ORIGINAL ARTICLE

Life Time Risk of Maternal Death in districts of Maharashtra State, India: Mathematical Estimation Using Proxy Indicators

Prakash Prabhakarrao Doke

Professor, Department of Community Medicine, Bharati Vidyapeeth Deemed University Medical College, Pune, 411043

Corresponding Author

Address for Correspondence: Prakash Prabhakarrao Doke, Professor, Department of Community Medicine, Bharati Vidyapeeth Deemed University Medical College, Pune, 411043
E Mail ID: prakash.doke@gmail.com

Citation

Doke PP. Life Time Risk of Maternal Death in districts of Maharashtra State, India: Mathematical Estimation Using Proxy Indicators. Indian J Comm Health. 2017; 29, 3: 215-221.

Source of Funding: Nil **Conflict of Interest:** None declared

Article Cycle

Received: 17/06/2017; **Revision:** 07/07/2017; **Accepted:** 13/09/2017; **Published:** 30/09/2017

Abstract

Background: Maternal Mortality Ratio, Maternal Mortality Rate, Life Time Risk of Maternal Death are used to describe maternal mortality. First is most commonly quoted indicator. The Life Time Risk is most comprehensive. Three simple methods of calculations of Life Time Risk are documented. The calculations require Maternal Mortality Ratio and Total Fertility Rate; Maternal Mortality Rate and Reproductive Age Group Span. Reliable district wise data of these indicators is unavailable. **Aim & Objectives**: To calculate district wise life time risk of maternal deaths. **Material & Methods**: The proportion of non-institutional deliveries was used as proxy for Maternal Mortality Ratio and the proportion of couples not using any family planning method was used as proxy for the Total Fertility Rate. The correlation and regression equation between estimated Life Time Risk using standard method and using proxies was calculated. District wise Life Time Risk for Maharashtra state was calculated using the regression equation. **Results:** Good correlation was observed using proxies (r=0.97) and regression equation was: y=0.09+1.71x. For Maharashtra state the estimated of Life Time Risk was found to be 0.14% which exactly matched the estimate using conventional method. **Conclusion**: Using proxies reliable estimates of Life Time Risk for districts can be calculated.

Keywords

Maternal mortality indicators; Life Time Risk; Proxy for Total Fertility Rate; Proxy for Maternal Mortality Ratio.

Introduction

The Sample Registration System (SRS) has published state wise maternal mortality from 1997 to 2011-13. (1) The Annual Health Surveys (AHS) covering nine states provide maternal mortality estimates for a cluster of districts. (2) Probably the Life Time Risk of Maternal Death is an ideal indicator because it is easily understandable even by lay persons, as it tells one's own risk and secondly it is composite index. Health administrators want estimate of maternal mortality for specific districts. However, an accurate estimation of maternal mortality is difficult due to many reasons including the inherent definitional problem. There is substantial under registration of deaths in developing countries including India. Even if the death is registered, the cause of death is not given precisely; instead some vague term is used. The Government of India has continued the goal of reduction in Maternal Mortality Ratio to less than 100/100,000 live births in the National Health Mission and also in the 12th Five Year Plan. Regular

monitoring up to district level to assess the progress is an essential aspect of achieving this goal. Considering the inability of directly calculating the ratio or rate for the districts, there is a need for some alternative estimation of maternal mortality.

Aims & Objectives

1. To choose most informative maternal mortality indicator
2. To estimate district wise information of the selected indicator

Material & Methods

Study type: It is a desk research of available data.

Study population: The population of Maharashtra state as per 2011 census is 112,374,333 and it constitutes about 10% of the population of India. There are 35(one more is recently added) districts in the State and 17out of them have been notified as tribal districts.

Study duration: The study was carried out in 2016.

Sampling: It is an analysis of available secondary data pertaining to whole state. Hence sample size estimation, inclusion and exclusion criteria, data collection and ethical approval is not applicable.

Calculation methods: The author has used well acknowledged three simple methods of calculating LTR in this article and they are given below. The first two methods of calculation have been described by Wilmoth. (3) These simple methods have been formulated disregarding other causes of death in the specific age groups.

Lifetime Risk of Maternal Death (LTR_1) = Maternal Mortality Ratio X Total Fertility Rate

Lifetime Risk of Maternal Death (LTR_2) = Maternal Mortality Rate X 35

SRS Maternal Mortality (MM) reports have calculated estimates of all indicators of maternal mortality for Indian states. In these reports LTR is calculated by using a slightly different method from the two described above. It is also another simple way of calculation of LTR and it is given below.

Lifetime Risk of Maternal Death (LTR_3) = 1 - (1- Maternal Mortality Rate/100,000)[35].

Sources of data and process of estimation: Author first calculated LTR for the same large states in India mentioned in the SRS report using the first two methods described above. The LTR thus calculated was expressed in percentage terms so as to make it comparable with LTR given by third method cited in the SRS MM reports. The pre-requisite information of Maternal Mortality Ratio and Mortality Rate required for calculation was taken from SRS MM report for 2011-2013 while the information about Total Fertility Rate was taken from SRS statistical report for 2013. (4)

The correlation coefficients between estimates of LTR by all the three methods were then calculated. The first method using Maternal Mortality Ratio and Total Fertility Rate was preferred over other two methods for further derivation because it gives precise and instant understanding of the concept of life time risk. Unfortunately, district level information of both prerequisite indicators is not available; hence the proportion of non-institutional deliveries was selected as a proxy for Maternal Mortality Ratio and proportion of couples not using any family planning method was selected as a proxy for Total Fertility Rate. The state wise data for these two proxy indicators was taken from the District Level Household Survey 3 (DLHS 3). (5) The correlation coefficient between the pre-requisite indicators and their proxies was then calculated. Next, proxy LTR was calculated by using proxy prerequisite indicators. The correlation coefficient between proxy LTR thus calculated and LTR_3 described in SRS report was then calculated. Finally, the regression equation to estimate LTR_3 from proxy LTR was calculated. The actual state wise data from SRS MM report 2011-2013 was used to derive the linear equation. Using this equation, LTR for the districts of Maharashtra state was calculated. The district wise information of the two proxy indicators is taken from DLHS 4 conducted in 2012-2013. (6)

Results

LTR calculated by all three methods for major Indian states is given in Table 1. The values of LTR derived by second and third methods were exactly same. The correlation between the first and third methods is also almost complete (r=0.99; 95% C.I. 0.97-1.00), excepting for the slight difference in six states. In all of these six states, the first method using TFR has given marginally lower estimates. All the deviations in the differences were within +1.5 Z score and t_{28}= -0.4 (p=0.69). The correlation between Total Fertility Rate and proportion of couples not using any family planning method as well as between Maternal Mortality Ratio and non-institutional deliveries is given in Table 2 using statistics from major states. There is very good and positive correlation between original indicators and their proxies. The analysis indicates that there is also very good positive

correlation between conventional LTR_3 and product of proportion of not using any family planning methods and non-institutional deliveries per 100,000 population (proxy LTR); however, for comparison it is expressed as %.

The linear relationship between LTR_3 and proxy LTR is depicted in the Figure 1. The line regression equation is; y==0.093+0.0172x.

The estimated LTR3 in the districts of Maharashtra state is given in Table 3. The estimated LTR_3 for Maharashtra by the proposed method is 0.14%.

The district wise LTR_3 as estimated by this method is depicted in Figure 2 as a box plot. It is observed that only one district is an outlier and that district is a tribal district.

Discussion

In Sustainable Development Goals, in health sphere maternal mortality has been mentioned at first position resulting into rejuvenated attention towards the problem. Out of the four indicators of maternal mortality, Life Time Risk of maternal death is an important summary measure of population health but rarely reported in the papers in the scientific journals. It only appears in few international reports like WHO estimates and in national publications like Office of the Registrar General India. Technically, Maternal Mortality Ratio is the probability of the woman dying any time during the whole process from conception of her child through the post-partum period. However, a complete registration of all conceptions or even pregnancies is an unachievable task. The best proxy used for the complete process therefore is live births. In most of the places and for a considerable time period, the proportion of live births to total pregnancies remains fairly constant and therefore comparison between two places or two periods may not vitiate the status tremendously. The Maternal Mortality Ratio is obviously affected by the quality of obstetrics services. In fact, one may consider that Maternal Mortality Ratio represents the obstetrics risk and therefore is also an indicator of the quality of obstetrics services. The second indicator, Maternal Mortality Rate considers the population at risk as denominator and is directly influenced by age-group composition. It is related to Maternal Mortality Ratio through the General Fertility Rate. Whereas the Life Time Risk of Dying a Maternal Death considers two aspects; the risk associated with each pregnancy and also how many times the woman is exposed to the risk in her life time. Exposure to the risk of pregnancy is natural but the frequency of pregnancy is in turn an outcome of provision and acceptance (or lack thereof) of family welfare services. The importance of family planning in reduction of maternal mortality was well acknowledged in 1987, since the concept of Life Time Risk was developed, (7) but appears to be trailing in terms of attracting attention. Life Time Risk seems to be a better indicator for providing evidence at an individual level and which may be more comprehensible for a lay or illiterate person. Life time risk of maternal death is expressed in two ways; deaths per standard denominator (100 or 1,000 or 10,000) like 0.4% (1) or 0.0125 (or 125/10,000), (3) 5 to 6 deaths per 1,000 women. (8) It is also expressed as 1 death in number of women like 1 in 4900 in developed countries and 1 in 180 in developing countries, (8,9) Published international statistics pertaining to this indicator are available from about 1990. The word “Life time” in this indicator implies woman’s reproductive lifespan. It assumes that prevalent fertility and mortality (including maternal mortality) levels do not change in the near future. The reproductive lifespan is usually taken to be a period of 35 years. Accordingly, the estimation methods are formulated.

Although conceptually and technically Life Time Risk is a good indicator, its calculation requires estimate of Maternal Mortality Rate or Maternal Mortality Ratio and Total Fertility Rate. All these prerequisite statistics are regularly not available. Especially for an administrative unit like the district, the estimates are certainly not available. For smaller districts, calculation may not yield valid estimates. Even for larger districts with population of more than 5 million, the availability of pre-requisite information is almost non-existent. In eight Empowered Action Group states and one difficult state, the Annual Health Surveys are currently providing all the required information about cluster of districts. (2) The difficulties in estimation of conventional indicators are clearly reflected in the differences about statistics published by two equally reputed systems from the same organization. (1,2) The reports from SRS do not correlate with reports from AHS. It is difficult to explain the discrepancy. Probably the only reason could be outsourcing of field work in AHS and well trained staff in SRS system. There may be difficulty in labeling maternal death. This, buttresses the felt need of alternative and

correct estimation method. All the three methods of estimating LTR are in almost full agreement, (10) and hence any method can be used. The best proxy for Maternal Mortality Ratio is the quality of obstetrics services. This indicator itself is conceptual one and data may not be easily generated. In developed countries, deliveries attended by obstetricians or rate of complications or prompt management of complications etc. may represent quality of obstetrics services. The author suggests that 'proportion of non-institutional deliveries' (to accommodate small and vulnerable proportion of deaths in transit and field) may be an appropriate proxy for quality of obstetrics services in developing countries including India and pertaining district level information is easily available from District Level Household Surveys. Other proxy indicators like full ante-natal care, registration in first trimester etc. were explored but non-institutional delivery was found to have the best correlation (r=0.85) as seen in Table 2. This correlation between maternal mortality ratio and institutional delivery is universally observed. (2,11,12) Realizing that institutional delivery is most important determinant for reduction in MMR Government of India has given strong emphasis on promoting institutional deliveries. Similarly, the author suggests proportion of couples not using any family planning method as a proxy for Total Fertility Rate. TFR is certainly strongly influenced by proportion of couples not using any family planning method/or contraception prevalence rate. (13,14) The correlation may be somewhat low at few places. (15) Results obtained using this indicator had a better correlation than results using the Contraception Prevalence Rate. The reason could be use of diverse methods which are dominated by permanent method to the tune of almost 50%. Proportion of couples not using any family planning method is also easily available from DLHS. Recent pre-requisite data for some states is available from DLHS 4 and for other states from Annual Health Surveys for 2012-2013. For one state Gujarat the recent data is not yet available, hence for uniformity DLHS 3 data which provides data for all states is used. The figures from Table 2 clearly show good and positive correlation between them. The proxy LTR is directly proportional to LTR_3 (r=0.86). Full agreement between these two variables is not expected and hence regression equation was derived to calculate LTR. The group of women possessing both the attributes is probably having highest risk and almost all deaths may be from this group only. The present attempt to calculate LTR as in context to the women from this group by using regression equation is thus justifiable.

The average life-time risk of dying a maternal death in Maharashtra is 0.14 which perfectly matches with the 2011-2013 SRS estimate. The statistics used in Table 3 are the latest for the year 2012-2013 and are almost corresponding to period of the recent SRS report. The range also seems to be realistic as per anticipation. It is high in tribal districts and low in non-tribal districts. The range for 15 notified tribal districts is 0.11-0.24 (0.13) and for non-tribal districts it is 0.10-0.18 (0.08). Only Nandurbar district is outlier district which is having the highest proportion (69.3%) of tribal population. Most importantly, the method appears to provide very reliable information of maternal mortality for the district level, which may not be available presently from any source. After regular maternal death audits district level information about maternal mortality ratio is available with varied reliability. These reports are usually grossly under reported. Under National Health Mission decentralization is one of the key strategies and hence district plans are emphasized. Such district level estimation certainly may serve useful purpose for giving appropriate emphasis the method on family-planning measures and in improving the quality and number of institutional deliveries in the districts. This can also guide to provide differential weightage to various strategies.

This mathematical estimation of LTR for districts or states (in developing countries) can be used where some proportion of deliveries are non-institutional. At extremes of observations particularly of non-institutional deliveries the equation may not be valid.

Conclusion

Life Time Risk of maternal death is easy to understand and more comprehensive indicator. The required information like MMR or TFR for its calculation is not available at district level. But information of suggested proxy indicators is easily available. Calculation of LTR for districts using proxies may provide reliable estimates.

Recommendation

This method of calculation of LTR is recommended to be used in the field in different states, including from developing countries.

Limitation of the study

While selecting the proxy indicators more weightage was given to correlation coefficient and regression than conceptual resemblance.

Relevance of the study

Although not popularly used LTR is very good indicator and its district wise estimation is easily computable.

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Tables

TABLE 1 LIFE TIME RISK; ESTIMATES BY DIFFERENT METHODS

S. No.	State	MM Ratio*	MM Rate*	LTR%$_3$*	TFR**	LTR%$_1$	LTR%$_2$
		1	2	3	4	5=1X4	6=2X35
1	Andhra Pradesh	92	5.9	0.2	1.8	0.2	0.2
2	Assam	300	19.6	0.7	2.3	0.7	0.7
3	Bihar/Jharkhand	208	21.4	0.7	3.4	0.7	0.7
4	Gujarat	112	8.7	0.3	2.3	0.3	0.3
5	Haryana	127	10	0.4	2.2	0.3	0.4
6	Karnataka	133	7.5	0.3	1.9	0.3	0.3
7	Kerala	61	3.2	0.1	1.8	0.1	0.1
8	M.P./Chhattisgarh	221	20.2	0.7	2.9	0.6	0.7
9	Maharashtra	68	4.1	0.1	1.8	0.1	0.1
10	Orissa	222	15.1	0.5	2.1	0.5	0.5
11	Punjab	141	8.2	0.3	1.7	0.2	0.3
12	Rajasthan	244	23.9	0.8	2.8	0.7	0.8
13	Tamil Nadu	79	4.5	0.2	1.7	0.1	0.2
14	U.P./Uttarakhand	285	27.6	1.0	3.1	0.9	1.0
15	West Bengal	113	6.3	0.2	1.6	0.2	0.2
	India	167	11.7	0.4	2.3	0.4	0.4

Source: *Ref. 1, ** Ref. 4

TABLE 2 SELECTED PROXIES FOR CALCULATION OF LIFE TIME RISK

S. No.	States/UTs	Not using any method %**	TFR*	Home del. %**	MM Ratio***	Proxy LTR (1)X(3)%	LTR_3%***
		(1)	(2)	(3)	(4)	(5)	(6)
1	Andhra P.	33.3	1.8	27.8	92	9.26	0.20
2	Assam	51.4	2.3	63.8	300	32.79	0.70
3	Bihar	66.7	3.4	71.6	208	47.76	0.70
4	Gujarat	36.7	2.3	42.2	112	15.49	0.30
5	Haryana	37.1	2.2	52.7	127	19.55	0.40
6	Karnataka	36.8	1.9	34.1	133	12.55	0.30
7	Kerala	35.6	1.8	0.6	61	0.21	0.10
8	Madhya P.	42.2	2.9	52.3	221	22.07	0.70
9	Maharashtra	34.9	1.8	35.9	68	12.53	0.10
10	Orissa	51.8	2.1	54.7	222	28.33	0.50
11	Punjab	30.7	1.7	36.5	141	11.21	0.30
12	Rajasthan	41.9	2.8	53.8	244	22.54	0.80
13	Tamil Nadu	38.9	1.7	5.7	79	2.22	0.20
14	Uttar P.	61.6	3.1	74.6	285	45.95	1.00
15	West Bengal	28.0	1.6	50	113	14.00	0.20
	r(C.coefficient) (95% C.I.)	0.82 (0.53-0.94)		0.85 (0.60-0.95)		0.86 (0.62-0.95)	

Source: *Ref. 4, **Ref. 5, *** Ref. 1

TABLE 3 ESTIMATION OF LTR IN MAHARASHTRA STATE

S. No.	District	Not using any FP** %	Non-inst.** Del. %	Proxy LTR=3X4	LTRE
1	2	3	4	5	6
1	Ahemadnagar*	35.10	6.3	0.02	0.13
2	Akola	27.40	11.4	0.03	0.15
3	Amravati*	28.50	4.0	0.01	0.11
4	Aurangabad	39.10	9.0	0.04	0.15
5	Bhandara*	30.60	5.1	0.02	0.12
6	Bid	33.30	1.3	0.00	0.10
7	Buldhana	32.70	6.8	0.02	0.13
8	Chandrapur*	28.40	10.6	0.03	0.14
9	Dhule*	35.30	15.7	0.06	0.19
10	Gadchiroli*	29.40	17.4	0.05	0.18
11	Gondiya*	31.20	11.5	0.04	0.15
12	Hingoli	34.70	5.9	0.02	0.13
13	Jalgaon*	40.40	13.7	0.06	0.19
14	Jalna	37.40	12.3	0.05	0.17
15	Kolhapur	26.00	2.6	0.01	0.10
16	Latur	34.80	4.5	0.02	0.12
17	Mumbai	38.20	0.8	0.00	0.10
18	Mumbai (Suburban)	42.90	5.1	0.02	0.13
19	Nagpur*	28.70	3.0	0.01	0.11
20	Nanded*	37.30	12.8	0.05	0.18
21	Nandurbar*	42.50	19.8	0.08	0.24
22	Nashik*	35.50	12.1	0.04	0.17
23	Osmanabad	32.00	4.2	0.01	0.12
24	Parbhani	37.40	6.2	0.02	0.13
25	Pune*	31.20	4.8	0.01	0.12
26	Raigad*	35.50	9.7	0.03	0.15

27	Ratnagiri	40.00	0.9	0.00	0.10
28	Sangli	31.90	5.9	0.02	0.13
29	Satara	29.90	2.4	0.01	0.11
30	Sindhudurga	39.10	0.8	0.00	0.10
31	Solapur	31.10	7.8	0.02	0.13
32	Thane*	42.30	5.6	0.02	0.13
33	Wardha	23.30	3.9	0.01	0.11
34	Washim	30.40	14.4	0.04	0.17
35	Yawatmal*	33.80	10.9	0.04	0.16
	Maharashtra	33.80	8.0	0.03	0.14

*Notified tribal district, ** Source: Ref. 6, E= Estimated

Figures

FIGURE 1 REGRESSION LINE BETWEEN PROXY LTR AND LTR

Figure 1 Regression line between proxy LTR and LTR

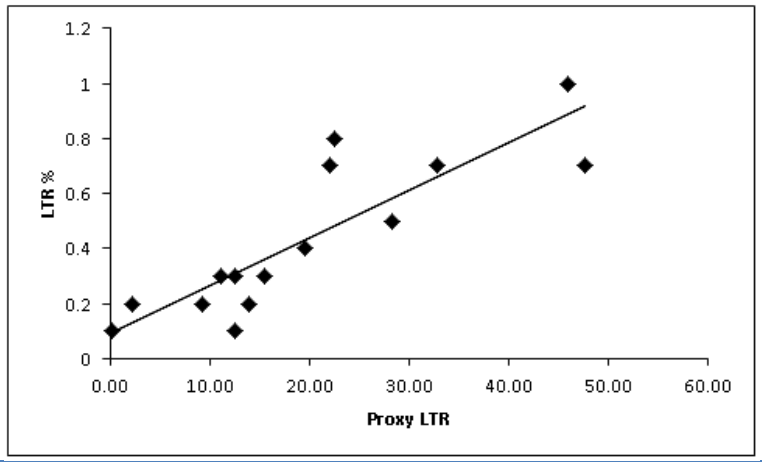

FIGURE 2 LIFE TIME RISK OF MATERNAL DEATH IN DISTRICTS IN MAHARASHTRA, INDIA

Figure 2 Life Time Risk of Maternal Death in districts in Maharashtra. India