvirth, or the puerperium (the procedure is called sisterhood method). The proportion of sisters dying during pregnancy, childbirth or the puerperium [$\pi_i(u)$], reported in a census or survey by respondent aged u, may related to the probability of dying from maternal causes by age u, q(u). The method corrects the π (u) to provide an estimate of q(u) or q(w), the probability of maternal death by the end of the reproductive period – in other words, lifetime risk. Adjustment factor, Ai (see Table A1), are applied to the number of sisters entering the reproductive period indicated by respondents in age group i (for five–year age groups), to derive sister units of risk exposure to maternal death over the whole reproductive period, Bi. Since the number of sisters who have entered the reproductive period reported by respondents in the younger age groups will exclude those sisters yet to enter the period, a raising factor is required to arrive at the expected ultimate number. An approximation of the expected number is proposed by multiplying the number of respondents in the younger age groups by the average number of sisters reaching the reproduc-

Table Al : Adjustment factors, Au, for estimating q(w) from π (u).*)

Age of respondent (u)	Au	Age of respondent (u)	Au
12.5	0.048	42.5	0.802
15	0.073	45	0.856
17.5	0.107	47.5	0.900
20	0.151	50	0.934
22.5	0.206	52.5	0.958
25	0.270	55	0.975
27.5	0.343	57.5	0.986
30	0.421	60	0.992
32.5	0.503	62.5	0.996
35	0.585	65	0.998
37.5	0.664	67.5	0.999
40	0.737	70	1.000

*) Derived from the model $q(u) = q(w) \exp[-\exp[0.5-0.8Y^*(u)]]$, where $y^*(u)$ is the standard schedule.

Source : Wendy Graham et.al. (1989).

Table A 2 : Estimates of time–location for the sisterhood method.*)

Age of respondent (u)	T(years)	Age of respondent (u)	T (years)
17.5	5.7	47.5	17.5
22.5	6.8	52.5	21.2
27.5	8.1	57.5	25.6
32.5	9.7	62.5	30.3
37.5	11.7	67.5	35.2
42.5	14.3	72.5	40.2

*) Derived from :

$$T = \frac{\int_0^{\infty} \ominus(z)\, dz \int_{u+z}^{\infty} q(x)\, dx}{\int_c^{\infty} \ominus(z)\, q(u+z)\, dz}$$

Source : Wendy Graham et.al. (1989).

tive period per respondent in the older age groups.

Taking the number of maternal deaths, ri, and dividing by Bi, adjusted sister units of risk exposure over the whole reproductive period, gives an estimate of q(w) can be taken as a separate estimate. In this circumstances, a relevant consideration is locating the time period to which the individual estimates of q(w) refer. The value of Ti, the number of years prior to data collection to which the estimates from group i refer, ranges from 5.7 years from the reports of respondents aged 15–19 to 35.2 years from respondents age 65–69 (see Table A2),

However, in many situations where the method is likely to be applied, the number of maternal deaths will be too small to derive stable estimates from the reports of individual age groups of respondents. The data will therefore need to be aggregated to provide a single best estimate of q(w), Q, and of T. For respondents under age 50, there is not much variation in the combined estimate of the latter, where $T = \Sigma [BiTi] / \Sigma [Bi]$, is about 12 years before data collection. The estimate of Q, lifetime risk, is calculated simply by summing over the ri for the age groups (say under 50) and over the corresponding Bi to give B, and calculating r/B.

FIELD TRIAL OF THE SISTERHOOD METHOD IN MOJOKERTO, EAST JAVA.

In April 1989 a community based survey was carried out in Mojokerto, East Java. The survey was part of the integrated studies : "Indirect measurement of childhood mortality" and "Simple monitoring of Childhood mortality"[8,9]. A sample of around 1500 households spread out in all 19 subdistricts of the municipality and regency of Mojokerto were included in the survey. These households were selected on the basis of two stage probability sample. Wilayah pencacahan (enumeration areas), recently created by the local statistical office for the 1990 census, formed the primary sampling units (PSUs). There are 867 enumeration areas (PSUs) in the municipality and regency of Mojokerto. In all, 100 PSUs were selected proportionally to their size (the size was the estimate number of households). At all 100 PSUs selected, listing and mapping were done by the field workers (local statistical office staff). The actual number of households listed may differ from the estimate number of households (used for the basis of PSU selection), but the difference was used for correction in the second stage of selection i.e., drawing equal numbers of households systematically from the enumeration area selected (it was planned to draw 15 households per PSU). Thus the sampling design for the study was actually probability proportional to size (PPS) which yielded a self–weighting sample.

Several questions ascertaining maternal deaths was part of the questionnaires used in the survey. Following the procedure introduced by Wendy Graham et. al, in order to calculate the proportions of sisters dying of maternal causes, four questions were included in the questionnaire and were asked to all members of household aged 15 years and above. The four questions were :

1. How many sisters (born to the same mother) have you ever had who were ever–married (including those who are now dead)?
2. How many of these ever–married sisters are alive now?
3. How many of these ever–married sisters are dead?
4. How many of these dead sisters died while they were pregnant, or during childbirth, or during the six weeks after the end of pregnancy?

These questions together with the five–year age group of the respondent (i.e. all members of household aged 15 +) from the basic data required for the sisterhood method for estimating maternal mortality.

FINDINGS.

Out of the total number of 6421 individuals covered in the survey, 67.7% or 4348 persons were those aged above 14 years, the eligible respondents for answering the four questions. Interviews were conducted with 4325 individuals (2067 male respondents (52.2%). The non–response rate was only 0.5%.

Table 1 : Maternal mortality estimates for Mojokerto, East Java using the sisterhood method (information from male and female respondents).

Age groups of resp. (i)	Number of respondents	Sisters ever married (Ni)	Maternal deaths (ri)	Adjustment factor (Ai)	Sister units of risk exposure (Bi)	Life-time risk of maternal death [q(w)]	Proportion of death sisters dying of maternal causes
(1)	(2)	(3)	(4)	(5)	(6) = (3) x (5)	(7) = (4)/(6)	(8)
15–19	710	1243*	1	0.107	133	0.0075	0.250
20–24	593	1038*	3	0.206	214	0.0140	0.300
25–29	557	886	3	0.343	304	0.0099	0.143
30–34	467	846	10	0.503	426	0.0235	0.400
35–39	361	644	2	0.664	441	0.0045	0.074
40–44	316	610	11	0.802	489	0.0225	0.190
45–49	326	586	10	0.900	527	0.0190	0.152
50–54	291	529	6	0.958	507	0.0118	0.079
55 +	704	1171	18	1.000	1171	0.0154	0.052
Total	4325	7573	64		4212	0.0152	0.102
Total	(15–19)		40		2534	0.0158	0.190

* Dirived by multiplying the number of respondents by the average number of ever–married sisters per respondent reported for the age grouped 25+, that is, 1.751. (Reported numbers : 15–19 = 615, 20–24 = 700).

Table 1 presents the results derived from the information given by both male and female respondents. The table also illustrates the steps involved in calculating the life–time risk of maternal mortality. Sixty–four maternal deaths (r) were identified from 627 death sisters reported by all respondents (10.2%). The number (r) divided by total sister units of risk exposure (B = 4212) gives a life–time risk of maternal death Q = 0.0152.

Table 1 also shows the life–time risk of maternal death [q(w)] by age–group of the respondent. The variations by age of respondents can be interpreted in terms of reporting errors, the limitations of the model fertility and mortality distributions, and time trends in maternal mortality. Considering the sample errors in each age–group are large, it is advisable to agregrate the data to give a more reliable overall estimate. The reports from the higher age groups are also more prone to recall error, it is preferable to omit the responses from respondents older than age 50. Thus a good estimate of overall estimates (Q) may be derived by summing over the ri and over the Bi for respondents under age 50,

and calculating r/B[3,4,5]. Table 1 gives this estimate of 0.0158 or a life–time risk of dying of pregnancy–related causes of about 1 in 63.

Life–time risk of maternal death may be translated into the more well–known measure of maternal mortality (maternal mortality ratio (MMR) : maternal deaths per 100,000 live births) by the approximation :

MMR = 1 – [(probability of survival)$^{1/TFR}$] where TFR is the total fertility rate[3,4,5]. Taking TFR of the survey area (Mojokerto) was 4.00 (the figure is likely close to the condition at the period of late 70's, the time allocation of the overall estimate[10]), an approximation of MMR is 397 maternal deaths per 100,000 live births.

Table 1 also indicates proportion mortality with almost one fifth of sisters reported dead by respondents under age 50 having died during pregnancy, childbirth, or the puerperium. The proportion is much higher than figures reported by respondents above age 50. It is expected for other causes of deaths unrelated to pregnancy, naturally assume greater importance with increasing age.

Table 2 : Maternal mortality estimates for Mojokerto, East Java using the sisterhood method (information from female respondents).

Age groups of resp. (i)	Number of respondents	Sisters ever married (Ni)	Maternal deaths (ri)	Adjustment factor (Ai)	Sister units of risk exposure (Bi)	Life–time risk of maternal death [q(w)]	Proportion of death sisters dying of maternal causes
(1)	(2)	(3)	(4)	(5)	(6)=(3)x(5)	(7)=(4)/(6)	(8)
15–19	359	652*	1	0.107	70	0.0143	0.250
20–24	309	561*	2	0.206	116	0.0172	0.250
25–29	297	487	1	0.343	167	0.0060	0.077
30–34	242	445	4	0.503	224	0.0179	0.235
35–39	157	312	1	0.664	207	0.0048	0.067
40–44	172	331	7	0.802	265	0.0264	0.212
45–49	168	328	5	0.900	295	0.0169	0.143
50–54	168	320	4	0.958	307	0.0130	0.071
55 +	386	663	9	1.000	663	0.0136	0.045
Total	2258	4099	34		2314	0.0147	0.089
Total	(15–49)		21		1344	0.0156	0.168

* Derived by multiplying the number of respondents by the average number of ever–married sisters per respondent reported for the age grouped 25+ that is, 1.815. (Reported numbers : 15–19 = 300, 20–24 = 373).

Table 2 gives a similar picture of maternal mortality estimates for Mojokerto derived from reports of female respondents only. The overall life–time risk of maternal death is 0.0156, not differ ent from the estimate from reports of male and female repondents combined (i.e. 0.0159). However, the proportion of death sisters dying of maternal causes reported by female respondents is much lower, i.e. 0.168 compared to 0.190 reported by both sexes combined. The figure for male respondents is higher i.e. 0.221. The number of dead sisters reported by female respondents are 382 or 0.17 per respondent. The figure for male respondents is 245 or 0.12 per respondent.

Table 3 : Maternal mortality estimates for Mojokerto, East Java using the sisterhood method (information from female age corrected respondents).*

Age groups of resp. (i)	Number of respondents	Sisters ever married (Ni)	Maternal deaths (ri)	Adjustment factor (Ai)	Sister units of risk exposure (Bi)	Life–time risk of maternal death [q(w)]	Proportion of death sisters dying of maternal causes
(1)	(2)	(3)	(4)	(5)	(6)=(3)x(5)	(7)=(4)/(6)	(8)
15–19	359	653 **	1	0.107	70	0.0143	0.250
20–24	308	560 **	1	0.206	115	0.0087	0.143
25–29	298	491	2	0.343	168	0.0119	0.143
30–34	242	445	4	0.503	224	0.0179	0.235
35–39	157	315	1	0.664	209	0.0048	0.067
40–44	171	330	5	0.802	265	0.0189	0.179
45–49	168	322	6	0.900	290	0.0207	0.143
50–54	168	321	4	0.958	308	0.0130	0.071
55+	387	666	10	1.000	666	0.0150	0.045
Total	2258	4103	34		2315	0.0147	0.089
Total	(15–49)		20		1341	0.0149	0.0168

* Corrected only for age of respondent reported their dead sisters of maternal causes (based on the second survey)

** Derived by multiplying the number of respondents by the average number of ever–married sisters per respondent reported for the age grouped 25+ that is, 1.818. (Reported numbers 15–19 = 300, 20–24 = 369).

Table 3 indicates the changes of maternal mortality estimates due to age–misreporting of female respondents with the dead sisters of maternal causes. Correction of age of female respondents was done by reinterviewing ever married women in the study. The ages of respondents derived from the re–interview were considered closer to the true value since probing and consistency checking with their pregnancy histories were paid more special attention. More than 80% female respondents reported dead sisters of maternal causes were from ever married women. Since age correction was applied only for those ever married women, the changes indicated by table 3 is thus partially corrected. Age misreporting changes the overal life–time risk of maternal death from 0.0156 (from table 2) to 0.0149 or a change of less than 5%.

Table 4 : Time–trend of maternal mortality for Mojokerto using the sisterhood method.

Age groups	Male and female respondents						Female respondents						Age corrected female respondents					
	Bi	$\sum B_i$	ri	$\sum r_i$	$q_{(w)}$	T*	B_i	$\sum B_i$	r_i	$\sum r_i$	$q_{(w)}$	T*	B_i	$\sum B_i$	r_i	$\sum r_i$	$q_{(w)}$	T*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
15–19	133	133	1	1	0.0075	5.7	70	70	1	1	0.0143	5.7	70	70	1	1	0.0143	5.7
20–24	214	347	3	4	0.0115	6.4	116	186	2	3	0.0161	6.4	115	185	1	2	0.0108	6.4
25–29	304	651	3	7	0.0108	7.2	167	353	1	4	0.0113	7.2	168	353	2	4	0.0113	7.2
30–34	426	1077	10	17	0.0158	8.2	224	557	4	8	0.0139	8.2	224	557	4	8	0.0139	8.2
35–39	441	1518	2	19	0.0125	9.2	207	784	1	9	0.0115	9.1	209	786	1	9	0.0115	9.1
40–44	489	2007	11	30	0.0150	10.4	265	1049	7	16	0.0153	10.4	265	1051	5	14	0.0133	10.4
45–49	527	2534	10	40	0.0158	11.9	295	1344	5	21	0.0156	12.0	290	1341	6	20	0.0149	11.9
50–54	507	3041	6	46	0.0151	13.5	307	1651	4	25	0.0151	13.7	308	1649	4	24	0.0146	13.7
55+	1171	4212	18	64	0.0151	–	663	2314	9	24	0.0147		666	2315	10	34	0.0147	–

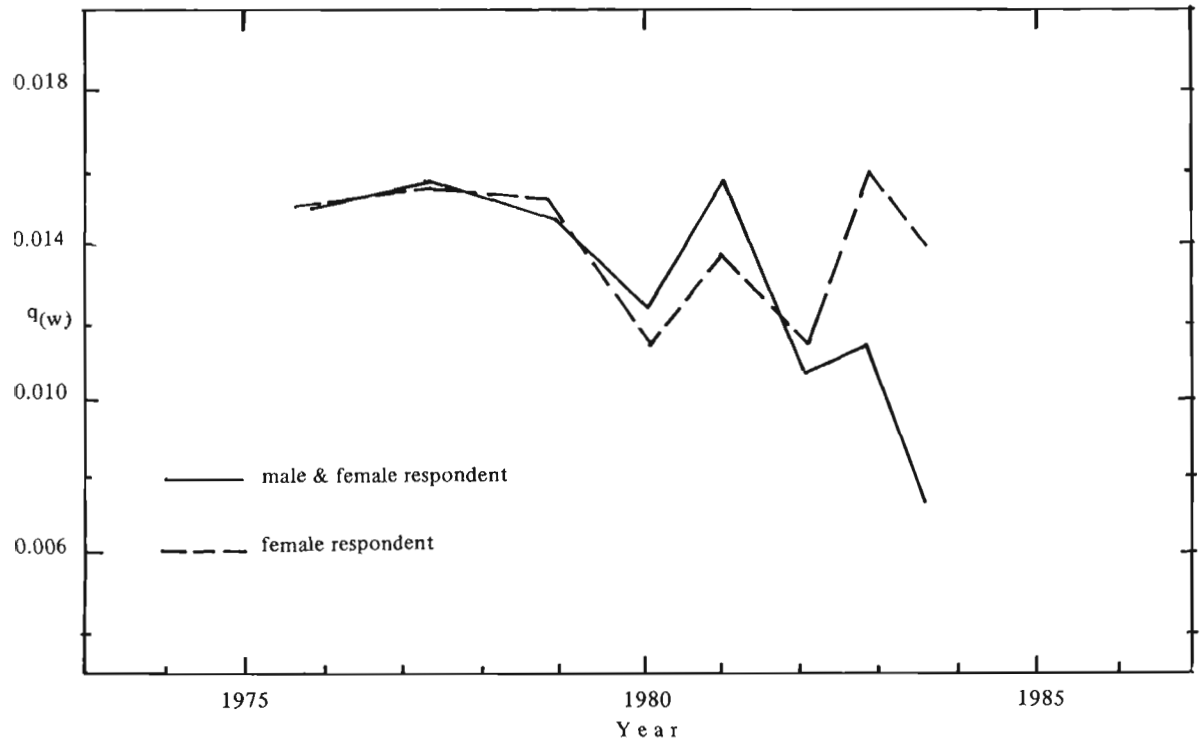
Note :

* Calculated from $[\sum BiTi/\sum Bi]$, where Ti refers to time–location by age group.
Col (2) and (4) are from Table 1, col (8) dan (10) are from Table and col (14) and (16) are from Table 3.
$q_{(w)} = [\sum r_i]/[\sum B_i]$.

Table 4 tries to show time–trend of maternal mortality for Mojokerto. Ideally, if the number of sisters in each respondent age group is large enough, each $q_{(w)}$ could be taken as a separate estimate with different time location. The number of sisters reported by respondents in Mojokerto study is not large enough, therefore a single estimate is advisable. However trying to agregrate the number of sisters by respondent age group subsequently, a cumulative r_i and B_i could be calculated by age group and different life–time risk of maternal death could be obtained. Different procedure of allocating time period for each estimate

could also be done (see note under Table 4). Doing this procedure we should be cautious that estimates by younger age groups are prone to instability. The estimates based on the above procedure are illustrated by Table 4. In general they indicate declining of maternal mortality in Mojokerto (see also Figure1).

Figure 1 : Trend of life–time risk of maternal death Mojokerto, East Java.



Source : Table 4.

DISCUSSION.

The first trial of sisterhood method in Indonesia was carried out in the municipality and regency of Mojokerto, East Java in April 1989. The first field trial of this method was conducted in The Gambia, West Africa , in September 1987[3]. Another field performance was reported in Lima, Peru[4]. The three field trials indicate estimates of maternal mortality consistent to the expected condition of the three areas. The overall life–time risk of maternal death in The Gambia was 0.0584 (or 1 in 17). The estimates for Mojokerto and Lima were 0.0158 (or 1 in 63) and 0.0090 (0r 1 in 111) respectively. The three estimates give approximate MMR's for the three

areas are respectively 1005, 397 and 253 per 100,000. WHO has reported the highes maternal deaths per 100,000 live births in Africa (640 per 100,000) followed by South Asia (572 per 100,000), Latin America (270 per 100,000), East Asia (55 per 100,000) and Lima were 0.0158 (or 1 in 63) and 0.0090 (or 1 in 111) respectively. The three estimates give approximate MMR's for the three areas are respectively 1005, 397 and 253 per 100,000. WHO nas reported the highest maternal deaths per 100,000 live births in Africa (640 per 100,000) followed by South Asia (572 per 100,000), Latin America (270 per 100,000), East Asia (55 per 100,000) and the lowest in North America and Europe (20 per 100,000). Life–time risk of dying from pregnancy–related causes in Africa was 1 in 25 , in South Asia was 1 in 38 and in Latin America was 1 in 90. Indonesia has shown a similar level of maternal mortality to those countries in the South Asia Region. [Fast Sheet, HFA–AFH, 1988] ;

Studies providing MMR estimation in Indonesia were reported by few researchers. Ratna Budiarso reported a high MMR based on her national health survey in 1985/86 i.e. 450 per 100.000 but much lower estimate based on her earlier survey (150 per 100,000 in 1980)[11,12]. Few studies by region showed variation of MMR. Ratna Budiarso reported MMR of 430 per 100,000 in Sukabumi (1982)[13], Anna Alisyahbana reported MMR of 170 per 100,000 in Ujung Berung (1978/80),[14] and Partiwi and Soemartono reported MMR of 244 per 100,000 in Mojokerto (1978/79).[15] The highest estimate of MMR(718 per 100,000) was reported for Bali (1989/82) by Inne Susanti[16]. The considerable variation in reported MMR to some extent could be due to differences in study design or perhaps due to actual variation. Direct method (from community survey) for providing MMR estimates on the basis of identification ofs maternal deaths from death of reproductive–aged women usually underestimate MMR. A more suitable estimate usually could be obtained by prospective monitoring of pregnant women up to 6 weeks after end of pregnancy.[1]

Indirect estimate of MMR for Mojokerto (397 per 100,000) is higher than direct estimate (224 per 100,000) reported by Partiwi and Soemartono (both estimates refer to the same period i.e. late 70 s).[15] The difference may be due to difference in study design. Partiwi's study was based on direct indentification of maternal deaths from deaths of reproductive–aged women, thus it can be expected to be prone to under reporting.

It was well documented that general mortality condition of East Java is better than that of West Java [17, 18, 19], and it can be expected that East Java will live a lower estimate of MMR than West Java. Based on this expectation, and considering of different time reference and prono to under–reporting of direct approach, a lower estimate of MMR for Mojokerto, East Java (397 per 100,000 for the period of late 70's) is comparable with higher estimate of MMR in Sukabumi, West Java (430 per 100,000 for the year of 1982).

CONCLUSION.

The indirect approach (called sisterhood method) of providing maternal mortality estimates is a new technique and can be cosidered as an alternative approach of data collection procedure. Field trials in Mojokerto has added experiences of applying the method integrated in other surveys. Consistent results was also demonstrated by the three field trials in Africa, Latin America and Indonesia. The indirect estimate of MMR is also comparable to the other direct method after taking into account the shorthcomings of the latter. Considering its simplicity, the technique is potentially promissing for the alternative data collection approach for providing maternal mortality in developing countries. The approach is suitable to be integrated in the routine data collection eg the national census/survey.

It is too early to conclude that the approach can be used as a standard technique. Further developments for refinement raised by the inventor are still in need eg. refinement of the adjustment factors, questions wording, inclusion of men and women respondents etc. The applicability of the approach for areas with high–mobility population (e.g. urban area) is another question to be examined.

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