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Contents lists available at ScienceDirect

International Journal of Gynecology and Obstetrics

journal homepage: www.elsevier.com/locate/ijgo



AVERTING MATERNAL DEATH AND DISABILITY

Maternal mortality in low-income countries: What interventions have been evaluated and how should the evidence base be developed further?

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ARTICLE INFO

Article history:

Received 27 May 2008

Accepted 21 December 2008

Keywords:

Evidence base

Interventions

Low-income countries

Maternal mortality

Research methods

Review

ABSTRACT

Objective: This article reviews the evidence for the effectiveness of non-clinical interventions to reduce maternal mortality in low-income settings and identifies the gaps in the evidence base. **Methods:** A systematic search was conducted to identify reviews and evaluations of non-clinical interventions to reduce maternal mortality in lower-income countries with high maternal mortality published between 1997 and 2008. Studies were reviewed to identify the topic focus, study design, and outcomes measured. **Results:** There were 109 intervention evaluations and 30 reviews identified. Studies had been conducted in less than half of the countries and were generally poor quality. More studies focused on tertiary prevention (i.e., preventing death) rather than secondary prevention (i.e., preventing complications). More interventions sought to address quality of care than delays in seeking or accessing care. **Conclusions:** While evidence partly reflects difficulties in evaluating complex public health interventions, more robust study designs are possible to evaluate interventions to reduce maternal mortality. In addition, better standardized outcome measures are needed. This overview identifies topic areas neglected by intervention research.

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1. Introduction

In 2000 there were an estimated 529 000 maternal deaths globally, with 99% occurring in low-income countries [1]. Reducing maternal mortality is a Millennium Development Goal, yet the differential between high- and low-income countries remains higher than for any other health indicator.

It is often claimed that “we know what works” to reduce maternal mortality [2–5]. While this is undoubtedly true in terms of clinical interventions, the evidence base is less clear regarding *how* to provide these interventions to ensure they reach all women, or which non-clinical interventions reduce the risk of developing complications that may lead to maternal death [6–9].

Maternal mortality prevention can be targeted at 3 levels: primary prevention (prevention of pregnancy); secondary prevention (prevention of obstetric complications); and tertiary prevention (preven-

tion of maternal death once complications have arisen). The “3 delays” (decision to seek care, access to care, and timeliness and quality of care) concern tertiary prevention. To maximize the potential utility of their own studies, it is important that maternal health researchers understand the state of the evidence base for non-clinical interventions, upon which policy and practice decisions could be based. This article aims to explore the breadth and nature of the evidence base surrounding the effectiveness of non-clinical interventions that aim to reduce maternal mortality in low-income countries. Three sets of research questions have been identified: (1) What interventions have been evaluated and where are the gaps?; (2) What study design and outcome measures were used and what are the challenges associated with them?; (3) What types of evaluations and what evaluation foci are needed to strengthen the evidence base?

Given that the greatest burden of maternal mortality falls on lower income countries, this article focuses on studies carried out in low-income countries (as defined by the World Bank) or higher income countries that had an estimated maternal mortality rate (MMR) of 500 or more in 2000 (Table 1) [1,10]. Although we recognize that evaluations in other higher income countries may also provide useful

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Table 1
Countries included in the evidence map

<i>Low income countries (n=54) [10]</i>
Afghanistan; Bangladesh; Benin; Bhutan; Burkina Faso; Burundi; Cambodia; Central African Republic; Chad; Comoros; Congo, Dem. Rep.; Cote d'Ivoire; Eritrea; Ethiopia; Gambia, The; Ghana; Guinea; Guinea-Bissau; Haiti; India; Kenya; Korea, Dem Rep.; Kyrgyz Republic; Lao PDR; Liberia; Madagascar; Malawi; Mali; Mauritania; Mongolia; Mozambique; Myanmar; Nepal; Niger; Nigeria; Pakistan; Papua New Guinea; Rwanda; Sao Tome and Principe; Senegal; Sierra Leone; Solomon Islands; Somalia; Sudan; Tajikistan; Tanzania; Timor-Leste; Togo; Uganda; Uzbekistan; Vietnam; Yemen, Rep.; Zambia; Zimbabwe
<i>Lower-middle income countries with a high maternal mortality ratio (n=5) [1,10]</i>
Angola; Cameroon; Republic of Congo; Djibouti; Lesotho

findings, assessment of their generalizability to lower income settings is beyond the scope of this article.

2. Materials and methods

Seven databases (Pubmed, Popline, African Healthline, CABDirect, Global Health, Cochrane Database, Eldis) were searched for references referring to maternal death, one of the immediate causes of maternal death, maternal health services or other non-clinical maternal health interventions. The search was limited to papers published between 1997 and 2008. In addition, reference lists from other systematic and literature reviews were searched. The *International Journal of Gynecology and Obstetrics* was also handsearched, from January 2006 to July 2008. Please contact the first author for the search strategy.

Studies were included if they: (1) were intervention evaluations (hereafter referred to as “studies”), or reviews of intervention evaluations; (2) aimed to reduce, or measure, maternal mortality or complications that may lead to maternal death; and (3) were conducted in low-income countries with a high MMR (Table 1); multicountry studies/reviews were included if they contained at least one included country).

Information on the study design, topic focus, and outcome measures used was extracted from included studies and reviews. Since the studies' substance was not being assessed (e.g., findings), key-wording was initially carried out using only the abstracts. If the abstract contained insufficient information, the full paper was sought. This method has been used in mapping research for previous systematic reviews [11].

An analysis was then carried out to identify which aspects of maternal mortality prevention most reviews and studies had investigated and how study designs and outcome measures varied across the evidence base.

3. Results

3.1. Reviews of intervention evaluations

Thirty reviews were identified. Full papers were retrieved for 25 reviews and 4 were key-worded on abstract alone. It was not possible

Table 2
Intervention foci of studies

Focus of intervention	Main focus (No. papers) ^a	Secondary focus (No. papers) ^a
<i>Risk factors of immediate causes of maternal death</i>		
Age	0	0
Health/nutritional status	19	2
Fertility status	4	3
Health service use (non-emergency)	22	1
<i>Inadequate treatment of causes of maternal death</i>		
Decision to seek care	35	7
Access to care	41	7
Quality of care received	51	4

^a Interventions could have more than one focus.

Table 3
Main focus of studies and reviews

Main focus	% Studies (No.)	% Reviews (No.)
<i>Risk factors of immediate causes of maternal death</i>		
Age	0 (0)	0 (0)
Health/nutritional status	17 (19)	37 (11)
Fertility status	4 (4)	10 (3)
Health service use preventing immediate causes	21 (22)	40 (12)
<i>Inadequate treatment of causes of maternal death</i>		
Decision to seek care	32 (35)	7 (2)
Access to care	38 (41)	13 (4)
Quality of care received	47 (51)	30 (9)

to retrieve either an abstract or full paper for 1 review (on skilled attendance at delivery).

Eleven were systematic reviews (i.e., they stated their search strategy and inclusion criteria). Four of these reviewed nutrition interventions; the remaining 7 covered a range of topics: complex interventions, private sector involvement, emergency obstetric care (EmOC), maternity referral systems, prenatal care, malaria prevention during pregnancy and Safe Motherhood interventions (please contact the first author for a complete list of identified articles).

Of the 19 non-systematic reviews, 5 were general reviews of interventions to reduce maternal mortality, 5 reviewed traditional birth attendant (TBA) interventions, and 3 focused on prenatal care. Two reviewed nutrition interventions and 1 each reviewed community interventions, interventions involving transport or communication for obstetric emergencies, and skilled attendance at delivery. One used a model-based analysis to estimate the total reduction in maternal mortality in Sub-Saharan Africa, which could be achieved by combining proven effective prenatal interventions.

Less than half of the reviews assessed the quality of evaluations (n=13); a further 3 were unclear. Five of the 6 nutrition reviews were quality assessed.

3.2. Interventions evaluations

The search identified 109 studies (reported in 124 papers) that met the inclusion criteria. Two additional papers, for which neither an abstract nor full paper could be retrieved, were excluded. Full papers were used to key-word 78 studies and 31 were key-worded using the abstract only.

Studies were identified for only 24 out of a possible 59 countries. The main focus for 25 studies was secondary prevention, 68 focused on tertiary prevention, and 16 covered both (Table 2).

Table 3 shows the topic foci of the studies and the reviews. A greater proportion of the reviews considered secondary prevention (particularly health service use and health/nutritional status) compared with the studies, which focused more on tertiary prevention.

3.3. Study design

Table 4 shows that the majority of studies used a before-and-after design. Relatively few used the more rigorous randomized controlled trial (RCT) design, or even (non-random) trial design.

Table 4
Study designs used

Study design	No. of studies (n=109)
Before-and-after evaluation	60
Randomised controlled trial	17
Trial	15
Post-intervention evaluation only	11
Unclear	6

3.4. Outcomes

Maternal death was measured in 48 studies. Twenty-two measured the number of maternal deaths or calculated maternal mortality ratios, although for almost all, the samples were either too small to detect significant differences or were not stated. Only 3 reported power calculations (one study stated that it only had power to detect a 90% reduction in maternal mortality).

Fourteen studies used the UN indicators of availability of emergency obstetric services [12], although only 10 measured all indicators. One study reported all indicators except the case fatality rate (CFR) and 2 measured only 2 of the indicators (percentage of births taking place in EmOC facilities and met need for EmOC; number of basic and comprehensive EmOC facilities and met need). One only reported the number of hospitals providing basic and comprehensive EmOC.

In addition to those using the UN process indicators, 20 studies measured CFRs. Eighteen studies measured health or nutritional status. Skilled attendance was measured in 14 studies and 5 reported trained TBA (not considered skilled attendants) use. Twelve studies reported the number of women with complications using obstetric services.

Twenty-three studies appeared to measure process indicators for the first “2 delays” (i.e., decision to seek care and access to care), although these were difficult to classify and overlapped considerably with each other. Sixteen of these included measures of emergency transport systems or loan funds for emergency transport or treatment. Ten measured awareness of complications or their danger signs among community members, or knowledge of safe motherhood.

Seventeen studies measured prenatal or postabortion care use. Other outcome measures included various standards of care measures (n=13), family planning use or birth spacing intentions (n=10), knowledge and skills of birth attendants (professional or traditional) (n=10), and referrals to health services (n=9). Outcome measures were not known for 4 studies.

4. Discussion

4.1. Interventions evaluated

Intervention evaluations have been carried out in less than half of the low-income countries with a high MMR. Even countries that have hosted studies do not have evidence on *all* relevant topics. This highlights the importance of the generalizability of evaluation findings to other settings.

Given the current international policy focus on intrapartum care (i.e., skilled attendance at delivery and emergency obstetric care) it is not surprising that more than twice as many interventions attempted to tackle tertiary prevention than secondary [3,4]. Within tertiary prevention, more interventions tackled the third delay (i.e., the timeliness and quality of care received) than the first or second delays (i.e., decision to seek care and access to care). This may be due to the medical and health service focus (which have long histories of evaluation) of the third delay rather than infrastructure or social factors. Interventions that address the first or second delays are more likely to be complex, targeting a wider population- or community-level audience, or addressing structural factors. For these reasons, it may be easier to conduct and evaluate interventions targeting medical or health service factors.

A wide range of topics were covered by the reviews and although this is encouraging, it is disappointing that only a few assessed the quality of the studies included. Compared with the studies, reviews were more likely to consider secondary prevention than tertiary. This may be because the focus on skilled attendance and emergency obstetric care has been more recent, with previous attention placed on prenatal care and TBA training [13,14]. More reviews of primary research should be carried out, particularly focusing on tertiary prevention, as these are lacking in comparison with the number of

evaluations carried out. Reviews should consider the quality of studies and weight the evidence accordingly.

4.2. Study designs

Most of the studies developed adequacy evidence (using before-and-after designs) rather than the more rigorous probability or plausibility evidence (derived from RCTs or trials) [15]. Although not always possible, RCTs can be carried out on complex, non-standard interventions [16]. However, most of the RCTs in this review evaluated relatively simple nutritional supplementation interventions.

If an RCT is not appropriate, the possibility of using a stepped-wedge design should be explored, where the intervention is introduced in a phased manner to sites, which act as comparison sites until then [17]. Failing that, at least one comparison group should be included in the evaluation and if it is not possible to include a comparison group, at the very least outcomes should be measured both before and repeatedly after the intervention [18].

Complex public health interventions ideally require a combination of study designs and data collection methods to develop a more comprehensive assessment of an intervention. For example, process data could highlight who did and did not access the intervention as well as how acceptable and feasible it was. Qualitative data can explore how sociocultural factors interact with intervention use and effects. Dose-response analysis could show if the level of intervention exposure is related to outcomes. Such triangulation of methods is especially important for creating evidence on the generalizability of interventions—an essential yet neglected component of the study designs in this review.

4.3. Outcome measures and indicators

It is understandable that nearly half of the studies measured maternal death in some way, since this was their primary or secondary focus. However, the lack of information about sample size or the power of the studies highlights the importance of appropriate outcome measures. Even in high mortality areas, deaths are sufficiently rare that studies must have a very large sample size to accurately detect changes in the rate or ratio. In many cases, proxy or process indicators may be more feasible measures to use.

Measuring morbidity, particularly “near miss” (a near miss is defined as “a severe, life-threatening complication, necessitating an urgent medical intervention in order to prevent the likely death of the mother”) has been put forward as an alternative to measuring mortality directly. One advantage is that near misses are more frequent than deaths, allowing greater statistical precision and requiring smaller sample sizes. However, given that current international attentions are focused on treating complications as opposed to preventing them, the number of near misses may rise (or remain the same) while mortality falls [19]. There is also some uncertainty around what is classified as a near miss; the lack of standardization currently inhibits comparisons between settings [20]. Although some studies in the evidence map measured the number of women with complications seen in health facilities, none appeared to measure near miss. Further work is required to ascertain the usefulness of this proxy measure and to determine what should be included in the definition of near miss [21].

In recent years recognition of the impracticalities of measuring maternal mortality (and the remaining uncertainties around proxy measures) has led to an increased focus on process measures. These are particularly useful for complex, programmatic interventions, with long causal pathways. They demonstrate how well different elements of a program are working, or what activities are required, rather than merely providing “good” or “bad” outcome information.

Substantial progress has been made in recent years to develop reliable, feasible, and useful indicators to measure the progress of interventions aiming to improve access and availability of treatment

for the immediate causes of maternal death. It is encouraging that several studies used the UN indicators to evaluate intervention progress, although some only used one or two rather than the whole set. A major benefit of having a set of commonly-used, clearly-defined indicators is that findings from different studies are easier to compare than if each study calculates its own measures.

Although it is important that, to prevent misinterpretation, the UN indicators are analyzed collectively rather than individually, this has not always been the case [22]. Twenty studies measured CFRs without using any of the other UN indicators, despite the fact that CFRs may change for a variety of interdependent factors, such as quality of care, the distribution of facilities, or the number and severity of complications treated.

It is positive that 23 studies attempted to measure process indicators for reductions in the first and second delay in reaching adequate treatment for obstetric complications. However, many of the studies focusing on these issues did not assess progress. The diversity of measures used makes it difficult to draw comparisons across studies. More work is needed to develop proxy and process indicators for other areas (as has been done, for example, for postabortion care [23]) and to test associations between these indicators and maternal death.

5. Strengthening the evidence base: Conclusions and recommendations

The evidence base for the effectiveness of maternal mortality interventions in low-income countries remains incomplete. This is partly a reflection that simple and clinical interventions (e.g., nutritional supplements) are easier to deliver and evaluate than programmatic or complex public health interventions (e.g., community knowledge/behavior or transport interventions). Nevertheless, as we have discussed, complex interventions could be better evaluated than at present through a combination of rigorous evaluation methods, inclusion of process evaluations, and consensus on outcome and process measures. The following recommendations would help the development of a stronger evidence base for policy-makers and practitioners:

- More reviews of primary research should be conducted on tertiary prevention issues.
- More research is needed into the effectiveness of interventions addressing the first and second delays.
- Studies should use robust study designs; if an RCT is not possible, other designs (e.g., stepped-wedge or non-randomized trials) should be used or at least before-and-after studies with repeated follow-ups.
- Studies should incorporate process evaluations.
- Maternal mortality should only be measured as an outcome if the study has a large enough sample size to detect statistically significant differences.
- The UN process indicators should be used in their entirety.
- Further work is required to develop, and reach consensus on, process and outcome measures for other aspects of prevention.

Acknowledgements

This review was conducted as part of an MSc completed by HB, which was funded by the Economic and Social Research Council.

References

- [1] AbouZahr C, Wardlaw T. Maternal mortality in 2000: estimates developed by WHO, UNICEF and UNFPA. Geneva: WHO; 2004.
- [2] Announcing the Partnership for Safe Motherhood and Newborn Health; 2004. Available at: http://www.safemotherhood.org/partnerships/Partnership_Brochure.pdf#search=%22%22we%20know%20what%20works%22%20%22maternal%20mortality%22%22. Accessed August 20, 2006.
- [3] Freedman L, Wirth M, Waldman R, Chowdhury M, Rosenfield A. Background Paper of the Task Force on Child Health and Maternal Health. New York: United Nations Millennium Project; 2003.
- [4] Department for International Development. Reducing Maternal Deaths: Evidence and Action. A Strategy for DfID. London: Department for International Development; 2004. p. 28.
- [5] Campbell OM, Graham WJ, Lancet Maternal Survival series steering group. Strategies for Reducing Maternal Mortality: Getting on with what works. *Lancet* 2006;368(9543):1284–99.
- [6] Braine T. How can health research help to save 500 000 mothers? *Bull World Health Organ* 2005;83(2):86–7.
- [7] Goodburn E, Campbell O. Reducing maternal mortality in the developing world: sector-wide approaches may be the key. *BMJ* 2001;322(7291):917–20.
- [8] Graham WJ, Cairns J, Bhattacharya S, Bullough CH, Quayyum Z, Rogo K. Maternal and Perinatal Conditions in Disease Control Priorities in Developing Countries. Washington DC, USA: Oxford University Press, The World Bank; 2006.
- [9] Gil-Gonzalez D, Carrasco-Portino M, Ruiz MT. Knowledge Gaps in Scientific Literature on Maternal Mortality: A Systematic Review. *Bull World Health Organ* 2006;84(11):903–9.
- [10] The World Bank. Data and Statistics: Country Classification; 2006. Available at: <http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,contentMDK:20420458-menuPK:64133156-pagePK:64133150-piPK:64133175-theSitePK:239419,00.html>. Accessed August 7, 2006.
- [11] Harden A, Brunton G, Fletcher A, Oakley A, Burchett H, Backhans M. Young people, pregnancy and social exclusion: A systematic synthesis of research evidence to identify effective, appropriate and promising approaches for prevention and support. London: EPPi-Centre, Social Science Research Unit, Institute of Education, University of London; 2006. p. 124.
- [12] UNICEF/WHO/UNFPA. Guidelines for monitoring availability and use of obstetric services. New York: UNICEF; 1997 (revised version is forthcoming.)
- [13] Bullough C, Meda N, Makowiecka K, Ronsmans C, Achadi EL, Hussein J. Current strategies for the reduction of maternal mortality. *BJOG* 2005;112(9):1180–8.
- [14] AbouZahr C. Safe motherhood: a brief history of the global movement 1947–2002. *Br Med Bull* 2003;67(1):13–25.
- [15] Habicht JP, Victora C, Vaughan JP. Evaluation Designs for Adequacy, Plausibility and Probability of Public Health Programme Performance and Impact. *Int J Epidemiol* 1999;28(1):10–8.
- [16] Manandhar DS, Osrin D, Shrestha BP, Mesko N, Morrison J, Tumbahangphe KM, et al. Effect of a participatory intervention with women's groups on birth outcomes in Nepal: cluster-randomised controlled trial. *Lancet* 2004;364(9438):970–9.
- [17] Bonell C, Hargreaves J, Strange V, Pronyk P, Porter J. Should Structural Interventions Be Evaluated Using RCTs? The Case of HIV Prevention. *Soc Sci Med* 2006;63(5):1135–42.
- [18] Ukoumunne OC, Gulliford MC, Chinn S, Sterne JA, Burney PG. Methods for Evaluating Area-Wide and Organisation-Based Interventions in Health and Health Care: A Systematic Reviews. *Health Technol Assess* 1999;3(5):iii–92.
- [19] Campbell OM. In: Berer M, Ravindran TKS, editors. Measuring Progress in Safe Motherhood Programmes: Uses and Limitations of Health Outcome Indicators, in Safe Motherhood Initiatives: Critical Issues. Oxford: Blackwell Science Ltd; 1999. p. 31–42.
- [20] Say L, Pattinson RC, Gulmezoglu AM. WHO Systematic Review of Maternal Morbidity and Mortality: The Prevalence of Severe Acute Maternal Morbidity (near miss). *Reprod Health* 2004;1(1):3.
- [21] Graham WJ, Filippi V, Ronsmans C. Demonstrating Programme Impact on Maternal Mortality. *Health Policy Plan* 1996;11(1):16–20.
- [22] Bailey PE, Paxton A. Program note. Using UN process indicators to assess needs in emergency obstetric services. *Int J Gynecol Obstet* 2002;76(3):299–305 discussion 306.
- [23] Healy J, Otsea K, Benson J. Counting abortions so that abortion counts: Indicators for monitoring the availability and use of abortion care services. *Int J Obstet Gynecol* 2006;95(2):209–20.