PERINATAL MORTALITY IN DEVELOPING COUNTRIES:

A REVIEW OF THE CURRENT LITERATURE AND METHODOLOGICAL ISSUES IN COMMUNITY-BASED ASSESSMENT

TECHNICAL WORKING PAPER 5

Prepared by
Donna Espeut

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EXECUTIVE SUMMARY

According to the World Health Organization (1996a), an estimated eight million perinatal deaths occur globally each year Like other health indicators, perinatal mortality disproportionately affects developing societies, where approximately 98% of all perinatal deaths occur Despite its pervasiveness, reductions in perinatal mortality have been mediocre in comparison to the gains made in post-neonatal and early childhood mortality In addition, many questions regarding appropriate methods of collecting perinatal mortality data remain unanswered

This document provides a comprehensive review of the current state of knowledge on perinatal mortality in the developing world It presents information and data on causes, correlates and interventions, and it identifies research gaps in the current perinatal mortality literature Case studies from countries such as Mexico, Zambia, India, Mozambique and Thailand illustrate relationships between selected factors and perinatal mortality, and they highlight methodological issues relevant to community-based assessment of perinatal mortality

Perinatal mortality results from a myriad of health care and biomedical causes classified as *fetal/neonatal*, *maternal* and *obstetric* (WHO, 1996a) The three leading causes of perinatal death are (1) complications of preterm birth (PTB), (2) birth asphyxia/birth trauma, and (3) bacterial infections These causes apply primarily to the early neonatal period, which is responsible for 3 3 million of the 7 6 million perinatal deaths (WHO, 1996a) Causes of the annual 4 3 million stillbirths are largely unknown due to difficulties in documenting stillbirths

The intervention literature focuses on issues surrounding antenatal, labor, and delivery care, and it reflects a general interest in (1) training of formal and informal health sector providers, (2) syphilis control, and (3) essential newborn care Postpartum practices remain undocumented in the perinatal mortality literature, despite the fact that infants are susceptible to perinatal death beyond labor and delivery Perinatal and maternal death audits are becoming widely recognized as valid approaches to understanding the problems of perinatal and maternal mortality in the developing world The perinatal audit is useful in identifying "weak links" in perinatal care and should be incorporated in all information-gathering and monitoring activities of interventions

Our knowledge regarding perinatal mortality has been obtained primarily from hospital-based studies, we know very little about perinatal mortality within the community In addition, the few published community-based studies do not provide detailed descriptions of their study methodologies These studies often cite the use of surveillance, key informants, or household surveys, while omitting details on issues such as the selection of interviewers and respondents, ascertainment of births and deaths, and survey design and implementation

Perinatal mortality research is driven primarily by quantitative methods However, community-based research will require a fusion of quantitative and qualitative research techniques Although methodological limitations of alternative data collection techniques (e g , the verbal autopsy) are apparent, it is erroneous to assume that people do not want to disclose information on vital events during the perinatal period In actuality, we may not have mastered how to make effective and culturally-appropriate inquiries within communities

Given a review of the current literature, the following areas warrant further research attention (1) quality of obstetric care, (2) care-seeking behavior and perceptions of pregnancy within the community, and (3) the use of the fresh versus macerated stillbirth distinction and time of death in identifying causes and

correlates of perinatal mortality Methodological recommendations presented in this report include (1) use of multiple data sources and data collection techniques within a given study, (2) application of qualitative research methods (e g , focus groups, key informant interviews) to document community knowledge, attitudes, and practices related to maternal and perinatal health, (3) incorporation of open-ended questions in structured interviews to establish rapport between the interviewer and the respondent, and (4) reliance on local culture to dictate the selection of respondents and interviewers, as well as the terminology used in inquiries

The limited ability to make specific recommendations regarding perinatal mortality research reflects the absence of detailed methodologies within the published literature Nevertheless, in reviewing current approaches to data collection, discussing their limitations, and highlighting potential modifications to existing techniques, this paper may assist researchers who are interested in devising more appropriate approaches to assessing, and ultimately, reducing perinatal mortality within the developing world

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WHAT IS PERINATAL MORTALITY?

According to 1996 World Health Organization [WHO] estimates, over 7 6 million perinatal deaths occur throughout the globe annually The perinatal period, which encompasses both the late fetal period and the early neonatal period, is defined in the International Classification of Diseases, Tenth Revision [ICD-10] as follows

> *The **perinatal period** commences at 22 completed weeks (154 days) of gestation (the time when birth weight is normally 500 g), and ends seven completed days after birth* (WHO, 1992a 1237)

Some countries continue to use the ICD-9 definition, which states that the perinatal period begins at 28 weeks gestation and continues through the 7th day post-delivery Inconsistencies in the definition of perinatal mortality create problems in international comparisons, since reported estimates from different contexts may not pertain to the same reference period

The most common measure of perinatal mortality is the **perinatal mortality rate** (PMR)

The *PMR* =

$$\frac{\text{number of late fetal deaths (i e , stillbirths)} + \text{number of early neonatal deaths}}{\text{total births*}} \times 1000$$

**TOTAL BIRTHS = live births + late fetal deaths (i e stillbirths)*

This indicator, which represents reproductive loss within a given jurisdiction (usually for a specified year), also reflects the quality of maternal and perinatal health care Thus, it has tremendous potential in international comparisons of health system performance

A GLOBAL OVERVIEW OF THE PROBLEM

Although perinatal mortality is usually viewed within the context of infant health, it is important to acknowledge the contribution of perinatal conditions to the total burden of disease According to Vos (1997), perinatal conditions are responsible for approximately 7 3% of the total disease burden in the developing world The author notes that the burden of disease (which is a function of both death and disability) associated with perinatal conditions may be attributed largely to perinatal mortality As a result, perinatal conditions should be considered a health service priority

This section presents data on the magnitude of perinatal mortality that highlight its global importance In addition, correlates of perinatal mortality are also discussed

THE MAGNITUDE OF PERINATAL MORTALITY

Like many other health and social indicators, perinatal mortality disproportionately affects less developed countries (LDCs), where 98% of perinatal deaths occur each year (WHO, 1996a) Large variations exist across countries with respect to perinatal mortality PMRs range from as low as 5 0 per 1000 total births in some European countries to 130 0 per 1000 total births in some African countries (WHO, 1996a)

Table 1 presents 1996 WHO regional estimates of perinatal mortality Asia is responsible for 60% of all perinatal deaths (and births) However, PMRs are highest in Africa, reflecting a higher risk of death within this region of the world Subsequent sections of this report will discuss factors that may be responsible for the observed disparity in perinatal mortality between regions

Country-specific trends in perinatal mortality are unavailable due to the absence of early country-level estimates One may examine temporal trends in perinatal mortality on a regional basis, though the earliest regional estimates only date back to 1983 There has been very little change in levels of perinatal mortality between 1983 and 1995 The disparity between more developed countries (MDCs) and LDCs has remained unchanged

******SEE APPENDIX A******

("Comparison of Perinatal Mortality 1983 and 1985")

Perinatal Mortality in Relation to Mortality Occurring at Other Stages in Early Childhood

Global reductions in perinatal mortality are unimpressive relative to the gains made in post-neonatal and early childhood mortality The perinate has not been able to reap the benefits associated with the child survival movement (Costello, 1993) The severity of perinatal mortality as a global problem is also apparent when one examines the proportion of fetal-infant mortality (i e , deaths occurring between the 22nd or 28th week gestation and the 1st year of life) attributed to stillbirths, early neonatal deaths, late neonatal deaths, and post-neonatal deaths Table 2 presents regional data on these indicators

In general, at least 60% of fetal-infant mortality occurs by the first week of life, suggesting highest susceptibility to death during the earliest stages of the fetal-infant period Perinatal mortality accounts for a higher percentage of fetal-infant mortality in MDCs (41 0%) compared to LDCs (33 4%), which reflects the fact that infants in MDCs are at highest risk of death early in life In contrast, infants in LDCs are vulnerable to death throughout the entire first year of life, despite the fact that the risk of death is most striking during the perinatal period

TABLE 1

Regional Comparisons of Number of Perinatal Deaths Percent Contribution to Global Perinatal Mortality, and Perinatal Mortality Rates

REGION	NUMBER OF PERINATAL DEATHS(000s) AROUND 1995	PERCENTAGE OF GLOBAL PERINATAL DEATHS	PERINATAL MORTALITY RATE (PER 1000)	HIGHEST PERINATAL MORTALITY RATE WITHIN THE REGION
WORLD	**7636**	--	**53**	**130 (Liberia & Guinea)**
--More Developed Countries	**155**	**2 0%**	**11**	**30 (Republic of Moldova)**
North America	39	0 5%	9	10 (Canada & U S)
Europe	107	1 4%	13	30 (Republic of Moldova)
Oceania	10	0 1%	44	50 (Vanuatu)
--Less Developed Countries	**7480**	**98 0%**	**57**	**130 (Liberia & Guinea)**
Africa	2404	31 5%	75	130 (Liberia & Guinea)
Eastern	845	--	76	120 (Somalia)
Middle	337	--	82	90 (Angola & Chad)
Northern	216	--	43	55 (Sudan)
Southern	89	--	57	65 (Lesotho)
Western	917	--	88	130 (Liberia & Guinea)
Asia	4583	60 1%	53	120 (Afghanistan)
Eastern	982	--	41	45 (China)
South-central	2875	--	66	120 (Afghanistan)
South-eastern	486	--	37	90 (Lao People's Dem Rep)
Western	240	--	44	70 (Yemen)
Latin America & the Caribbean	483	6 3%	39	95 (Haiti)
Caribbean	41	--	49	95 (Haiti)
Central America	138	--	38	45 (Guatemala)
South America	305	--	39	55 (Bolivia)

Adapted from World Health Organization 1996a

The fetal-infant mortality rate may be a useful alternative to the PMR and the infant mortality rate (IMR), since reporting and misclassification biases associated with the documentation of deaths make international comparisons in perinatal and infant mortality quite difficult However, the fetal-infant mortality rate combines intrinsically different periods in fetal-infant development, periods which also have different causes of mortality and degrees of mortality risk

Perinatal Mortality as a Function of Maternity Care Coverage

In many contexts there is a direct relationship between maternity care coverage and perinatal mortality As seen in Table 3, there is a general trend in which increasing maternity care coverage is associated with decreasing levels of perinatal mortality

Only 37% of all deliveries in LDCs take place within institutions, highlighting the need to assess perinatal mortality in both health facilities and the community Although the presence of a trained delivery attendant at birth is important for ensuring safe delivery conditions, it is not the panacea for perinatal mortality We must be equally concerned with the quality of maternity care coverage as we are with its magnitude Quality of care and its relation to perinatal mortality will be discussed in subsequent sections of this report

A substantial portion of perinatal research has been devoted to exploring the relationship between perinatal mortality and (a) antenatal care utilization and (b) the presence of a trained delivery attendant at the birth The correlation coefficients (which may range between -1 [high negative association] and +1 [high positive association]) between perinatal mortality and antenatal care utilization and trained attendant at delivery are -0 6 and -0 8 respectively, indicating fairly high negative associations (i e , perinatal mortality decreases as each of these factors increases)

******SEE APPENDIX B and APPENDIX C******

("Perinatal Mortality and % Antenatal Care Utilization" and "Perinatal Mortality and % Trained Attendant at Delivery")

TABLE 2

Stages of the Fetal-Infant Period

Regional Comparisons in Percent Contributions to Fetal-Infant Mortality in 1995

(see Appendix D for calculations)

[COLUMN A] **REGION**	*[COLUMN B]* **TOTAL NUMBER OF DEATHS. LATE FETAL PERIOD THROUGH THE 1ST YR OF LIFE**	*[COLUMN C]* **% FETAL-INFANT MORTALITY ATTRIBUTED TO STILLBIRTHS (SB*)**	*[COLUMN D]* **% FETAL-INFANT MORTALITY ATTRIBUTED TO EARLY NEONATAL DEATHS (ENND**)**	*[COLUMN E (=C+D)]* **% FETAL-INFANT MORTALITY ATTRIBUTED TO PERINATAL DEATHS (SB + ENND)**	*[COLUMN F]* **% FETAL-INFANT MORTALITY ATTRIBUTED TO LATE NEONATAL DEATHS (LNND)**	*[COLUMN G]* **% FETAL-INFANT MORTALITY ATTRIBUTED TO POST NEONATAL DEATHS**
WORLD	12,909 224	33 5%	25 7%	59 2%	13 7%	27 2%
MORE DEVELOPED COUNTRIES	214,198	41 0%	31 4%	72 4%	13 4%	14 2%
LESS DEVELOPED COUNTRIES	12,679,280	33 4%	25 6%	59 0%	13 7%	27 3%
AFRICA	4,091,756	33 3%	25 5%	58 8%	6 1%	35 2%
ASIA	7,803,466	33 2%	25 5%	58 7%	17 9%	23 4%
EUROPE	148,650	40 7%	31 2%	71 9%	13 2%	14 9%
LATIN AMERICA & THE CARIBBEAN	816,726	33 5%	25 7%	59 2%	11 2%	29 7%
NORTH AMERICA	53,049	41 6%	31 9%	73 5%	17 1%	9 4%
OCEANIA	18,884	30 0%	23 0%	53 0%	3 5%	43 6%
*Stillbirth(SB)= late fetal loss (after 22nd week [ICD-10 definition] or 28th week [ICD-9 definition] gestation) **Early neonatal death (ENND)= death occurring between birth and the 7th completed day of life						

Adapted from WHO 1996a Population Reference Bureau 1996

TABLE 3

Global and Regional Estimates

of the Percentage of Institutional Deliveries and Deliveries with Trained Attendants (around 1996)

REGION	INSTITUTIONAL DELIVERIES (%)	TRAINED ATTENDANT AT DELIVERY (%)	PMR per 1000
WORLD	46	57	53
MORE DEVELOPED COUNTRIES*	98	99	11
LESS DEVELOPED COUNTRIES	40	53	57
AFRICA	36	42	75
Eastern	32	34	76
Middle	41	42	82
Northern	39	63	43
Southern	76	79	57
Western	32	34	88
ASIA*	37	53	53
Eastern*	54	86	41
South-central	26	34	37
South-eastern	33	53	66
Western	57	68	44
LATIN AMERICA/ THE CARIBBEAN	71	75	39
Caribbean	70	71	49
Central	58	65	38
South	78	80	39
NORTH AMERICA	99	99	11
EUROPE	97	98	13
OCEANIA*	49	52	44

** Regional estimates exclude Japan Australia and New Zealand These countries are included in the total for more developed countries*

Adapted from WHO 1996a and WHO, 1996d

Information presented in this section is based upon data compiled by WHO (1996a) and selected epidemiologic studies from the current perinatal mortality literature

******SEE APPENDIX E******

("Summary Matrices for Institution-Based, Community-Based, and Multisample Perinatal Mortality Studies)

Generally speaking, perinatal mortality results from a myriad of health care and biomedical causes classified as *fetal/neonatal*, *maternal*, and *obstetric* (WHO, 1996a)

FETAL/NEONATAL

- Complications of Preterm Birth
- Asphyxia
- Congenital Malformations
- Infection

MATERNAL

- Anemia and Poor Maternal Nutritional Status
- Hypertensive Disorders of Pregnancy
- Obstructed Labor
- Maternal Infections

OBSTETRIC

- Inadequate/Inappropriate Newborn Care
- Unhygienic Medical Practices
- Poor Medical Management of Pregnancy, Labor and/or Delivery Complications

The perinatal mortality literature often addresses fetal/neonatal, maternal, and obstetric causes of death as mutually exclusive However, their interrelatedness should be apparent, since what affects the mother's health often has serious implications for her baby's health Of the aforementioned categories, perinatal mortality studies explore obstetric causes of perinatal death the least This is partially due to the fact that the majority of births in LDCs occur outside of hospitals (WHO, 1993) As a result, the nature and quality of labor, delivery, and postpartum practices within the community remain relatively undocumented Obstetric causes of death warrant research attention, since healthy babies and babies with medical complications fall prey to inadequate and inappropriate care, often resulting in perinatal death Although babies may die of specific conditions (e g , asphyxia), obstetric care should be regarded as a contributory factor

Fetal/Neonatal Causes of Perinatal Death

The three leading fetal/neonatal causes of perinatal death are (1) complications of preterm birth (PTB), (2) birth asphyxia, and (3) bacterial infections These causes apply primarily to the early neonatal period, which is responsible for 3 3 million of the 7 6 million global perinatal deaths Causes of stillbirths are largely unknown (WHO, 1996a) Limited data on stillbirths are partially due to difficulties in

documenting stillbirths in the developing world For example, in many societies, it is not culturally acceptable to acknowledge a birth until it has survived the critical period of the first week of life (Costello, 1993) In addition, few studies distinguish between a *fresh* stillbirth (i e , a fetus that has been dead for less than 12 hours) and a *macerated* stillbirth (i e , a fetus that has been dead for longer than 12 hours) (Hoverd & Brown, 1986) However, these two types of stillbirths are manifestations of different underlying and contributory factors Making the fresh-macerated distinction and, more importantly, documenting the age at death (for both stillbirths and early neonatal deaths) may improve our ability to identify probable causes and correlates of perinatal mortality

Complications associated with PTB, or birth "less than 37 completed weeks (less than 259 days) of gestation" (WHO, 1992a 1236) is the most common fetal/neonatal cause of perinatal death Preterm birth is associated with low birth weight (LBW), or weight at birth "less than 2500 g (up to, and including 2499 g)" (WHO, 1992a 1236) A preterm LBW infant is also called "premature " WHO (1992b) estimates that 70-80% of neonates without congenital malformations die from conditions related to prematurity

Despite its association with PTB, LBW is not a direct cause of perinatal mortality, though it predisposes the neonate to conditions that jeopardize survival during the neonatal period (WHO, 1996a) For example, LBW infants are particularly vulnerable to hypothermia (i e , extreme loss of body heat) Limited data are available on the incidence of hypothermia, nor do we know the proportion of neonatal deaths due to hypothermia (WHO, 1996b) However, it is speculated that hypothermia is a major contributory cause of neonatal deaths among LBW infants (WHO, 1992b)

As seen in Table 4, LBW prevalence varies substantially across regions

TABLE 4
Estimated 1990 Low Birth Weight (LBW) Prevalence (%), By Region

COUNTRY	REGIONAL PMR (per 1000)	LBW PREVALENCE (%)
WORLD	53	17%
MORE DEVELOPED COUNTRIES	11	7%
LESS DEVELOPED COUNTRIES	57	19%
AFRICA	75	15%
ASIA	53	21%
LATIN AMERICA	39	11%
NORTH AMERICA	9	7%
EUROPE	13	6%
OCEANIA	44	20%

Adapted from WHO 1996a and WHO 1992b

In general, low LBW prevalences are associated with low PMRs However, the countries with the highest LBW prevalences (Asia and Oceania) do not have the highest PMRs Although LBW puts infants at increased risk of perinatal death, perinatal mortality also occurs among normal birth weight infants This evidence suggests that perinatal mortality should be largely preventable with appropriate maternal and perinatal health services, since normal birth weight infants are generally regarded as having the highest viability Nevertheless, addressing conditions in the mother that often result in LBW (e g , sexually transmitted diseases, micronutrient deficiencies, low prepregnancy weight, and low weight gain during pregnancy) will help to reduce the number of highly susceptible infants at birth This, in turn, would place less strain on the medical system to treat LBW infants suffering from conditions that are known to increase their risk of perinatal death

In an effort to tailor services that will be most effective in reducing perinatal mortality, it is necessary to distinguish between LBW due to *preterm birth* (PTB) and LBW due to *intrauterine growth retardation* (IUGR) Within the developing world, IUGR accounts for most of LBW, whereas PTB predominates in MDCs (Kramer, 1987) Although few studies distinguish between PTB and IUGR, these two conditions have very different etiologies (Kramer, 1987) The absence of data specific to these two conditions is partially due to the shortcomings of current methods of gestational age assessment For example, duration of gestation is often determined using the first day of the last menstrual period as the starting point (WHO, 1992a) However, many women cannot accurately recall the exact dates of their menstrual period As a result, length of gestation cannot be determined with any degree of consistency

In addition to problems in determining length of gestation, no standard definition exists for IUGR Kramer (1987) notes that the following definitions are commonly used (1) birth weight less than the 5th or 10th percentile for gestational age, (2) birth weight less than 2500g and gestational age of at least 37 weeks, and (3) birth weight less than two standard deviations below the mean value for gestational age Given the multiple definitions that exist to describe IUGR, and the degree of error associated with gestational age assessment, it is not very feasible to study growth retardation within and across contexts

In addition to differences in the consistency of their definitions, there is also evidence to suggest that the management and prognosis of preterm and growth-retarded infants differs substantially Regardless of the prevalences of PTB and IUGR within a particular population, preterm infants generally have a higher risk of perinatal death than growth-retarded infants (WHO, 1996a) For example, Barros et al (1992) discovered that preterm infants were 13 times more likely to experience a perinatal death than infants of appropriate birth weight and gestational age, and twice as likely to experience a perinatal death as growth-retarded infants

The PTB-IUGR distinction becomes even more salient when developing medical interventions With respect to the management of conditions, work by Bartlett et al (1991a) suggests that medical interventions to reduce mortality due to lethal illnesses and infections are less effective in preterm infants than in term normal birth weight and term LBW infants Therefore, there is a need to identify approaches specific to the management of the preterm infant in order to impact perinatal mortality Treating all LBW infants as a homogeneous group will do little to reduce perinatal mortality

In addition to complications of PTB, other common causes of perinatal death include birth asphyxia and birth trauma Although preterm infants are susceptible to asphyxia and trauma, these conditions are symptomatic of poor labor and delivery care, and often arise from obstetric complications such as malpresentation, abruptio placentae, and prolonged or obstructed labor (WHO, 1996a) Thus, it is likely that improvements in the quality of care will have the greatest impact in reducing perinatal deaths due to asphyxia The following section provides evidence from the literature that highlights the need to direct

our programmatic and research attention to quality of care

Obstetric Causes of Perinatal Death

Relative to conventional risk factors and causes of death (e g , maternal and fetal characteristics and conditions), the relationship between perinatal mortality and the nature and quality of obstetric care is largely overlooked However, as an increasing number of births are being exposed to medical interventions, the issue of quality of care moves to the forefront Inappropriate intervention, and not just the absence of timely obstetric care, contributes to perinatal mortality

As stated earlier, reported causes of perinatal death such as birth asphyxia, birth trauma, and sepsis are suggestive of poor obstetric care (WHO, 1996a) In addition, other conditions such as hypothermia also speak directly to the quality of immediate newborn care In a community-based study in Guatemala, Bartlett et al (1991b) found that fetal malpresentation, premature rupture of membranes, and prolonged labor were significant contributors to intrapartum and one-day mortality The authors also identified inappropriate intervention during labor as an important mediating factor Also, traditional birth attendants (TBAs) within the study population demonstrated an inability to detect and refer obstetric complications in a timely manner Thus, mistimed, inadequate, and inappropriate obstetric care were major contributors to perinatal death within this population

Based upon results from another community-based study of home deliveries in rural Tanzania, Walraven et al (1994) concluded that deliveries supervised by untrained birth attendants were more likely to result in perinatal death Although the authors were unable to assess the specific contributions of inappropriate obstetric care and poor referral systems to perinatal outcome, they speculated that improvements in these two areas would have a dramatic impact on perinatal mortality within the community Thus there is a need to improve access to care, and to ensure that women and infants in need of medical attention receive it in a timely manner However, there is also a need to train formal and informal health care providers in the proper use of medical interventions and technology (e g , the bag and mask apparatus used to resuscitate newborns), in order to avoid instances of perinatal death due to medical mismanagement and improper medical intervention (WHO, 1996b)

Case Study #1 highlights an analysis by Bobadilla (1988) that explored the relationship between quality of perinatal medical care and perinatal mortality in Mexico City, Mexico Bobadilla's work as described in Case Study #1 made a substantial contribution to the literature by quantifying the structure, process, and outcome of perinatal medical care Study results also highlighted important areas that warrant specific attention in future quality of care studies In studying quality of care, one must decide whether the focus is on the antenatal period, the labor and delivery period, or both This decision must reflect the nature of perinatal mortality within the target population (e g , a high proportion of macerated stillbirths warrants programmatic attention during the antenatal period) The findings from this institution-based study, though representative of deliveries taking place in Mexico City, may not be generalizable to other contexts where home deliveries predominate The author chose to exclude macerated stillbirths from this analysis, stating that they generally take place prior to hospital admission and are therefore non-preventable at the hospital level Unlike macerated stillbirths, which are a greater reflection of events and conditions occurring during the antenatal period, fresh stillbirths and early neonatal deaths center primarily around labor, delivery, and immediate postpartum Thus, fresh stillbirths and early neonatal deaths are more amenable to hospital intervention

With respect to quality of care research, the fresh-macerated distinction may not be as feasible or relevant in other contexts for two reasons First, most deliveries in the developing world occur outside of

hospitals, in comparison to Mexico City, where approximately 87% of deliveries take place in hospitals (Bobadilla, 1988) As a result, it may not be feasible to disentangle types of stillbirths when it is already difficult to ascertain the overall magnitude of stillbirths (regardless of type) Second, in Africa and other regions where syphilis prevalence is high, infectious diseases contribute to the occurrence of macerated stillbirths (which account for a large portion of perinatal mortality) Thus, timely intervention during the antenatal period to detect and treat infectious diseases such syphilis may have a substantial impact on perinatal mortality in these contexts Exclusion of macerated stillbirths in areas of high infectious disease prevalence would overlook a critical component of perinatal mortality

CASE STUDY #1 MEXICO

Bobadilla JL (1988)

Quality of Perinatal Medical Care in Mexico City

An Epidemiological Study on the Effects of Medical Care Quality on Perinatal Mortality

Bobadilla (1988) conducted a case-control study to determine the net contribution of variations in quality of perinatal care on the perinatal mortality rate (PMR) in Mexico City In order to assess the quality of perinatal care, the author collected data on various levels (1) the hospital, (2) the health agency [to assess the structure of services], and (3) the individual [to assess the process of perinatal care, and the outcome (perinatal mortality)] There are three health schemes in Mexico City the public assistance scheme, the social security scheme and the private hospital scheme The author selected the health agencies with the largest number of annual births from each scheme, yielding a total of 25 hospitals (four private hospitals, seven public assistance hospitals, and 14 social security hospitals) in the hospital sample Detailed questionnaires were administered to hospital administrators and obstetric and neonatal ward doctors and nurses The questionnaire covered issues such as general hospital characteristics and size, material resources and technology, organization, and human resources, and it was used to assess the structure of each of the hospitals

Individual-level data were based upon three methods a case-control study (to assess the relationship between perinatal mortality and the process of perinatal care), a census of births (which provided the sampling frame for the case-control study and birth weight-specific rates for each hospital), and a neonatal follow-up of all infants discharged before the 7th day of life (to ensure identification of all neonatal deaths, irrespective of place of death) Cases (n=983) were babies born at the hospitals who died during the perinatal period Controls (n=3,599) were selected from among hospital-born babies who survived beyond the 7th day of life Macerated stillbirths, multiple births, babies <1000g, and babies with congenital anomalies were excluded from the analysis Subjects were interviewed using a standardized, precoded questionnaire Because birth weight is related to both perinatal mortality and quality of care, subjects were stratified into a normal birth weight group (i e , 2500g or more) and low birth weight group (i e , 1000-2499g) Mortality rates standardized for birth weight were used to assess the quality of perinatal medical care

RESULTS

During the 14-week study period, there were 32,701 births and 983 perinatal deaths (PMR= 30 1 per 1000, stillbirth rate=14 1 per 1000, early neonatal mortality rate=16 0 per 1000) PMRs were 20 times higher among LBW infants than normal birth weight infants (202 2 per 1000 versus 9 8 per 1000) There was little variation in birth weight distribution across hospitals Quality of perinatal medical care was shown to affect the PMR (as measured by mortality ratios standardized for birth weight), even when controlling for biological and social factors Quality of care, which was lowest in the private hospitals and highest in the public hospitals, was also a reflection of medical staffing ratios (i e , the mix of various types of trained medical personnel), and not the actual number of physicians Cesarean section rates, medical staffing ratios, and antenatal care were not related to stillbirths In contrast, content and quality of antenatal care had a moderate effect on early neonatal mortality, and lower medical staffing ratios were associated with lower levels of standardized early neonatal mortality Number of ANC visits had no positive association with rates of stillbirth or early neonatal death

Given these results, the author concludes that quality of perinatal medical care is related to perinatal mortality Standardized PMRs are sensitive indicators of quality of care, and exclusion of non-preventable deaths (e g , macerated stillbirths and babies <1000g) improves the sensitivity of the PMR The stillbirth rate is a less sensitive indicator than the early neonatal mortality rate Based upon observed differences in the correlates of stillbirths and early neonatal deaths, the author also concludes that, when possible, studies on the quality of perinatal medical care should disaggregate perinatal mortality into stillbirths and neonatal deaths, since failure to do so may underestimate the effects of structure and process factors

Because numerous aspects of the mother are related to perinatal outcome, an entire section of this report is devoted to exploring the relationship between maternal health and perinatal outcome This section presents information on maternal risk factors for PTB and IUGR, maternal nutritional status, STD infection, and malaria infection

Maternal Risk Factors for PTB and IUGR

Fetal and neonatal conditions such as PTB and IUGR are highly dependent upon maternal health status Tables 5 and 6 present maternal risk factors for IUGR and PTB, respectively

TABLE 5

INTRAUTERINE GROWTH RETARDATION Maternal Risk Factors (listed in order of importance)

DEVELOPING COUNTRIES	DEVELOPED COUNTRIES
LARGE IMPACT ON IUGR	
low energy intake	cigarette smoking
low weight gain	low energy intake
low prepregnancy weight	low weight gain
short stature	low prepregnancy weight
non-white race	
INTERMEDIATE IMPACT ON IUGR	
malaria	primiparity
female sex	female sex
primiparity	short stature
	non-white race
SMALL IMPACT ON IUGR	
maternal low birth weight	maternal low birth weight
prior history of low birth weight	prior history of low birth weight
general morbidity	general morbidity
small paternal size	other

SOURCES Berendes 1993 Kramer 1987

TABLE 6
PRETERM BIRTH Maternal Risk Factors
(listed in order of importance)

DEVELOPING COUNTRIES	***DEVELOPED COUNTRIES***
low maternal weight	*cigarette smoking*
history of preterm births	*history of preterm births*
history of spontaneous abortions	*history of spontaneous abortions*
	low maternal weight
	exposure to diethylstilbestrol in utero

SOURCES Berendes 1993 Kramer 1987

Comments on Berendes' List of Risk Factors for IUGR and PTB
Maternal health, history (e g , prior LBW baby), and behavioral factors (e g , cigarette smoking) seem plausible as contributors to PTB and IUGR However, the mechanisms of other factors such as race and infant sex seem less clear

RACE AND IUGR The impact of non-white race on IUGR is ambiguous, particularly for the developing world, where the majority of societies are of non-white racial/ethnic origin The classification of white versus non-white in developing countries is not documented in the literature Therefore, it is unclear to which racial/ethnic groups the term "non-white" refers Among MDCs, non-white groups often include Hispanics and Blacks in the United States, West Indians, Indians, and Pakistanis in the United Kingdom, and West Indians and North Africans in France (Kramer, 1987) However, studies that cite race and ethnicity as determining factors for IUGR have not adequately controlled for bonafide risk factors such as maternal height, pre-pregnancy weight, and caloric intake" (Kramer, 1987)

SEX AND LBW Consideration of female sex as a risk factor for LBW also raises questions, since it implies a genetic (i e , gender-based) component to risk of death It is a well known fact that women generally weigh less than men Therefore, it should not be surprising that female infants have lower birth weights than male infants and are more susceptible to perinatal mortality

Maternal Nutritional Status and Perinatal Mortality
Poor nutritional status is a major contributor to medical conditions arising in the mother during pregnancy (e g , anemia, hemorrhage), which, in turn, result in perinatal outcomes such as PTB, IUGR, and LBW (Kramer, 1987) Although sociodemographic factors and a history of poor pregnancy outcomes should not be ignored for their impact on mortality, poor maternal nutritional status is one of the most amenable health correlates of poor pregnancy outcome The vast majority of nutritional studies have observational study designs and relatively small sample sizes, however, studies from as early as the 1960s cite associations between maternal nutritional status and poor pregnancy outcome Nutritional studies tend to select outcomes such as LBW, PTB, and IUGR, few have explored the direct link between maternal nutritional status and perinatal mortality

A large portion of the pregnancy literature is devoted to maternal anemia Maternal anemia is a broad term that applies to both anemia during pregnancy and anemia among non-pregnant women of reproductive age (Sloan & Jordan, 1992) Anemia prevalences among pregnant women range across countries from 8% to 94% (Sloan & Jordan, 1992) Iron deficiency is the leading cause of anemia worldwide, however, deficiencies in other micronutrients such as vitamin B12 and folate also contribute to anemia (WHO, 1992c) In addition, conditions such as hookworm infestation, malaria, and AIDS, which are prevalent in many LDCs, may also result in anemia (WHO, 1991)

With respect to pregnancy outcomes, anemia has been linked to stillbirths, LBW, and PTB Kessel et al (1985) collected data on 36,611 singleton deliveries in Indonesia and discovered that 42% of mothers who gave birth to LBW infants were anemic Llewellyn-Jones (1965) found that maternal anemia resulted in a disproportionately high stillbirth rate as well as an increase in prematurity The investigator also discovered that 65% of patients in the study (N= 73,048) showed signs of hookworm infestation, and the higher the proportion of hookworm ova found in the stool, the more severe the iron deficiency anemia Thus, when assessing the impact of anemia on pregnancy outcome, it is important to also examine other conditions (namely, infectious diseases) that compromise the nutritional and health status of the mother and her baby

Sexually Transmitted Diseases (STDs) and Perinatal Mortality

Sexually transmitted diseases (STDs) are disease burdens for the general population, however, they are particularly salient to the discussion of perinatal mortality and pregnancy outcome STD infections such as gonorrhea and herpes may indirectly increase the risk of perinatal death by increasing the occurrence of conditions such as PTB (Brunham & Plummer, 1990) STDs may also be direct causes of perinatal death, as seen in the relationship between untreated maternal syphilis and macerated stillbirth (McDermott et al , 1993) In addition, subclinical intrauterine infections (e g , chorioamnionitis) have been linked to PTB and stillbirths (Axemo et al , 1993) Table 7 outlines the major STD microbial agents and their associated impact on pregnancy outcome

TABLE 7

STDs and Their Association with Poor Pregnancy Outcomes

STD	PREGNANCY-ASSOCIATED DISEASE
N gonorrhea	prematurity
	septic abortion
	ophthalmia
	postpartum endometritis
C trachomatis	ophthalmia
	pneumonia
	postpartum endometritis
T pallidum	spontaneous abortion
	stillbirth

STD	PREGNANCY-ASSOCIATED DISEASE
	congenital syphilis
H ducreyi	NONE KNOWN
Human immunodeficiency virus (HIV)	prematurity
	stillbirth
	perinatal HIV
Human papilloma virus (HPV)	laryngeal papillomatosis
Herpes simplex type 2 (HSV-2)	neonatal HSV
	prematurity
Hepatitis B virus (HBV)	perinatal HBV

SOURCE Brunham & Plummer 1990

Despite the vast number of STDs that contribute to adverse pregnancy outcomes, syphilis appears most frequently in the perinatal mortality literature The mother may transmit syphilis to the fetus as early as the 9th week of gestation, though adverse consequences are rarely detected before the 16th week (Islam, 1996) In addition to being a major cause of poor pregnancy outcome in developing countries, congenital syphilis has recently resurfaced among disadvantaged subpopulations in industrialized countries due to poor antenatal care utilization (Islam, 1996)

As seen in Table 7, common outcomes of untreated syphilis infection in the mother are macerated stillbirth, spontaneous abortion, preterm birth, and delivery of an infant with clinical symptoms of congenital syphilis Of all the regions, the toll of maternal syphilis infection in Africa is particularly striking High infectious disease prevalence accounts for part of the observed disparity in perinatal mortality between Africa and other regions of the world For example, approximately 30% of all perinatal mortality in Zambia may be attributed to syphilis in pregnancy, in Ethiopia, syphilis is recognized as one of the top four causes of perinatal death, and in a study in Zimbabwe, 63% of 19 consecutive stillbirths were delivered by women infected with syphilis (Islam, 1996) Unfortunately, comparable data from Latin America, Asia and the Pacific are unavailable, though it is speculated that the prevalence of syphilis among pregnant women is also quite high within these regions (Islam, 1996) Case Study #2 highlights an analysis by McDermott et al (1993) that explored the association between active syphilis infection in the mother and selected fetal-infant outcomes

Despite the wide and overlapping confidence intervals associated with the risk estimates, Case Study #2 illustrates a strong association between maternal syphilis and poor pregnancy outcome, in particular, macerated stillbirths These findings suggest that within high syphilis prevalence areas, there is the potential to reduce perinatal mortality through the prevention, timely detection, and treatment of syphilis

CASE STUDY #2 MALAWI

McDermott JM, Steketee R, Larsen S and J Wirima (1993)

Syphilis-associated Perinatal and Infant Mortality in Rural Malawi

McDermott et al (1993) explored syphilis-associated perinatal and infant mortality between 1987 and 1990 in Mangochi District, Malawi using longitudinal data from a malaria chemoprophylaxis study The study team recruited consecutive pregnant women who attended four selected antenatal clinics This study is population-based because antenatal care coverage in Malawi is 93%

The women were followed-up throughout their pregnancies and once every two months for approximately one year post-delivery Although these women received routine antenatal care (i e , tetanus toxoid immunization, iron supplementation, and malaria chemoprophylaxis), routine syphilis screening was not available through the clinic system Blood specimens that were initially obtained during the antepartum period and delivery to test for malaria were stored and later tested for syphilis In this analysis, women with active syphilis (antibody titre $\geq$ 1 8) were compared to non-syphilitic women The following variables were included in the multivariate analysis syphilis, late antenatal care, home delivery, nulliparity, maternal age <18 years, low SES, illiteracy, clinic site, smoking, alcohol consumption, haematocrit <21% at enrollment, and peripheral *Plasmodium falciparum* (i e , malaria) parasite density >2000 at enrollment In assessing poor pregnancy outcomes, the referent group was live birth survivors of the post-delivery period that was considered as the outcome (e g , live births were the reference group for stillbirths, and live births who survived the 7th day of life were the reference group for early neonatal deaths)

RESULTS

A total of 3,591 HIV-negative mothers of singleton babies were included in this analysis The prevalence of active syphilis within the study population was 3 6% Women with confirmed active syphilis infection experienced a substantially increased risk of adverse pregnancy outcome, with the greatest impact observed for macerated stillbirths (OR=18 07, 95% confidence interval 7 32, 44 64) Other associations included the following stillbirths (OR=10 89, 95% confidence interval 6 61, 17 93), fresh stillbirths (OR= 7 72, 95% confidence interval 3 05, 19 53) The population attributable risks for syphilis were as follows 26% for stillbirths, 21% for perinatal mortality, 11% for neonatal mortality, 5% for postneonatal mortality, and 8% for infant mortality The authors also observed an impact of syphilis during the late neonatal and postneonatal periods

Based upon this analysis, the authors conclude that there is tremendous potential for syphilis prevention in sub-Saharan Africa In high prevalence areas, efforts must include antenatal syphilis screening using rapid tests and treatment during the first visit

Apart from syphilis, much of what we know regarding the association between STDs and adverse pregnancy outcomes is based primarily upon research from more developed countries However, small sample sizes have been responsible for inconclusive findings regarding other STDs Generally speaking, both gonococcal and chlamydia infections have been linked to premature rupture of membranes, preterm birth, and LBW (Elliot et al , 1989, Gravett et al , 1986, Martin et al , 1982), few studies have looked at perinatal mortality directly

One U S study (Gravett et al , 1986), identified bacterial vaginosis as a significant contributor to poor pregnancy outcomes In this study, bacterial vaginosis (study prevalence 19%) was associated with premature rupture of membranes (adjusted OR= 2 0, 95% confidence interval 1 1,3 7), preterm labor at less than 37 weeks gestation (adjusted OR=2 0, 95% confidence interval 1 1,3 5), and amniotic fluid infection (adjusted OR=2 7, 95% confidence interval 1 1,6 1), but not LBW Risk estimates were derived from a multiple logistic regression analysis which included preterm labor <34 weeks, preterm

labor <37 weeks, premature rupture of membranes (<37 weeks), LBW, and amniotic fluid infection The influence of bacterial vaginosis persisted even when controlling for chlamydia infection, which is also linked to the aforementioned conditions

A small number of developing country studies have explored the roles of gonorrhea and chlamydia in determining pregnancy outcome The following two case studies present data from LDC research

CASE STUDY #3 KENYA

Elliot B, Brunham RC, Laga M, Piot P, Ndinya-Achola JO, Maitha G, Cheang M and FA Plummer (1989) *Maternal Gonococcal Infection as a Preventable Risk Factor for Low Birth Weight*

Elliott et al (1989) conducted a case-control study in an urban maternity hospital in Nairobi, Kenya to determine the association between preterm birth and the following STD pathogens *N gonorrhoea C trachomatis T pallidum, U urealyticum, M hominis*, group B streptococci, bacterial vaginosis, and human immunodeficiency virus (HIV) The hospital, where 25-30% of all deliveries in Nairobi take place, serves low-risk pregnancies Most women delivering at the hospital are of low socioeconomic status

In this analysis, cases (n=166) included mothers of singleton live-births who were LBW (i e , $\leq$ 2500g) and who were clinically diagnosed as preterm (i e , gestational age $\leq$ 36 weeks) Controls (n=175) were mothers of singleton live-births who weighed >2500g or who had an estimated gestational age of >36 weeks and were already enrolled in a concurrent study on the prevention of ophthalmia neonatorum Women who had multiple births, cesarean sections, or induced labor for reasons other than premature rupture of membranes (defined by the authors as "rupture before the onset of painful labor, regardless of gestational age") were excluded from this study Specially trained nurse midwives and medical students conducted structured interviews with the mothers and collected specimens for STD screening Specimens were collected within 24 hours of delivery and at the 7th day post-delivery

RESULTS

Although cases and controls were comparable in terms of gravidity, parity and coital frequency, cases were younger and more likely to be single than controls Cases and controls did not differ significantly with respect to any of the microorganisms except *N gonorrhoeae* (OR= 3 23, 95% confidence interval 1 25,8 37) The prevalence of maternal gonococcal infection was 3 8% in controls and 11 0% in cases Other variables that were associated with prematurity in the univariate analysis (age, marital status, hypertension, rupture of membranes, and gonococcal infection) were included in the multivariate analyses For the multivariate analyses, the authors report that infection with *N gonorrhoeae* was associated with a five-fold increase in the risk of preterm birth (adjusted OR=5 31, 95% confidence interval 1 57,17 94), controlling for age, rupture of membranes, and hypertension

The authors note that although prior studies have found a strong correlation between maternal gonorrhea and premature rupture of membranes, this study indicates that the two are independent correlates of prematurity Gonorrhea and premature rupture of membranes accounted for up to 51% of prematurity within the study population, and the authors speculate that control of maternal gonococcal infection may reduce prematurity by 14% They also speculate that failure to observe associations between prematurity and the other STD microbial agents (in particular, *C trachomatis* and bacterial vaginosis) in this study is due to the fact that prior studies were conducted in low gonorrhea prevalence areas As a result, the absence of a strong determinant of prematurity such as gonorrhea allowed weak determinants (namely chlamydia and bacterial vaginosis) to emerge as dominant predictors of prematurity

Case Study #3 is one of the few studies that have explored the relationship between STDs and pregnancy

outcome in a developing country Although the investigators did not assess the direct impact of STDs on perinatal mortality, they did contribute to the body of evidence suggesting a strong association between gonorrhea and PTB However, there is a potential bias in using individuals selected for the purpose of another study Controls in the above analysis were in an ophthalmia neonatorum prevention trial Ophthalmia neonatorum is an outcome of both gonorrhea and chlamydia infection, and it is possible that the use of controls from a trial that is related to the risk factor of interest may bias study results For example, in the above case study, women who were concurrently enrolled in the ophthalmia neonatorum prevention study may have been infected with gonorrhea and chlamydia, and they may have received treatment as a precautionary measure against ophthalmia neonatorum Although the investigators did not observe differences between cases and controls on maternal history factors, they may have also differed on other dimensions such as general health status, health care seeking behavior or health awareness, as a result of possible selection bias

CASE STUDY #4 INDIA

Tewari S, Setia V, Gulati N and H Lal (1995)

Chlamydia Trachomatis Infection A Cause for Preterm Birth and High Perinatal Loss

Tewari et al (1995) explored the relationship between chlamydia and unexplained preterm birth (PTB) and perinatal death In this study, two groups of patients were selected from a labor ward at PT B D S M C in Rohtak, India 64 women with unexplained PTB in Group I and 20 women with normal, term deliveries in Group II Subjects were matched on age, parity, height, weight, nutritional status, and socioeconomic status Women with apparent infection or antibiotic treatment within the preceding four weeks were excluded from the study (chlamydia infection status was determined using the enzyme linked immunosorbent assay [ELISA] technique)

RESULTS

The prevalence of chlamydia infection within Group I and Group II was 40 6% and 15 0%, respectively Within Group I, the authors observed a highly statistically significant association ($p< 0\ 001$) between perinatal mortality and chlamydia infection perinatal death resulted in 46 2% of deliveries to mothers with positive test results, compared to 10 5% of deliveries among seronegative mothers Among Group I women with chlamydia (n=26), 84 6% delivered prior to week 33 and 80 8% delivered babies <1 5 kg In comparison, 65 8% of non-infected Group I mothers delivered prior to week 33 and 42 1% had babies <1 5 kg

Based upon these results, the authors conclude that a causal relationship exists between chlamydia infection and unexplained PTB, and that severity of infection may be related to birth weight, gestational age, and perinatal loss

Although the above case study also contributes to the general body of knowledge regarding STDs and pregnancy outcome in LDCs, the authors neither acknowledged nor controlled for the presence of other infections For example, Elliot et al (1989) note that studies reporting associations of chlamydia and bacterial vaginosis infections with prematurity were conducted in low gonorrhea prevalence areas As a result, diseases such as chlamydia, which are weak predictors of poor pregnancy outcome, appear to more strongly predict adverse pregnancy outcomes due to the absence of gonorrhea within those populations In addition, the investigators only reported data related to pregnancy outcome for women in Group I (i e , those women who experienced an unexplained preterm birth)

The investigators in Case Study #4 also failed to discuss the possible role of maternity care in determining these outcomes, nor did they control for potential non-disease confounders (e g , health care utilization) to the relationship between chlamydia and perinatal mortality In addition, although Groups I and II were matched on selected sociodemographic, history, and anthropometric factors, the authors did

not mention what nutritional factors were controlled for (e g , anemia, which is also linked to LBW), nor did they state the sensitivity and specificity of the screening test used to determine chlamydia infection status

The scarcity of STD data in the perinatal mortality literature is partly attributable to the fact that STD diagnostic and screening tests vary in sensitivity and specificity These tests are usually expensive to conduct, and they rely upon making contact with the pregnant woman during the earlier stages of pregnancy Although the above case studies from Malawi, India, and Kenya highlight the influence of STDs in determining pregnancy outcome, they do not shed light on appropriate timing of intervention (e g , latest possible stage during pregnancy to intervene in order to reduce adverse pregnancy outcomes due to STDs), nor did they all control for critical confounders (e g , nutritional status) to the relationship between STDs and pregnancy outcome

The need for developing country research in the area of STDs and pregnancy outcome cannot be overemphasized Although studies from MDCs indicate associations between selected STDs and poor pregnancy outcome, the incidence and prevalence of these infections among pregnant women are low relative to those in LDCs In addition, most MDCs have devised means of systematically detecting and treating pregnant women with such infections (WHO, 1991) Without empirical data from developing countries, we are unable to estimate the impact of STD control during pregnancy on pregnancy outcome, and more specifically, on perinatal mortality (WHO, 1991)

Maternal Malaria Infection

Apart from STDs, malaria is the only other infectious disease that receives attention in the perinatal mortality literature Although findings from studies (McDermott et al , 1996, Taha & Gray, 1993, Ibhanesebhor & Okolo, 1992) do not suggest a direct association between malaria and perinatal mortality, placental malaria infection does appear to increase the risk of LBW However, when time of death and timing of malaria attack were assessed, Taha and Gray (1993), observed a slightly increased risk (OR=1 4, 95% confidence interval 1 1,1 9) of stillbirth (in particular, macerated stillbirth) among women who reported malaria attacks during the first and second trimesters of pregnancy This relationship persisted even when controlling for factors such as maternal weight, birth interval, prior obstetric history, antenatal care visits, pregnancy and delivery complications, place of delivery, and infant sex The authors identified malaria infection during pregnancy and low maternal weight as modifiable predictors of term and preterm LBW In addition to influencing pregnancy outcomes, the authors also observed an association between malaria and neonatal mortality, and they speculated that preterm birth and LBW were possible mechanisms for this relationship (Taha & Gray, 1993)

PERINATAL MORTALITY INTERVENTIONS

Despite the paucity of intervention studies in the perinatal literature, it is possible to identify simple and low-cost interventions that may reduce perinatal mortality

******SEE APPENDIX F******
("Perinatal Mortality Intervention Studies")

The intervention literature reflects a general interest in (1) the training of formal and informal health sector providers (O'Rourke, 1995, Woods & Theron 1995, Ibrahim et al , 1992, Rahman, 1982), (2) syphilis control (Islam, 1996), and (3) essential newborn care (Sloan & Jordan, 1992, Daga, 1989) Apart from syphilis interventions, little or no published data exist on intervention efforts aimed at reducing late fetal loss This paucity is partially due to the fact that little is known about the causes and correlates of stillbirth In addition, the heterogeneity of the stillbirth group implies that different intervention strategies would have to occur at different stages of pregnancy (i e , antenatal period for macerated stillbirths versus labor and delivery for fresh stillbirths)

Training of traditional birth attendants (TBAs) has shown some promise in combating perinatal mortality (Kumar, 1991, Rahman, 1982) However, the formal health system must be equipped with the resources and the infrastructure to (1) identify high risk cases prior to delivery, (2) prevent conditions known to compromise the baby's health, and (3) transfer and treat babies with medical complications to higher-level health facilities when the need arises (Costello, 1993) Most interventions focus on supply-oriented factors, however, in order to maximize program effectiveness, it is necessary to address the social, economic and cultural barriers to access of services As a result, health planners must pay equal attention to demand for services as they do to supply-side factors (Costello, 1993), since quality of care is an issue that cannot be overlooked in resolving the problem of perinatal mortality

Potential also exists with respect to early detection and treatment of hypertension, diabetes, and syphilis infection among women of childbearing age (Costello, 1993) Of the aforementioned conditions, efforts to combat infectious diseases appear most frequently in the perinatal mortality intervention literature Syphilis is one of the few known causes of perinatal death that can be addressed pre-delivery Case Study #5 reviews a syphilis intervention study by Hira et al (1990) in Lusaka, Zambia In 1992, a similar, MotherCare-funded intervention study was conducted in Nairobi, Kenya by Jenniskens et al (1995) In the Kenya study, the percentage of pregnant women screened for syphilis increased from 60% to 100%, and the percentage of adequately treated women rose from 9% to 87%

With the exception of syphilis, few intervention studies have been devoted to STD prevention and its impact on birth outcomes Joesoef et al (1995) conducted a double-blind, multicenter randomized clinical trial in Indonesia, whereby they evaluated the effectiveness of intravaginal clindamycin (which is used to treat bacterial vaginosis) in preventing low birth weight and preterm delivery However, the authors did not observe a reduced incidence of low birth weight and preterm delivery among the 745 pregnant women included in the study, despite the proven efficacy of clindamycin in treating bacterial vaginosis

Although the efficacy of syphilis interventions in reducing perinatal mortality has been proven, their effectiveness will rely heavily upon the utilization of formal health sector services by the community Although the authors in Case Study #5 observed a positive impact of the screening and education program on pregnancy outcome, they did not acknowledge the limitations of implementing an

intervention during the antenatal period Jenniskens et al (1995) noted that their intervention in Kenya was not successful in encouraging women to initiate prenatal visits early in pregnancy

Because STD interventions target prenatal care attenders, antenatal contact between pregnant women and the health care system is at the crux of this approach As stated earlier, antenatal care utilization varies substantially across the globe, thus, program effectiveness will be a function of utilization patterns as well as intervention efficacy The authors of the Zambian study also did not control for *history bias* in the evaluation of the intervention That is, factors external to the program (e g , a government-sponsored syphilis prevention campaign) may have resulted in the decline in syphilis-associated early mortality Program effectiveness was assessed using two different populations of pregnant women before and after the intervention Based upon this approach, it is apparent that their aim was to observe the impact of the intervention at the population level and not at the individual level

As stated earlier, most interventions focus on antenatal and labor/delivery care as targets Postpartum practices remain undocumented in the perinatal mortality literature, in spite of the fact that infants who escape early perinatal death are still susceptible to perinatal mortality for seven days after delivery Once mother and neonate are discharged from the hospital, traditional practices within the community may also place the baby at risk (WHO, 1996b) Case Study #6 highlights the use of low-cost methods to reduce mortality during the neonatal period in a hospital setting, as described by Daga (1989)

Despite the fact that the intervention and evaluation methodology are not explained in Case Study #6 many of the activities that are outlined are in concordance with guidelines for Essential Newborn Care issued by WHO (1996b) The above illustration is not a true intervention study per se, since it only describes NICU performance before and after activities were initiated In addition, the author makes no mention of sampling or data collection As a result, the program's impact (i e , the degree to which improvements in neonatal and infant survival may be attributed to the program) on neonatal survival is not known Multiple activities (e g , nurses training, audits, exclusive breastfeeding) were initiated simultaneously, making it unclear which component of the intervention had the greatest effect on survival

Despite these shortcomings, the above illustration demonstrates that expensive technology is not requisite for improvements in neonatal survival in a hospital setting This feature is important, in the interest of both cost-effectiveness and sustainability However, Daga does not discuss possible modifications that can be made to this approach in order to make it more feasible within a community setting Different components of the intervention may need to be emphasized depending on the setting (i e , within a health facility versus the community) For example, the use of room heaters is not a realistic component of a community-based or a hospital-based intervention in most contexts Consequently, other means of thermal regulation are required Exclusive and frequent breastfeeding, which impacts infant nutrition, may be used as an alternative means of maintaining infant warmth immediately after birth

CASE STUDY #5 ZAMBIA

Hira SK, Bhat GJ, Chikamata DM, Nkowane B, Tembo G, Perine PL and A Meheus (1990)
Syphilis Intervention in Pregnancy Zambian Demonstration Project

Hira et al (1990) evaluated the effectiveness of a community health education and prenatal syphilis screening program in reducing poor pregnancy outcomes in Lusaka, Zambia Three periurban health centers formed the intervention groups and another three health centers formed the control groups Facilities in both groups served populations of comparable size and socioeconomic status Staff members working at the three intervention sites received specialized health education training, as well as instruction in clinical evaluation, syphilis serological testing, and assessment of pregnancy outcomes

During the pre-intervention phase (September 1985 through January 1986), the study team (1) tested blood samples from the mothers and their umbilical cords for syphilis, (2) conducted physical examinations, and (3) obtained detailed prenatal histories from 491 consecutive women from the study centers and 434 consecutive women from the three control health centers Each antenatal clinic attender filled out a questionnaire that documented the pattern and frequency of prenatal attendance, as well as reasons for attending late in pregnancy A similar questionnaire was administered one year after program implementation to prenatal attenders at each of the study centers

Between February 1986 and January 1987, the intervention, which entailed prenatal syphilis screening, health education and information dissemination, encouraged early antenatal care attendance and health care-seeking behavior There were three target groups for the intervention (1) sexually-active women at antenatal, family planning, and under-five clinics, (2) sexually-active men and women at general outpatient clinics, and (3) elderly men and women at general outpatient clinics (targeted because older individuals are influential in evoking behavior change within this society) Information was disseminated via lectures (with audiovisuals), question and answer sessions, brainstorming sessions, group discussions, and individual counseling (for seroreactive clients) All educational materials were pretested, and local words, pictures, and stories were incorporated in the curriculum For each pregnant woman, on-site syphilis screening was performed twice during the pregnancy Seroreactive women and their partners were treated by clinic staff

Between February and June 1987 (post-intervention phase), 1,274 women were recruited from the three control sites Program performance was evaluated by comparing pregnancy outcome data before and after the intervention and between the intervention and control groups

RESULTS

Syphilis prevalence within this population was 8 0% The authors observed no significant difference in syphilis seroprevalence between the control and study groups With respect to adverse pregnancy outcomes, 10% of seronegative mothers (n=2,647) experienced an adverse pregnancy outcome, compared to approximately 58% of all seropositive mothers (n=230) Adverse outcomes included the following abortion (among seroreactive and seronegative women 14 8% and 2 3%, respectively, RR=5 0 [95% confidence interval 3 72 ,6 80]), stillbirth (among seroreactive and seronegative women 7 0% and 1 6%, respectively, RR=3 6 [95% confidence interval 2 31, 5 53]), prematurity (among seroreactive and seronegative women 12 2% and 4 4%, respectively, RR=2 6 [95% confidence interval 1 83, 3 74]), and low birth weight (among seroreactive and seronegative women 21 3% and 1 8%, respectively, RR=7 8 [95% confidence interval 6 09, 9 88]) The prevalence of congenital syphilis within this population was 2 2% The authors also observed a 33 3 percentage point increase in antenatal care initiation prior to the 16th week of gestation In addition, there was a statistically significant difference in the percent attributable risk of adverse pregnancy outcomes associated with syphilis (28 3% in the intervention group versus 72 4% among control groups)

The authors conclude that it is possible to incorporate health education activities into existing health center activities They underscore the importance of revitalizing syphilis intervention programs during pregnancy, and they believe that program effectiveness will depend on the pattern of antenatal care utilization sensitivity of screening tests, and treatment of seroreactive clients and their partners

CASE STUDY #6 INDIA

Daga SR (1989)

Reduction in Neonatal Mortality by Simple Interventions

Daga (1989) describes a four-pronged intervention to reduce neonatal mortality within a hospital neonatal intensive care unit (NICU) in Bombay, India that was both cost-effective and successful in lowering mortality

The intervention entailed improving the quality of immediate care of the newborn via four types of activities (1) provision of warmth to the neonate through room heaters, (2) exclusive and frequent breastfeeding, (3) mother's participation in infant care, and (4) minimal handling of the infant and minimal interventions

Starting in 1982, neonates in the NICU at the Institute of Child Health in Bombay were kept warm in cubicles with glass partitions and were exclusively breastfed Mothers' participation in early newborn care was highly encouraged by making use of their nursing skills and minimizing the use of machines and monitors During the study period, other activities supplemented the four-pronged intervention For example, nurses received additional training in perinatal and neonatal care, and hospital staff implemented a perinatal audit NICU performance was assessed using the survival rates of NICU infants and quality of survival of discharged babies

RESULTS

After implementation of the intervention, overall mortality and average length of stay in the NICU declined by almost 50% Despite the fact that intervention efforts targeted the early neonatal period, benefits extended far beyond this stage For example, the author notes that during the follow-up period, infants subjected to this simple intervention experienced lower post-neonatal mortality, despite being initially classified as high-risk at birth It is believed that sustained breastfeeding is also associated with reduced risk of post-neonatal mortality

The author concludes that neonatal care (as proposed in this article) can reduce the existing gap in infant mortality between developed and developing countries

Nutritional Interventions

Despite its important association with poor health outcomes in both the mother and the baby, most interventions aimed at altering maternal nutritional status rely upon the antenatal period as the point of intervention However, huge variations exist within and across regions with respect to antenatal care coverage 2-99% in Africa, 23-98% in Latin America, and 8-98% in Asia (Islam, 1996) In addition, deaths among normal birth weight infants cannot be predicted during the antenatal period, as they often result from practices related to labor, delivery, and immediate postpartum Nevertheless, poor maternal nutritional status is an underlying factor for medical conditions that compromise the mother's health (e g , anemia) and subsequently, result in infant conditions (e g , LBW) known to increase the risk of perinatal death

With respect to LBW, Kramer (1987) notes that caloric supplementation is a major preventive intervention against both IUGR and prematurity in LDCs However, as seen in Table 8, it must be coupled with other public health interventions

TABLE 8

Public Health Interventions for Intrauterine Growth Retardation and Prematurity

CONDITION	INTERVENTIONS IN MDCs	INTERVENTIONS IN LDCs
Intrauterine Growth Retardation (IUGR)	anti-smoking efforts	caloric supplementation before and during pregnancy
	selective caloric supplementation before and during pregnancy	malaria prophylaxis or treatment
	delayed child-bearing in young adolescents	anti-smoking efforts
	improved maternal nutrition	efforts to reduce tobacco chewing
	selective improvements in nutrition	delayed child-bearing in young adolescents
	selective improvements in socioeconomic conditions	improved maternal education
	new vaccines to prevent communicable diseases	general improvements in nutrition
		general improvements in socioeconomic conditions
		improved sanitation and water supplies
Prematurity	anti-smoking efforts	caloric supplementation before pregnancy
	selective caloric supplementation before pregnancy	delayed child-bearing in young adolescents
	delayed child-bearing in young adolescents	improved maternal education
	improved maternal education	general improvements in socioeconomic conditions
	selective improvements in socioeconomic conditions	

SOURCE Kramer 1987 723

PERINATAL AND MATERNAL DEATH AUDITS

Perinatal and maternal death audits are becoming widely recognized as valid approaches to addressing the problem of perinatal and maternal mortality in the developing world This section highlights features of perinatal audits that make them appealing in documenting perinatal mortality Selected articles (Bhatt, 1989, Ward et al , 1995) have erroneously attributed reductions in perinatal mortality solely to the implementation of audits The perinatal audit, in and of itself, is not an intervention However, it is useful in identifying "weak links" in perinatal care (and thus, in identifying potential points of intervention) It should therefore, be incorporated in all information-gathering and monitoring activities of interventions Case Studies #7 and #8 illustrate the use of the perinatal audit at both the district and hospital levels

Most published perinatal audits (Ward et al , 1995, Bugalho & Bergstrom, 1993, Bhatt, 1989) are

hospital-based, thereby limiting our ability to make inferences regarding the broader health system and community Case Study #7 illustrates the feasibility of a district-level audit Despite the district-level approach, the Zimbabwean audit only examined deaths occurring within the formal health system As a result, investigators were not able to ascertain information on non-institutional births and deaths, nor were they able to document care-seeking behavior within the community Because women generally did not seek formal health services in a timely manner, it is possible that complicated deliveries entered the health system only after all possible alternatives (i e , informal/traditional) were exhausted In sum, there may be multiple points of intervention prior to when a pregnant woman presents at the hospital or health facility for treatment of complications

One of the strengths of Case Study #7 is that it separated stillbirths from early neonatal deaths, and it made the distinction between fresh and macerated stillbirths This study is also an extension of the usual cause of death analysis because it examined avoidable factors associated with perinatal death, thereby highlighting the role of medical care in determining perinatal outcome However, caution should be given to coining delay in care-seeking as solely "maternal" in nature (as done in the article), since structural and process factors such as quality of care are related to client satisfaction, and may thus contribute to the care-seeking behavior patterns observed within the community

Although the authors in Case Study #8 did not observe a decline in overall perinatal mortality during the study period, the Maputo audit is an illustration of how structured surveillance and increased accountability of medical staff can impact certain aspects of the perinatal period Perinatal mortality should not be perceived as solely an obstetric or a pediatric problem The success of perinatal mortality interventions, particularly at the institution-level, relies upon the collaborative efforts of different types of health care providers and medical specialists

In Case Study #8, failure to assess mortality occurring between days two and seven (due to the nature of hospital discharge practices) highlights the need for follow-up within community Unlike the hospital-based audit, which usually entails a review of medical records and open dialogue among health personnel with regard to selected cases of perinatal death, community-based audits will require special techniques and data sources (e g , key informant interviews) to ensure adequate follow-up and information-gathering Community-based audits have not been employed on a broad scale, and published articles on this topic do not exist Although institution-based audits have been successful in creating dialogue among medical professionals, audits that are more community-oriented should aim to open lines of communication between formal and informal sector health providers, as well as within the community at large Therefore, in addition to being a tool for monitoring activities and outcomes, the audit also has the potential to provide a forum for open discussion of health problems, as well as educate the broader community on factors that affect both maternal and perinatal survival

CASE STUDY #7 ZIMBABWE

De Muylder (1989)

Perinatal Mortality Audit in a Zimbabwean District

A study team investigated all perinatal deaths occurring within a Zimbabwean district health system (from 1984-1986) in order to identify common etiological and avoidable factors Data were derived from maternal interviews, maternal, neonatal, and placental examinations, necropsy (in 17% of cases) and clinic charts Perinatal deaths included all stillbirths greater than 500g and all neonatal deaths within the first week of life The study criteria for an "avoidable death" was departure from an accepted standard of care, as outlined by the Zimbabwean Mother and Child Health committee In addition, the investigators used the *Wigglesworth Classification System* (which is based on the pathophysiology of the dead fetus/infant) to assign causes of death

RESULTS

During the study period, 11,094 deliveries resulted in 340 perinatal deaths, yielding a PMR of 30 6 per 1000 Of the 89 macerated stillbirths, 21 3% were due to syphilis, 18 0% to hypertension/pre-eclampsia, 15 7% to abruptio placentae, 9 0% to amniotic fluid infection, 7 9% to diabetes, 6 7% to malformations, 2 2% to postmaturity, 2 2% to Rhesus immunizations, 2 2% to cord problems, and 1 1% to multiple births The remainder (13 5%) were of unknown etiology Among the 76 fresh stillbirths, the leading causes were intrapartum asphyxia (38 2%), cord prolapse (13 2%), abruptio placentae (10 5%), multiple birth (9 2%), breech delivery (8 0%), malformations (8 0%), cephalo pelvic disproportion (8 0%), shoulder dystocia (2 6%), placenta previa (1 3%), and trauma (1 3%) Among the 154 neonatal deaths, there was normally formed low birth weight [<2000g was the cutoff because the author found this to be of clinical significance in a previous study] (51 3%), intrapartum asphyxia (19 5%), congenital malformations (10 4%), respiratory distress syndrome/meconium aspiration (5 2%), breech delivery (4 0%), neonatal sepsis (4 0%), second twin delivery (2 6%), shoulder dystocia (1 3%), neonatal anemia (0 6%), neonatal volvulus (0 6%), and abruptio placentae (0 6%) The investigators were able to identify an avoidable factor in 242 (75 6%) of the perinatal deaths In 38% of cases, delay in seeking care was the avoidable factor, followed by practices at maternity centers (9%) and the hospital (30%)

In sum, the study team was able to explain 96% of perinatal deaths occurring within the study period Asphyxial conditions during labor was the most common cause of perinatal death, and hospital management was partially responsible for adverse outcome in most of those cases The author concludes that because maternal attitudinal factors (e g , poor compliance with instructions, no antenatal care, or delay in seeking labor/delivery care) and poor hospital practices are the most common avoidable factors, they should be targets of intervention Detection and treatment of infections (e g , syphilis) and medical conditions (e g , hypertension) should be incorporated into mortality prevention strategies

CASE STUDY #8 MOZAMBIQUE

Bugalho A & S Bergstrom (1993)

Value of Perinatal Audit in Obstetric Care in the Developing World
A Ten-Year Experience of the Maputo Model

A daily and weekly perinatal audit took place at Maputo Central Hospital between 1982 and 1991, and its usefulness as a tool for improved obstetric care was assessed The audit paid special attention to the following six aspects of the perinatal period (1) late fetal death prior to delivery (with particular interest in antenatal activities), (2) intrapartum fetal death, (3) neonatal infant death (divided into deaths occurring within the first 24-hours postpartum and deaths during days two through seven postpartum), (4) maternal mortality (audit of antenatal management, pre-labor and intrapartum events), (5) neonatal infant morbidity (assessed using a referral sheet that documented perinatal trauma or other morbidity related to obstetric management), and (6) perinatal maternal morbidity (post-cesarean complications, anemia, postpartum hemorrhage, endometritis-myometritis, and malaria) The delivery book was the primary source of data The study team compiled data on a weekly basis and held weekly, fortnightly, and monthly perinatal and obstetric conferences in order to present and discuss cases Midwives, obstetricians, neonatologists, and other delivery staff played active roles in the perinatal audit

RESULTS

Although the overall perinatal mortality rate (PMR) did not exhibit a permanent decline over the ten-year period (75 0 per 1000 in 1982 and 78 5 per 1000 in 1991), avoidable intrapartum fetal deaths in the delivery room declined by approximately 65% In general, no new norms, practices or corrective measures were implemented during the study period However, the cesarean section rate did increase from 6 9% in 1982 to 16 0% in 1991 The authors partially attribute gains made in intrapartum fetal survival to the increase in cesarean deliveries

The authors state that the fluctuations in overall perinatal mortality and the unimpressive changes over the ten-year observation period should be viewed against the backdrop of the war in Mozambique The war resulted in a large influx of refugees and migrants into Maputo, and a subsequent increase in high-risk patients at Maputo Central Hospital In addition, the authors also note that the study's PMR is falsely low due to the inability to adequately follow mothers and their infants after they were discharged from the hospital on the 1st or 2nd day postpartum

Nevertheless, the authors conclude that this audit was successful in incorporating maternal and perinatal outcomes, both of which are indicators of quality of obstetric care An audit-oriented perinatal surveillance sensitizes staff to issues affecting maternal and perinatal survival It also provides a forum for different types of health practitioners to communicate, and thus, take measures to improve existing health services

LESSONS LEARNED FROM THE LITERATURE

Based upon a review of the current literature, it is apparent that maternal, fetal, and obstetric factors are interrelated, thus making it difficult to assign a single cause of perinatal death Although studies have identified a number of risk factors and causes of perinatal mortality, the informativeness of these findings and the potential for intervention must also be assessed The literature suggests that the medical management of LBW and other conditions, and not solely the conditions themselves, are major contributors to perinatal mortality In addition, a reduction in the prevalence of conditions such as PTB is not feasible within a short period of time, though there is the potential to improve the medical management of those conditions through (1) adequate training of health providers and (2) improvements in systems of referral

Data on STDs and pregnancy outcome are derived primarily from studies based in industrialized countries Nevertheless, there is evidence to suggest that preterm labor is linked to STDs such as gonorrhea, chlamydia, and bacterial vaginosis The potential impact of STD interventions on pregnancy outcome (and more specifically, perinatal mortality) in high prevalence countries is unknown due to the absence of data Of all the STDs, syphilis interventions have demonstrated a direct impact on perinatal mortality--in particular, on macerated stillbirths Thus STD prevention and control may be one means of reducing perinatal mortality in high STD prevalence areas

Maternal nutritional status has not been linked directly to perinatal death, though it is critical in determining infant outcomes such as birth weight (which is a major determinant of neonatal survival) Despite the role of maternal nutritional status in determining maternal and infant health outcomes, nutritional interventions should not be the major thrust of efforts against perinatal mortality Instead, interventions that aim to improve the nutritional status of women should be incorporated into broader-scale efforts aimed at (1) reducing the presence of certain maternal conditions known to compromise the health outcomes of the mother and the perinate, and (2) ensuring timely and appropriate medical management of conditions if and when they arise

Historically, much of the perinatal and infant mortality literature has been devoted to maternal sociodemographic factors (e g , maternal age, parity, maternal education) Although these factors are critical in determining the risk of perinatal death, they are not amenable to short-term interventions For example, nulliparity and primigravidity are widely cited risk factors for perinatal mortality However, all women who bear children must experience a first birth Although special monitoring of first-time mothers is advised, very little can be done programmatically to reduce the risk of death associated with this risk factor The overabundance of data on sociodemographic variables is partially due to the fact that these factors are easily and objectively measured in many contexts In contrast, it is much more difficult to ascertain information on aspects of labor and delivery when these events seldom occur in the presence of medically trained health personnel Nonetheless, it is important to identify program areas that will have the greatest impact on perinatal mortality in least amount of time

Our current state of knowledge regarding perinatal mortality is primarily derived from hospital-based studies Despite the convenience of hospital-based sampling, there are limitations in using hospital data to assess perinatal mortality One of the biggest limitations pertains to the overabundance of complicated deliveries within hospitals, thus rendering the hospital-based sample a biased representation of the general population There is merit in assessing perinatal mortality in institution-based populations as long as the limited generalizability of findings is recognized However, it is apparent that despite the gross confluence of information on perinatal mortality in the published literature, very little is known about perinatal mortality as it applies to the majority of the developing world's births Although there is

a need for supervised delivery by trained health personnel, hospital delivery is not the panacea for perinatal mortality Moreover, a dramatic shift in the developing world from a preponderance of home deliveries to hospital deliveries is unlikely Therefore, it is imperative that both institution-based and community-based deliveries receive research attention

With respect to collecting information on perinatal mortality, the perinatal audit is a good first step Although the audit is not an intervention in and of itself, it can be a valuable component of monitoring and evaluation activities In addition, it provides the added bonus of increasing communication and accountability among medical staff Although the ultimate goal of most interventions is to produce favorable outcomes (e g , a reduction in the PMR), monitoring process (e g , the nature and quality of obstetric practices) is equally important The perinatal audit is one such means of examining the process of perinatal care, highlighting the gaps in service delivery and identifying key areas that warrant programmatic attention

ISSUES NEEDING FURTHER INVESTIGATION

Given our current state of knowledge regarding perinatal mortality, the following outline highlights issues that deserve research attention

METHODOLOGICAL and MEASUREMENT ISSUES

- Implementation and evaluation of **community-based perinatal audits**, including identification of valid sources of data, methods of surveillance, etc
- **Improvements in methods of gestational age assessment,** which will assist in making more precise distinctions between IUGR and PTB
- Estimation of the degree of **underascertainment and/or misclassification** of stillbirths and early neonatal deaths
- **Cost-effectiveness**, process and/or outcome **evaluation**(s) of perinatal interventions

QUALITY OF CARE

- **Quality of maternity care in institutions**
- **Nature and quality of obstetric and traditional practices** (antenatal, labor/delivery, postnatal) in the community, and their impact on perinatal mortality
- Inadequate and inappropriate **resuscitation** of newborns
- Incidence of **hypothermia**, which is a reflection of the quality of immediate newborn care
- Appropriate cause of **death classification systems** for perinatal mortality in LDCs

CARE-SEEKING BEHAVIOR AND PERCEPTIONS WITHIN THE COMMUNITY

- **Perceptions of normal pregnancy and delivery** among pregnant women, traditional birth attendants (TBAs), and other members of the community (e g , mothers, mothers-in-law)

- Issues surrounding **access and utilization** of institution-based maternity services

- Factors that influence **care-seeking behavior** for obstetric and newborn conditions in the community

CAUSES OF PERINATAL DEATH

- **Differentiation between** LBW due to **PTB** and LBW due to **IUGR** (important since preterm infants are at a higher risk of perinatal death, though most LBW infants in the developing world are growth-retarded)

- Impact of **infections** (both intrauterine infection and sepsis) on perinatal mortality

- **Magnitude and causes of stillbirths,** as well as the distinction between **fresh and macerated stillbirths**

- Documentation of **perinatal mortality by age of death** (which also sheds light on probable causes of death)

In reviewing the perinatal literature it is apparent that very little is known regarding the nature and quality of maternal and perinatal care outside of the formal health sector In order to implement the most appropriate interventions the magnitude and nature of perinatal mortality must first be assessed Lack of data on perinatal mortality outside of institutions is largely due to our limited knowledge on how to assess perinatal mortality in the community Vital registries and other systems of reporting are sub par in LDCs though their potential informativeness as sources of data should not be underestimated In contexts with poor infrastructure and poor systems of reporting, much of the information obtained on perinatal mortality in the community will be derived primarily from individuals within the community Thus it is imperative that we not only address what types of questions need to be asked, but how and when these inquiries should be conducted, by whom and to whom in order to derive the maximum quantity and quality of information from the minimum amount of resources

The remainder of this report will review conventional sources and techniques used in perinatal data collection and it will present recommendations on how they may be modified to more accurately assess perinatal mortality within the community

COMMUNITY-BASED ASSESSMENT OF PERINATAL MORTALITY
METHODOLOGICAL ISSUES

General Comments on the Nature & Quality of Community-Based Studies in the Published Literature

Although studies vary substantially with respect to their methodologies, most community-based studies are characterized by small sample sizes This should not be surprising, since study recruitment within the community is more difficult than in hospital wards or health facilities In general, published community-based studies are not explicit in their description of study methodology, often citing the use of community surveillance, key informants, or household surveys, while omitting details on sample selection, methods of birth and death ascertainment, and survey development and implementation In addition, many studies use traditional data sources and data collection techniques, with very few modifications for application within a community setting

The following sections provide a general discussion of relevant issues in perinatal mortality research, with particular emphasis on community-based assessment of perinatal mortality

Sources of Perinatal Data

Perinatal mortality research is driven primarily by quantitative methods Two widely used sources of perinatal data are structured surveys and vital records, both of which vary in accuracy and reliability from one context to the next Vital registration data tend to underestimate perinatal mortality to a larger degree than survey data This underestimation is due to the inaccuracy and incompleteness of vital events reporting throughout the developing world The following two case studies from Thailand and Burkina Faso illustrate differences in data completeness between four data sources vital registration, a community survey, community surveillance, and a census

Case Study #9 from Thailand supports the common belief that vital registration data are less complete than survey data However, in order to effectively critique vital registries as a source of perinatal data, it is important to determine whether the vital registration system is equipped to document perinatal deaths It should not be surprising that a weekly surveillance system was more successful in capturing perinatal mortality than a system that relied upon an individual's own initiative to report vital events In the Thai study, the investigators noted that neither legal sanctions for non-reporting nor incentives for timely reporting of vital events exist in Thailand As a result, one would expect that specific and targeted inquiries into the occurrence of stillbirths, early neonatal, and late neonatal deaths yield more complete estimates of mortality

The authors of the Thai study were unable to assess the true *validity* (i e , accuracy) of estimates derived from each of the data sources, since no gold standard exists for measuring perinatal mortality in the community Consequently, they can only assess *relative* validity (i e , the degree to which one data source captures events more successfully than another), though there is no means of quantifying the true number of missed events

CASE STUDY #9 THAILAND

Lumbiganon P, Panamonta M, Laopaiboon M, Pothinam S and N Patithat (1990)
Why Are Thai Official Perinatal and Infant Mortality Rates So Low?

Lumbiganon et al (1990) compared the completeness of one-year perinatal and infant mortality data obtained from a community survey with vital registration data in Nong Rua district (population over 80,000), Thailand Vital registration statistics were collected from district and provincial health offices, whereas community data were obtained from weekly visits to every household within the 120 villages which compose Nong Rua district

In 1988, mothers and relatives of all stillbirths and infant deaths were interviewed regarding stillbirth and infant death registration The study team also collected information on sociodemographic characteristics (e g , maternal and paternal age, education, family occupation) and assessed the usefulness of place of death, age at death, and birth registration as predictors of non-registration

RESULTS

Fertility and mortality estimates from vital registration data were consistently lower than statistics from community survey data According to the community survey, 28 perinatal deaths occurred during the study period (PMR= 22 0 per 1000 total births, 95% confidence interval 13 9,29 6) In contrast, the vital registration system missed all of these deaths and only captured one-half of all neonatal deaths The authors found perfect concordance between the presence or absence of birth registration and the presence or absence of death registration In addition, the number of missed events decreased with increasing age at death The authors also observed that most people did not recognize the importance of reporting stillbirths and infant deaths More specifically, they saw no need to report a death occurring within a few days of birth if the birth had not yet been reported

Based upon data from Nong Rua district, the authors conclude that Thai perinatal and infant mortality statistics derived from vital registration are immensely inaccurate Rates derived from this study are likely to be accurate since the sample size was large enough to provide good estimates of under-reporting However, similar studies in other districts within Thailand should be conducted to test the generalizability of these findings The authors speculate that the accuracy of national statistics may be improved in three possible ways (1) indirect estimation, (2) establishment of a new mechanism of vital registration (e g , use of village health volunteers to collect vital data), and (3) improvement of the existing vital system by implementing a psychosocial intervention to increase community awareness and participation Collecting accurate crude perinatal and infant mortality rates is only a first step, rates should be broken down into birth weight categories or expressed as the standardized mortality ratio

Although systems of collecting and compiling vital information already exist in most contexts, it is important to ask the following two questions when evaluating a vital registration system as a source of perinatal statistics (1) Are there separate forms or specific items allotted to the documentation of stillbirths and early neonatal deaths? -AND- (2) Are there penalties for failure to report events? A system that has not historically collected perinatal information should not be considered as a source of perinatal data without making structural changes to ensure more accurate and timely reporting of events Nevertheless, as illustrated in the Thai study, structural changes are necessary but not sufficient to ensuring accurate reporting of deaths Cultural perceptions of viability must also be taken into account

Given the deficiencies of most vital registration systems in documenting perinatal mortality, it is important to identify alternative sources of data Unfortunately, most published studies have not explored other data sources specifically for perinatal mortality but have instead focused on early child mortality (in most instances, defined as death between birth and age five) Case Study #10 from Burkina Faso explores a community surveillance and a census used to assess child mortality

CASE STUDY #10 BURKINA FASO

Diallo DA, Habluetzel A, Esposito F and SN Cousens (1996)
Comparison of Two Methods for Assessing Child Mortality in Areas Without Comprehensive Registration Systems

Diallo et al (1996) compared the completeness of child mortality data from a cross-sectional census with a surveillance that used community informants in rural Burkina Faso The study outcome was all-cause mortality from six months to 59 months of life

A census was taken of 158 villages (N=90,000) surrounding Ouagadougou, (the capital of Burkina Faso) for the following periods January to August 1993, January to March 1994, and January to March 1995 Census enumerators, who documented births, deaths, and migration within the population, received paid incentives (approximately US$1) for identification of each death of a child who was already registered, and US$2 for each child who was born and died between censuses Enumerators were financially penalized for errors and falsification of information

The longitudinal surveillance entailed tri-weekly visits by field workers to the same villages Each field worker identified at least one village key informant, who relayed information on births, deaths, and other events occurring within the village Data were confirmed weekly by field supervisors Field workers received US $1 for each birth and death that was identified through the surveillance Community informants received no compensation

The 1994 census enumerators were unaware of events occurring among children under age five As a result, the authors claim that identification of births and deaths using the census was independent of identification of those same events through the surveillance For the purpose of the analysis, vital events were classified as follows (1) events identified independently by both approaches, (2) events only identified by the surveillance, (3) events only identified by the census, and (4) events reported by the surveillance but not confirmed by the census Sensitivities of the two systems in identifying infant and child deaths were calculated, with the assumption that the probability of a missed event was independent between the two systems

RESULTS

The census identified 410 deaths among children between the ages of six and 59 months, whereas the surveillance only identified 319 With respect to cost, a year-long community surveillance was twice as expensive as a single census (US$16,000 versus US$8,000) Both methods were ineffective in documenting deaths under six months, though the census yielded more complete information For example, the census identified 36% of deaths under the age of six months (n=371), compared to 16% using the longitudinal surveillance Although enumeration was more complete when both methods were used simultaneously (47% of all deaths to infants less than six months were identified), there remained a substantial number of missed events The estimated sensitivities of the census and the surveillance in identifying deaths was 97% and 76%, respectively The authors estimated that for deaths under 6 months of age, the sensitivities of the census and longitudinal surveillance were approximately 74% and 57%, respectively

The authors conclude that annual censuses may be sufficient in documenting deaths over the age of six months, but they are insufficient for deaths during the earlier stages of life Compensation of community informants may be a means of improving completeness of data derived from community surveillance, however, this would increase costs substantially The use of unpaid informants in census enumeration may also improve death ascertainment However, regular home visits to assess occurrence of vital events may be the only reliable approach to obtaining accurate estimates of early infant mortality

The above case study dispels a common belief that a longitudinal surveillance with community

informants is more effective than a census Although the census was more complete than the surveillance, the census missed between two-thirds and three-fourths of infant and child deaths, depending on the age at death Enumeration was more complete when both methods were used simultaneously (47%), however, the immense number of missed events resulted in inaccurate perinatal or neonatal estimates

Before choosing to abandon the community surveillance as a viable means of assessing perinatal mortality, it is important to assess why it was unsuccessful in Case Study #10 For example, the authors did not discuss the credibility of the community informants Field workers selected the informants, however, it is unknown whether the informants were chosen based upon their position and credibility within the community or out of convenience (e g , field workers may have selected friends and relatives as informants) In addition, the methods used by the informants to ascertain the occurrence of events is unknown Informants may have relied upon word-of-mouth, or they may have visited homes every three weeks Both of these approaches are not likely to be adequate in assessing mortality during the earliest stages of life Finally, this study must be placed within a cultural context As illustrated in Case Study #9 from Thailand, community members may not perceive the need to report a perinatal death or other deaths within the first six months of life, once again illustrating the need to identify the cultural constraints of assessing mortality within the community

STUDY DESIGNS

Researchers may assess perinatal mortality using a variety of retrospective, cross-sectional, and prospective study designs This section presents a brief overview of common study designs used in perinatal mortality research

The Case-Control Study

The *case-control study* is a widely used study design that allows the investigator to collect information on risk factors, as well as evaluate program impact (Barbieri, 1991) This study design is most appropriate when the outcome is rare As a result, the case-control study may be better suited in some contexts (e g , countries with lower PMRs) than others *Cases* are individuals with the outcome of interest (for our purposes, perinatal death) As seen in the current literature, cases may not necessarily be defined in terms of mortality, but rather the presence of conditions such as LBW or prematurity *Controls* are generally singleton infants who survived the perinatal period (or in the case of LBW, normal birth weight infants) Specific attention must be given to the selection of both cases and controls, which not only influences the generalizability of results, but may also affect the internal validity of the study For example, in a hospital-based study of perinatal mortality, it is most appropriate to select cases and controls from the hospital, since these mothers probably share similar characteristics that may be related to perinatal mortality (e g , general health status of both cases and controls, health awareness, care seeking behavior)

The appeal of the case-control study design in perinatal research is that it may be conducted in a short period of time, at relatively low cost, and with small sample sizes (Barbieri, 1991) In addition, the case-control study allows one to explore multiple risk factors (e g , sociodemographic, biological, health care-related) associated with the outcome of interest In the area of perinatal mortality, case-control studies have been used to identify many maternal risk factors such as parity and prior reproductive loss, as well as to assess the role of obstetric care in determining perinatal outcome

The Cohort (Longitudinal) Study

Investigators usually embark upon a *cohort study* to explore factors, in further detail, that were initially identified in case-control studies In a perinatal mortality cohort study, a cohort may be comprised of a group of pregnant women identified during the antenatal period and followed up through delivery and a specified period of time postpartum (e g , seven days post-delivery) Pregnancy outcomes (e g , perinatal mortality) of women with and without a particular factor (e g , active syphilis infection) are then compared

Although costly, cohort studies are not as susceptible to biases associated with recall and self-reporting as case-control studies In addition, sufficient data on a particular factor are usually available in a cohort study, in contrast to many case-control studies, which rely on data that are often collected for purposes other than the study's objectives Unlike case-control studies, however, high attrition rates pose a particular threat to cohort studies This shortcoming is particularly salient within the community, where there are often difficulties in not only recruiting mothers, but retaining them within a study Nevertheless, the cohort study is essential for inferring causality between a specific factor and perinatal mortality

Hybrid Designs

Hybrid designs such as the *nested case-control study* are becoming increasingly widespread in the literature In a nested design, both cases of perinatal death and controls are identified within a defined cohort of women Baseline data are collected on all women within the cohort who are followed for a specified period of time In doing so, data are available prior to the occurrence of perinatal deaths, which allows the investigator to establish causality (by documenting risk factor status prior to outcome status) Gray et al (1991) conducted an institution-based surveillance between September 1984 and February 1986 in Natal, Brazil However, because it was not feasible to obtain detailed maternal information for all births (N=11,171), the authors used a nested case-control design to assess determinants of adverse pregnancy outcome In this analysis, 221 cases of early neonatal deaths were compared to 3367 controls (survivors of the first week of life), thereby reducing the potential burden of collecting data on over 11,000 births

Cross-sectional (Prevalence) Study

The *cross-sectional study* gives the investigator an impression of both risk factor(s) and outcome(s) simultaneously Censuses, Demographic and Health Surveys (DHS), or any other studies that document events within a particular population at a specified point in time, are cross-sectional in nature Characterized by temporal ambiguity, the cross-sectional study is probably the least attractive of the study designs, with respect to perinatal mortality That is, it is difficult to establish whether the risk factor precedes or follows the outcome of interest However, results from such a study may be suggestive of potential risk factors for mortality (Gordis, 1996), which may then be examined more closely using a longitudinal or case-control study design

Despite their limitations in assessing temporality or causality, cross-sectional studies still have the potential to be quite informative This is particularly true when they are combined with retrospective methods of data collection For example, the DHS combines cross-sectional sampling (e g , a sample of all women of reproductive age within a particular country in a given year) with a retrospective questionnaire (e g , pregnancy or birth history) There has been a general perception that demographic survey data are inappropriate sources of perinatal statistics However, studies in the Philippines (Stanton, 1995) and Pakistan (Fikree & Gray, 1996) provide evidence that the demographic survey is a viable

source of data for perinatal mortality statistics In the Filipino study, the reliability (i e , the consistency/reproducibility of results) of PMRs was 95%, which is comparable to the reliability of infant and child mortality rates The Pakistani study yielded an even higher reliability (98%) Thus, it is possible to combine elements of different study designs in order to increase the feasibility of a study, as well as the reliability of estimates derived from it

Community Randomized Trials

In light of the need to implement community-based perinatal mortality interventions, it is necessary to identify evaluation study designs that are not only methodologically rigorous, but feasible to implement Most intervention studies are quasi-experimental, that is, individuals are <u>not</u> randomly assigned to intervention and control groups Few studies involve randomization due to ethical concerns regarding the "denial" of an intervention or treatment to the individuals assigned to the control group However, in making intervention and control groups comparable on dimensions other than the intervention, randomization attempts to guard against erroneous conclusions regarding program impact

Despite the benefits of individual randomization, it is not always feasible to administer an intervention to selected individuals (i e , those individuals assigned to the treatment group) within a particular community In addition, individual randomization may be cost-prohibitive (Gail et al , 1996) Costs may be reduced by conducting *community randomized trials* Community randomized trials entail the "randomization of subjects in groups, rather than of each individual separately" (Gail et al , 1996 1070) to treatment (i e , intervention) and control (i e , non-intervention) groups In community-based studies, randomization of groups (e g , communities) is equally as important as randomization of individuals (Koepsell et al , 1995) Because it is generally not feasible to study all members of a particular community, one may evaluate program effectiveness by selecting a cohort of individuals from the intervention communities When one is interested in obtaining information on the effects of an intervention on individuals, a longitudinal study design should be used, whereas a cross-sectional design is more appropriate to assess program impact on group indices of health (Gail et al , 1996)

With respect to perinatal mortality, community randomized trials may hold promise in the evaluation of STD treatment and prevention, community-based health education, and training programs

<u>DATA COLLECTION TECHNIQUES--SURVEY DATA</u>

Surveys are one of the most common sources of data on early mortality, and they may be used in any of the three study designs discussed in the previous section In addition, surveys may employ a number of approaches to capture fertility and mortality This section reviews the accuracy and reliability of three retrospective instruments *complete pregnancy histories*, *complete birth histories*, and *truncated pregnancy histories*

Pregnancy Histories

As stated earlier, pregnancy histories are retrospective in nature, though they may be used with non-retrospective study designs (e g , DHS) Pregnancy histories document previous and current pregnancies experienced by a woman Two approaches may be used with the pregnancy history *backward* and *forward* The main distinction between a ***backward*** pregnancy history and ***forward*** pregnancy history is

that the former begins with an inquiry into the last or previous baby alive, whereas the latter starts with the first baby born alive Apart from the way in which the reference *birth* is determined, both approaches involve the collection of information regarding all *pregnancies* occurring before or after the reference birth (Becker & Mahmud, 1984)

Becker and Mahmud (1984) assessed the validity of backward and forward pregnancy histories using data on ever-married women of reproductive age in Matlab, Bangladesh Although they did not observe a statistically significant difference between backward and forward pregnancy histories, the backward approach yielded a lower proportion of missed events [defined as a birth identified in the vital registry, but not reported by the respondent in the pregnancy history] The authors attribute the inability to observe statistically significant differences between the two types of pregnancy histories to the small number of missed events (n=71) The majority of missed events (61 6%) in this study were non-live-births

Stanton (1995) investigated the data quality and reliability of pregnancy history data in the Philippines and discovered that the reliability of early loss and perinatal mortality rates from survey data was comparable to rates of infant and child mortality Findings from this study dispelled the common myth that events surrounding the perinatal period cannot be measured as accurately as deaths at other stages of life using a demographic survey

Birth Histories

Historically, birth histories have been proven useful in the collection of demographic data, particularly when vital registration is unreliable or lacking Until recently, all DHS surveys included a complete birth history Unlike the pregnancy history, the birth history presents an incomplete picture of a woman's reproductive history, since only live births are recorded As a result, its application is limited with respect to assessing perinatal mortality, and it is better suited for assessing infant and child mortality

The term "birth history" has been used interchangeably with "pregnancy history," and even when actual birth histories are used, they may be supplemented with special inquiries into stillbirths and abortions For example, Garenne (1994) analyzed a birth history employed in Niakhar, Senegal that documented all live births to women ages 15-89 years However, the enumerators made special note of children who died before the naming ceremony, which takes place on the 7th day post-delivery (i e , at the end of the early neonatal period) In addition, enumerators systematically researched and recorded stillbirths and abortions Using this approach, the author concludes that the birth history can accurately depict live births, deaths, and stillbirths, and that a woman is capable of reporting all vital events occurring in her reproductive lifetime, regardless of her age However, without modifying the birth history to include specific inquiries into non-live births, the birth history is not recommended as a viable option when assessing perinatal mortality Once non-live births are included in the inquiry, the term "birth history" becomes a misnomer, since the maternal report takes on characteristics that are more similar to a pregnancy history

Truncated Histories

The previous two sections discussed the use of complete (a k a "full") pregnancy and birth histories in deriving perinatal data However, the question also arises as to whether one may obtain accurate estimates of perinatal mortality by collecting a smaller amount of information (e g , limiting the reference period to the past 5 years as opposed to documenting a woman's entire reproductive life)

The ***month-by-month calendar method*** is one approach to collecting data on reproductive events that occur during a specific period prior to the survey Apart from the obvious fact that a smaller amount of information required to be collected saves a tremendous amount of time and resources, the quality of date-reporting tends to be much higher than in full histories, since only the most recent events are documented (Westoff et al , 1990) It is also more feasible to obtain data on a myriad of reproductive events other than pregnancy (e g , contraception, induced abortions, and marital unions) using truncated histories Case Study #11 reviews one such application in Costa Rica

CASE STUDY #11 COSTA RICA

Becker S and D Sosa (1992)

An Experiment Using a Month-by-Month Calendar in a Family Planning Survey in Costa Rica

Becker and Sosa (1992) compared data from month-by-month calendar questionnaires with similar data from traditional pregnancy histories (from the 1986 Costa Rican Maternal and Child Health and Family Planning (MCH-FP) Survey) The month-by-month calendar was devised as a means of coding each woman's reproductive status and events for every month within the reference period The authors chose a five-year period prior to the survey implementation as the reference period for reproductive events, and they examined similarities and differences in the questionnaire designs by alternating questionnaire type by cluster (i e , group of households) Items appearing in each of the surveys were almost identical, and interviewer training was also identical for both questionnaires

In half of the 3,527 interviews with women, the calendar questionnaire was used, and in the other half, a traditional demographic questionnaire was used The questionnaire included modules on issues such as household characteristics, contraceptive practices, marital history, pregnancy history (truncated), and current sexual activity

RESULTS

The response rate for both types of questionnaires was 95% The mean duration of the interviews using the calendar questionnaire was only one minute longer than traditional interviews Despite the slightly longer duration, the calendar questionnaire yielded a higher completeness of recording when compared to the traditional history questionnaire Although a greater proportion of women reported at least one event for each of the variables when interviewed via the calendar method, only reporting of pregnancy losses (i e , abortions and stillbirths) differed significantly between calendar and traditional methods

The authors conclude that the calendar approach assists the interviewer in helping the woman to recall events sequentially However, there is a need to determine whether truncated histories that proceed from first to last births differ in accuracy compared to truncated histories that proceed from last to first births

Results from Case Study #11 are encouraging, since they not only suggest that truncated reproductive histories miss fewer vital events than traditional (i e , "complete") histories, but that they may incorporate modules on various aspects of reproductive health (e g , fertility, mortality, and contraceptive behavior) Results from this study corroborate findings from other studies that have explored the truncated history in reproductive health research (Fikree & Gray, 1996, Westoff et al , 1990, Goldman et al , 1989) However, only Fikree and Gray (1996) have examined the utility of the truncated pregnancy history specifically for perinatal mortality research Based upon their work in Pakistan, Fikree and Gray conclude that a demographic survey, which in this instance, was based on truncated pregnancy histories, could estimate levels of perinatal mortality

When testing alternative data collection approaches, researchers must pay attention to the types of instruments/approaches being compared For example, Goldman et al (1989) compared the truncated pregnancy history to a complete birth history in Peru Apart from using different reference periods, the complete birth history and the truncated pregnancy history measure different phenomena (live births and live births + non-live births, respectively)

Documenting Magnitude Versus Causes/Correlates of Perinatal Death

When collecting data, it is important to identify whether the study's objective is to document magnitude (i e , levels), causes, or correlates of perinatal mortality-- or ideally, all three Traditional sources of data such as surveys or vital registration systems are more appropriate in capturing the magnitude of perinatal death, though they carry a certain degree of underascertainment However, a health worker or health planner within a developing country may not be as concerned with rates or absolute numbers of deaths but rather the identification of causes of death and gaps in service delivery Information on these factors will assist him/her in choosing the most appropriate interventions for a given jurisdiction Because time, financial, and human resource constraints may not permit the conduct of large-scale studies, techniques that rely on small sample sizes can facilitate the implementation of appropriate interventions The following sections will review existing data collection techniques and suggest changes to ensure more effective data collection within community-based settings

Alternative Approaches to Collecting Perinatal Mortality Data

Despite their demonstrated effectiveness in documenting mortality, the instruments and approaches presented in the previous section often require large-scale efforts, and thus, place burdens on already-constrained financial and human resources Although surveys that employ pregnancy histories should remain a mainstay of population-based perinatal mortality research, it is necessary to develop alternative techniques that allow for low cost, rapid assessments of perinatal mortality within a community setting

Verbal Autopsy

Aside from traditional sources of data (e g , vital registration, birth/pregnancy histories), the verbal autopsy is the most widely documented alternative technique for collecting mortality data The verbal autopsy is a post-mortem interview of family members (and/or other individuals familiar with the deceased) that reconstructs details of events leading up to the subject's death (WHO, 1996c) In general, verbal autopsy interviews take the form of semi-structured questionnaires in which the structured questions investigate specifics regarding signs and symptoms, and the open-ended questions examine the respondent's perception of the probable cause of death (Barbieri, 1991) Findings from selected studies (Kalter et al , 1990, Datta et al , 1988) that tested the verbal autopsy method suggest that lay reporters are highly capable of conducting inquiries Costs associated with lay reporting are considerably less than costs incurred when using trained health personnel as interviewers However, although lay persons are capable of collecting information both accurately and efficiently, there is evidence to suggest that cause of death may be best assigned by a physician (Bang et al , 1992)

Two applications of the verbal autopsy technique appear extensively throughout the literature (1) in the documentation of under-five mortality, and (2) in the assessment of maternal mortality Studies (Datta et al , 1988, Greenwood et al , 1987, Kalter et al , 1990, Marsh et al , 1995, Mizra et al , 1990, Nykanen et al , 1995) demonstrated the effectiveness of the verbal autopsy technique in collecting data on selected

diseases and conditions relevant to perinatal mortality (e g , prematurity/LBW, neonatal tetanus, and to a lesser degree, neonatal sepsis) Findings from these studies suggest that the verbal autopsy method may be more sensitive in capturing early neonatal mortality than stillbirths Although methodological limitations of current verbal autopsy instruments are apparent, lack of cultural specificity (e g , the absence of context-specific terminologies that describe certain health phenomena) account equally for the demonstrated "failure" of the verbal autopsy method as it relates to perinatal mortality

One of the major limitations of the verbal autopsy method is that even when information on the stillbirth or early neonatal death is obtained, appropriate classifications systems for cause of death do not exist Existing classification schemes for perinatal mortality (e g , Wigglesworth or Aberdeen classification systems) are not suited for LDCs, where infections and poor obstetric practice account for a substantial portion of mortality These types of contributory causes of death generally fall under the "other" category of existing classification systems Another problem in classifying perinatal deaths is the non-specific nature of signs and symptoms associated with many of the causes of perinatal mortality For this reason, verbal autopsies have only proven successful in classifying deaths due to conditions with relatively clear-cut syndromes (e g , LBW, neonatal tetanus) Thus, the potential for misclassification is quite high in using this method for perinatal mortality, particularly since standardized algorithms do not exist for assigning cause of perinatal death

Applications of this technique in assessing other types of mortality provide valuable lessons Because of similarities in causes of perinatal mortality and causes of maternal mortality, the verbal autopsy approach for maternal mortality may be the most appropriate starting point for devising a technique specific to perinatal mortality Two characteristics of the maternal verbal autopsy that should be duplicated are (1) assignment of multiple causes of deaths (e g , "immediate-underlying-associated causes," or "essential versus specific causes"), and (2) identification of avoidable factors (which highlights the role of quality of care) The following section provides specific recommendations as to ways in which the verbal autopsy instrument and technique may be made more appropriate for perinatal mortality research

Recommended Modifications of the Verbal Autopsy Instrument to More Effectively Assess Perinatal Mortality

As discussed in the Memorandum from the 1992 WHO/UNICEF meeting on "Measurement of overall and cause-specific mortality in infants and children" (WHO, 1994), future field testing of the verbal autopsy technique should focus on the following methodological issues (1) determination of required sample sizes, (2) construction of a standard verbal autopsy questionnaire (which should be validated in different contexts), (3) the effect of different recall periods, (4) advantages and disadvantages of using open-ended versus structured formats, and (5) the effect of inclusion/exclusion of a focused ethnographic component on validity and reliability It is also necessary to refine existing algorithms used to assign causes of death, and to develop a standard set of algorithms for determining causes of perinatal death using the verbal autopsy instrument The development of specific algorithms will allow for more objective cause of death classification This may ultimately minimize the role of physicians in the verbal autopsy process, since other individuals (and possibly, computer programs) would be able to assign causes using a standardized approach with a known degree of precision

Despite the need for creating a standardized format for the verbal autopsy tools, there is also a need to derive context-specific terminology The absence of appropriate terms may explain why verbal autopsies have not been very successful in assessing perinatal mortality We may erroneously assume that people do not want to disclose information on vital events, when, in actuality, we have not mastered how to make inquiries into events surrounding perinatal death within communities

Because of small sample sizes, verbal autopsies may not be very useful in studying temporal trends However, researchers and other professionals in public health should regard verbal autopsies as methods of assessing causes, and not necessarily levels of perinatal death The verbal autopsy or similar techniques may play critical roles in identifying high risk women within the communities, and consequently, may assist in tailoring interventions to meet the specific needs of those populations One means of overcoming the limitations of the verbal autopsy method is to couple it with other sources of data (e g , community informants, surveillance, record linkage, vital registration) to ensure a more complete picture of the problem

Qualitative Research Techniques

The verbal autopsy technique is one attempt at combining a structured interview format with open-ended inquiries Although qualitative research studies are absent from the perinatal mortality literature, a myriad of qualitative techniques exist to assist the community-based practitioner or researcher in assessing perinatal mortality on a smaller scale Three types of data collection frequently constitute qualitative research methods (1) direct observation (i e , detailed descriptions of individuals' behaviors and activities), (2) in-depth, open-ended interviews (i e , direct quotations from interviewee regarding his/her beliefs, experiences, etc), and (3) written documents (i e , excerpts or quotations from program, clinical, or organizational records) (Patton, 1990) Open-ended interviews, though more difficult to analyze objectively, allow for the collection of information from the respondent's perspective

With respect to perinatal mortality research, a qualitative component using one of the methods outlined above may prove invaluable in explaining health care utilization patterns within the community For instance, it can document community perceptions that hamper access to and utilization of maternal and perinatal services Thus, understanding the client's perspective through qualitative research allows researchers to devise means of generating demand for services within the community In addition, key informant interviews and focus group discussions with formal and informal health sector providers may provide valuable information on their practices and decision-making processes This information may be used to tailor more appropriate training or health education interventions In addition, qualitative research can assist scientists in identifying local terminology related to pregnancy, delivery, and maternal and perinatal health that may be used in health education campaigns or in the development of research instruments used to assess perinatal mortality within the community In the interest of exploring the quality of maternal and perinatal care, qualitative techniques may also be employed in process evaluations of programs and interventions, these techniques are applicable in both hospital and community settings

Historically, there has been a general sentiment that qualitative research methods are not as rigorous as quantitative methods However, qualitative researchers must be equally concerned with sampling and other methodological issues, though the nature of these issues may differ dramatically from quantitative research For example, quantitative research often employs *simple random, stratified, or systematic sampling* techniques with the goal of selecting respondents who are representative of the target population A representative sample ensures that study findings are generalizable to individuals outside of the study In contrast, many qualitative studies rely upon *purposive sampling* (Gittlesohn et al , 1995) Although this approach may compromise the generalizability of study findings, it ensures that sufficient information is obtained from individuals with certain characteristics of interest (e g , mothers or mothers-in-law, who may be most knowledgeable about the events occurring during labor and delivery for a specific case)

LESSONS LEARNED and RECOMMENDATIONS REGARDING COMMUNITY-BASED ASSESSMENT OF PERINATAL MORTALITY

METHODOLOGICAL LESSONS LEARNED FROM THIS LITERATURE REVIEW

Given a review of the current perinatal mortality literature, the following methodological lessons have been learned

- *General Lessons*

  (1) Study objectives should guide the researcher in choosing the most appropriate study methodology Appropriateness of methods relies heavily upon whether the objective is to measure (a) levels, (b) causes or (c) correlates of perinatal mortality

  (2) There is an absence of small-scale methodologies that can be implemented by community-based individuals with adequate training and minimal technical assistance

  (3) The PMR is perceived as a standard indicator for cross-country and temporal comparisons However, due to inconsistent definitions of perinatal mortality (e g , using the 22nd week of gestation as a cutoff versus the 28th week of gestation), as well as variations in the degree of underascertainment and misclassification of stillbirths and early neonatal deaths, statistics from different contexts are not likely to be comparable

  (4) Failure to disaggregate perinatal mortality into stillbirths and early neonatal deaths, and more importantly, disaggregate stillbirths into fresh and macerated may compromise the sensitivity of the perinatal mortality rate as an indicator for quality of obstetric care

- *Study Designs*

  (1) There are places for the case-control, cohort, and cross-sectional study designs within perinatal mortality research, though the feasibility of each design may vary from one context to the next In populations with little context-specific data on the causes and correlates of perinatal mortality, case-control studies are easily implemented within the community and are a good first step to assessing the problem

  (2) There is also the potential to combine different elements within the study methodology in order to obtain a more complete picture of a woman's reproductive experience (e g , the DHS uses cross-sectional sampling and a retrospective instrument (the birth history) to document births and deaths)

- *Sampling*

  (1) Hospital-based studies have provided much of our information on perinatal mortality However, most are biased in their depiction of the problem, since hospital samples are generally characterized by an overabundance of complicated pregnancies and deliveries

(2) In order to maximize generalizability of results, studies should be population-based, sampling from both health facilities and the community to ensure representativeness of all births and deaths occurring within a given population The only exception to sampling from both health facilities and the community is when health care coverage is extremely high or extremely low For instance, where the percentage of institutional deliveries is high (e g , 85% in the Southern Africa region), a hospital-based study is relatively representative of the general population, and thus, is population-based Nevertheless, caution should still be exercised with respect to study recruitment, particularly for referral hospitals

(3) Qualitative and quantitative research endeavors in the area of perinatal mortality may depend on vastly different sampling techniques (e g , purposive versus random sampling, respectively)

- *Data Sources*

(1) In general, vital registration systems within the developing world are structurally ill-equipped to document perinatal mortality, and thus are inefficient sources of perinatal statistics However, the accuracy and completeness of perinatal data from vital records are as much functions of cultural perceptions as they are of structural factors

(2) Despite the general perception that community surveillance yields a higher ascertainment of births and perinatal deaths, there is evidence to suggest that its effectiveness in documenting perinatal mortality is as much a function of who identifies and reports the events as it is methodological factors (such as the frequency of the surveillance)

(3) Surveys are the mainstay of perinatal mortality research, though their accuracy and reliability are constrained by the structure (e g , backward versus forward pregnancy histories, structured versus open-ended questions) and content of the survey (e g , information derived from complete versus truncated histories, or birth versus pregnancy histories)

- *Instruments*

(1) Validity and reliability are often confused within the perinatal literature Although there are means of testing whether results from a particular tool are consistent (i e , reliable), no gold standard for measuring perinatal mortality exists whereby we can assess the accuracy (i e , validity) of those estimates As a result, it is incorrect to make conclusions regarding the true validity of an instrument We can only assess the completeness of information derived from one instrument or data source relative to another

(2) With the exception of the verbal autopsy method, few alternative methods of assessing perinatal mortality have been field tested outside of Latin America There is an obvious need to test methods in contexts that not only differ in levels of perinatal mortality, but also in levels of female literacy and other factors that may affect the interpretation of (and response to) questions

- *Data Collection Techniques*
  (1) Perinatal mortality research is primarily rooted in conventional (i e , quantitative) data collection techniques Qualitative research studies are virtually absent from the perinatal literature, despite the ineffectiveness of most quantitative techniques in assessing perinatal mortality at the community level

  (2) There is some potential in using the verbal autopsy method for community-based assessment of perinatal mortality, since it relies on small numbers of events However, it may be ineffective in estimating levels or mapping temporal trends in perinatal mortality Methods of cause of death classification using the verbal autopsy must also be refined

RECOMMENDATIONS FOR COMMUNITY-BASED ASSESSMENT OF PERINATAL MORTALITY

The following recommendations are made with respect to community-based assessment of perinatal mortality

- *Triangulation of data sources and data collection techniques*
  (1) Because accuracy and completeness of data varies from one context to the next, the use of multiple data sources (e g , dual use of vital registration with interviews/surveys) and data collection techniques (quantitative and qualitative) are recommended to avoid information gaps on critical aspects of perinatal mortality

  (2) The types of data and techniques employed should reflect the study's objectives

  WHEN THE OBJECTIVE IS TO DOCUMENT **SUPPLY-SIDE FACTORS**, THE FOLLOWING TOOLS ARE RECOMMENDED

  ***Situation Analysis** to identify weak links in service delivery (e g , with respect to supplies/resources)

  ***Training Needs Assessment** to identify deficiencies among health workers within the formal health system

  ***Structured (quantitative) and Unstructured/Semi-Structured (qualitative) Interviews** to document perspectives of both formal and informal health providers

  There is a particular need to examine the perceptions of traditional birth attendants (TBAs) and other informal health sector providers, and to document their decision-making algorithms used in the management of pregnancy and pregnancy complications within the community Such information may highlight potential targets for community-based health education and health promotion

WHEN THE OBJECTIVE IS TO DOCUMENT **DEMAND-SIDE FACTORS**, THE FOLLOWING TOOLS ARE RECOMMENDED

***Community Diagnosis** or similar instruments to ascertain information on factors that affect demand for, access to, and utilization of maternal and perinatal services

***Focus Groups, In-depth Interviews,** and **Event Histories** with clients and community members may also achieve the above objective

Qualitative research techniques can also be used to identify context-specific terminology related to pregnancy, pregnancy complications, and pregnancy outcomes, as well as perceptions of "normal" pregnancy and disease severity within the community Such techniques may also aid in identifying community informants for perinatal mortality surveillance within the community, and in documenting community practices in maternal and neonatal care

WHEN THE OBJECTIVE IS TO DOCUMENT **LEVELS AND CAUSES OF PERINATAL MORTALITY**, THE FOLLOWING ARE RECOMMENDED

*Census data (use of community informants may improve data completeness)
*Demographic and Health Survey (DHS) data (based upon pregnancy histories)
*Pregnancy history data from other types of surveys (truncated histories are appropriate for perinatal mortality)
*Surveillance data
*Verbal autopsies (for causes, not levels of perinatal mortality)

- *Documentation of cultural perceptions of life and death*
When evaluating the appropriateness of data sources such as vital registries, there is a need to document cultural views that may impede the collection of accurate and reliable data

- *Use of open-ended questions*
Open-ended questions have proven to yield accurate responses to questions regarding pregnancy and pregnancy complications In addition, they are effective in establishing rapport between the interviewer and the respondent

- In addition to selecting the type of questions to ask individuals, *local culture should dictate* the *selection of both respondents and interviewers* For example, the mother may not be the most appropriate interviewee Her mother, mother-in-law, or other relatives may be more cognizant of the events surrounding the perinatal death Although the TBA may also be a potential respondent, the accuracy of inquiries with TBAs is questionable for two reasons First, TBAs oversee a number of deliveries over a period of time, and may thus be unable to accurately recall events pertaining to a specific case Second, the TBA, in an effort to avoid blame or liability, may consciously or unconsciously alter events leading up to the death Despite these potential biases, the TBA's perspective should not be overlooked in assessing perinatal mortality and planning interventions

- *Wider application of the nested case-control study design*
  Nested designs allow researchers to reap the benefits of the longitudinal study design, without the prohibitive cost

- *Field-testing of the verbal autopsy method specifically for perinatal mortality*, and the development of a standardized verbal autopsy instrument and algorithms for assigning causes of death

- Use of *community informants* to improve completeness of census data

- For longitudinal surveillance, *frequency of* birth and death *ascertainment that is more appropriate for assessing early mortality* (e g , monthly home visits, as opposed to tri-monthly visits)

- *Additional field-testing of the truncated pregnancy history* in different contexts

- Use of *verbal autopsies for community wide epidemiological assessment*, not on an individual (i e , case-by-case) basis

CONCLUSION

The purpose of this report was not to present specific methodologies for assessing perinatal mortality within the community Such methodologies are absent from the literature, and additional field testing of techniques within different contexts are required in order to make such recommendations This paper does, however, aim to review current approaches to data collection, discuss their limitations, and highlight potential modifications to these existing techniques in order to make them more appropriate for use in perinatal mortality research The need for additional research (both qualitative and quantitative) must be underscored Given the constrained health systems that are characteristic of the developing world, it is imperative that simple, low-cost, rapid assessment techniques be devised to assist health planners and professionals in allocating resources to areas that will yield the greatest impact

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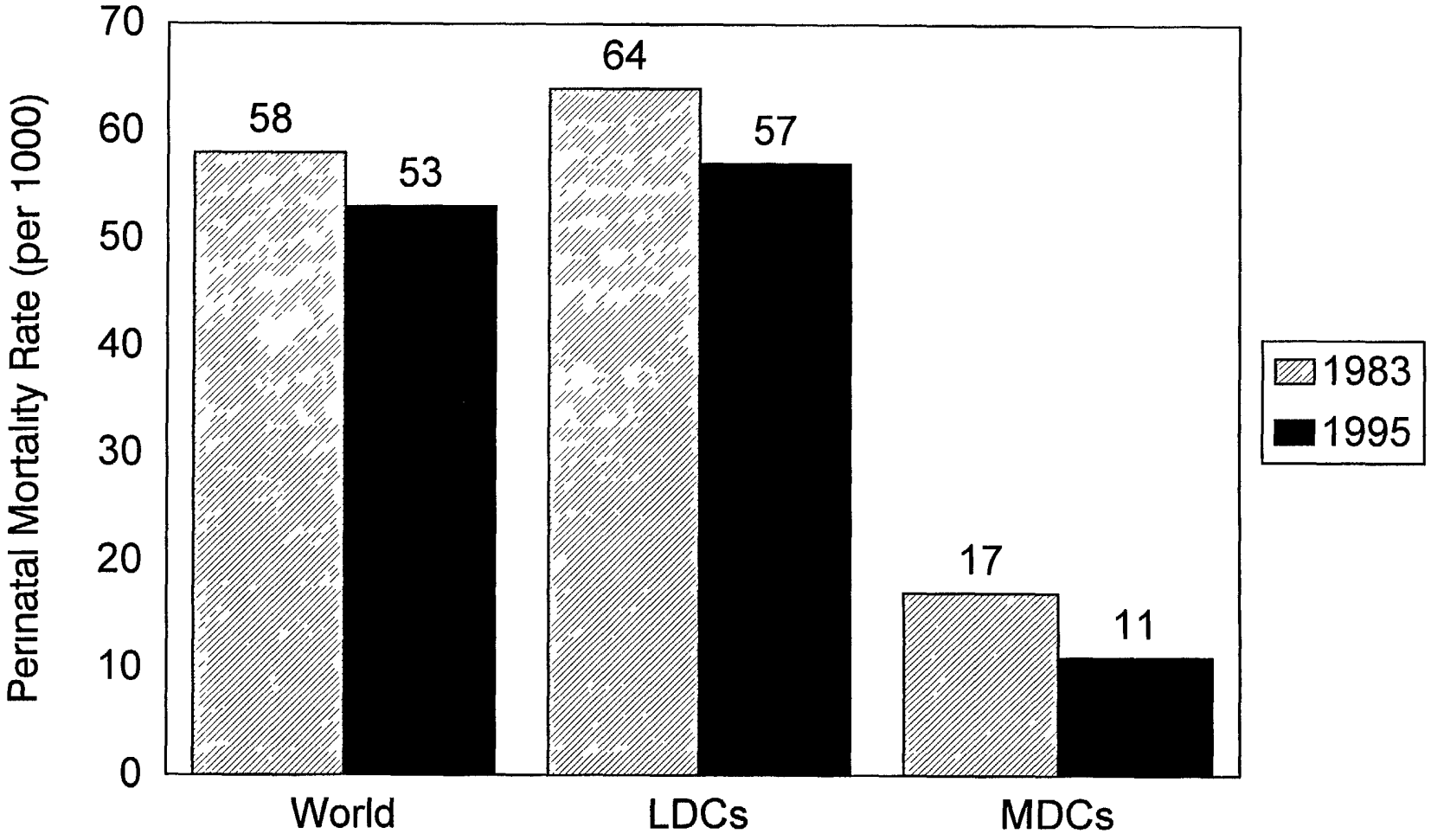
APPENDICES

APPENDIX A

Comparison of Perinatal Mortality 1983 and 1995

COMPARISON OF PERINATAL MORTALITY:

1983 and 1995

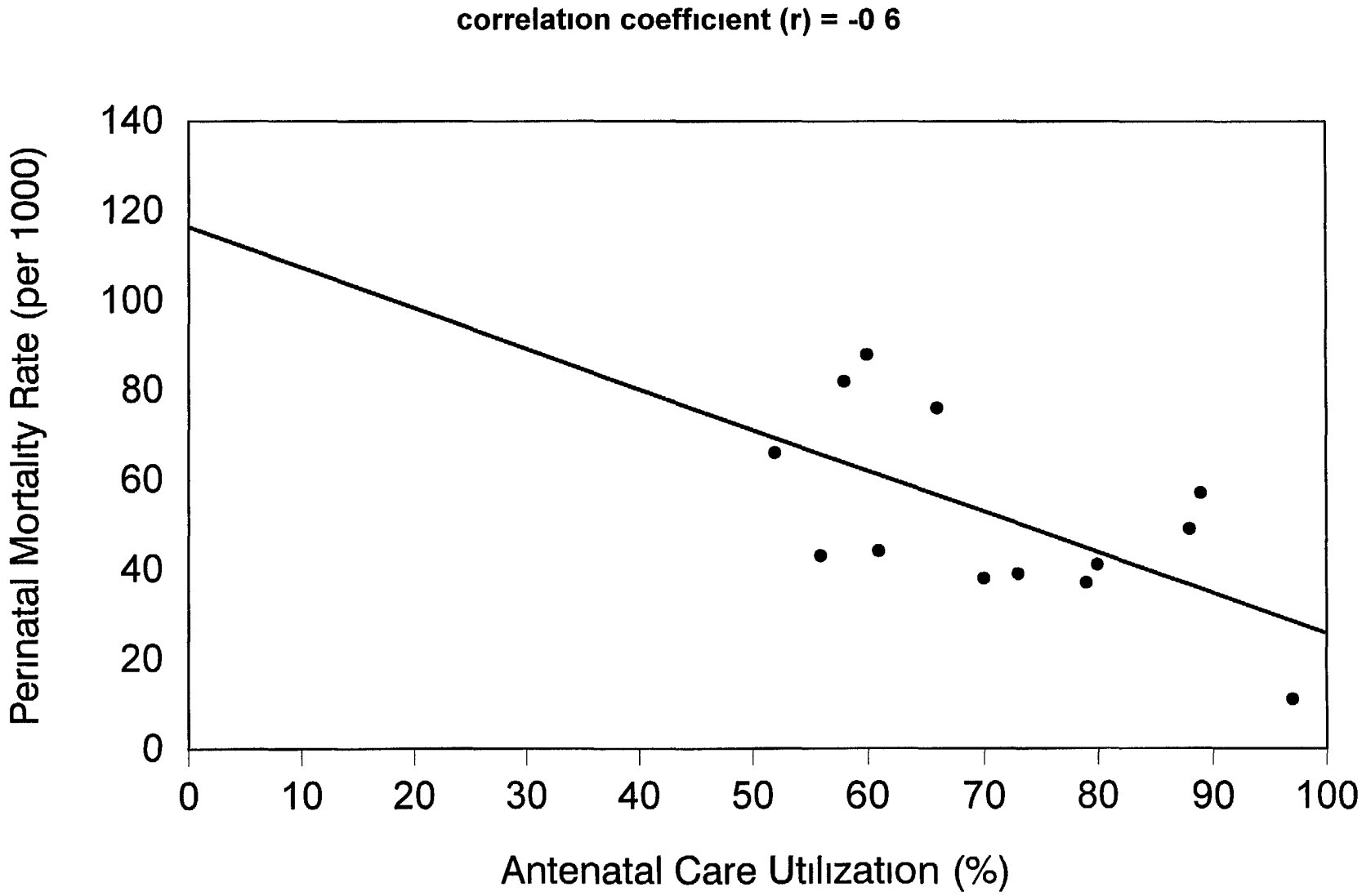


SOURCE WHO, 1996a 14

APPENDIX B

Perinatal Mortality and % Antenatal Care Utilization

PERINATAL MORTALITY AND % ANTENATAL CARE UTILIZATION by Subregion



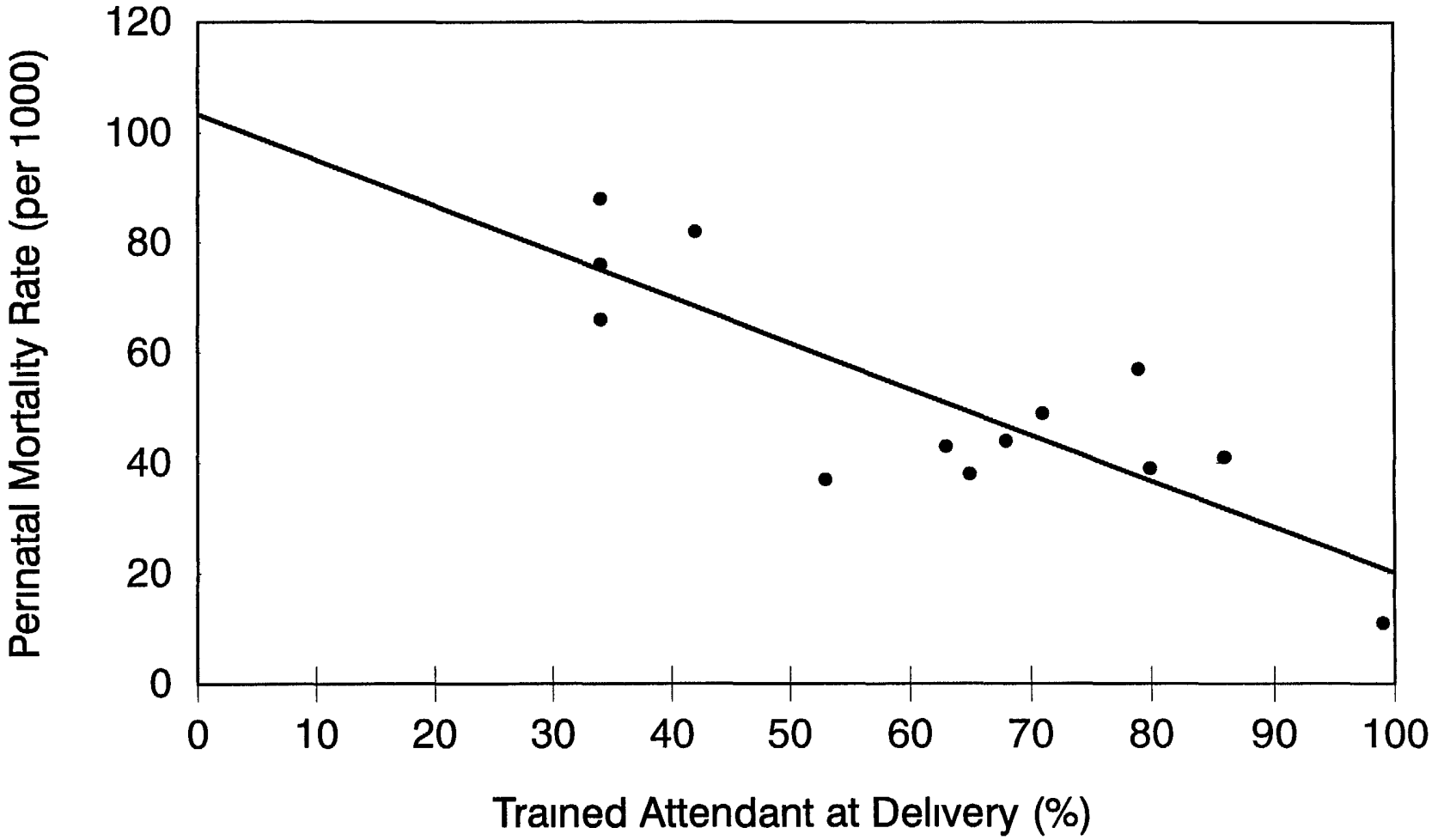
adapted from WHO, 1997 and WHO, 1996b

APPENDIX C

Perinatal Mortality and % Trained Attendant at Delivery

PERINATAL MORTALITY AND % TRAINED ATTENDANT AT DELIVERY
by Subregion

correlation coefficient (r) = -0 8



adapted from WHO, 1997 and WHO, 1996b

APPENDIX D

Calculations for TABLE 2
("Regional Comparisons in Percent Contributions
to Fetal-Infant Mortality in 1995")

CALCULATIONS FOR TABLE 2

("REGIONAL COMPARISONS IN PERCENT CONTRIBUTIONS TO FETAL-INFANT MORTALITY IN 1995")

Sources

Number of perinatal deaths	WHO, 1996a
Number of neonatal deaths	WHO, 1996a
Number of early neonatal deaths	WHO, 1996a
Number of late fetal deaths	WHO, 1996a
Total population	PRB, 1996
Crude birth rate (CBR)	PRB, 1996
Infant mortality rate (IMR)	PRB, 1996

4 3 million stillbirths/ 7 6 million perinatal deaths = 0 566
3 4 million early neonatal deaths/ 7 6 million perinatal deaths = 0 434

THEREFORE
Proportion of all perinatal deaths that are early neonatal deaths (ENND) 0 434
Proportion of all perinatal deaths that are stillbirths (SB) 0 566

****NOTE Because region-specific data on the SB to ENND ratio are not available, the global ratio of SB to ENND was used to obtain the following regional estimates**

WORLD

- **calculation of early neonatal deaths and stillbirths**

7,636,000 perinatal deaths x 434 = 3 314 024 ENND
7,636,000 perinatal deaths x 566 = 4 321 976 SB

- **calculation of number of live births and infant deaths**

5,771,000,000 (total population) x 024 (CBR) = 138 504 000 annual number of live births
138,504,000 x 062 (IMR) = 8 587 248 annual number of infant deaths

- **neonatal, early neonatal, late neonatal, and postneonatal deaths**

*5,080,000/ 8,587,248 = 59 2% neonatal deaths
*3,314,024/ 8,587,248 = 38 6% early neonatal deaths
*(5,080,000 - 3,314,024)/ 8,587,248 = 20 6% late neonatal deaths
*(8,587,248 - 5,080,000)/8,587,248 = 40 8% postneonatal deaths

- **proportion of fetal-infant mortality (i e , stillbirths plus deaths during the first year of life)**
  *[4 321 976(stillbirths) + 8,587 248 (infant deaths) = **12,909,224 fetal-infant deaths**]*

%SB	%ENND	%LNND	%PNND
4,321,976/12,909,224	3,314,024/12,909,224	1,765,976/12,909,224	3,507,248/12,909,224
33 5%	**25 7%**	**13 7%**	**27 2%**

(**59 2%** PERINATAL DEATHS)

MORE DEVELOPED COUNTRIES

- **calculation of early neonatal deaths and stillbirths**

155,000 perinatal deaths x 434 = 67,270 ENND
155,000 perinatal deaths x 566 = 87,730 SB

- **calculation of number of live births and infant deaths**

1,171,000,000 (total population) x 012 (CBR) = 14,052,000 annual number of live births
14,052,000 x 009 (IMR) = 126,468 annual number of infant deaths

- **neonatal, early neonatal, late neonatal, and postneonatal deaths**

* 96, 000/126,468 = 75 9% neonatal deaths
*67, 270/126, 468 = 53 2% early neonatal deaths
*(96, 000 - 67,270)/126,468 = 22 7% late neonatal deaths
*(126,468 - 96,000)/126,468 = 24 1% postneonatal deaths

- **proportion of fetal-infant mortality (i e , stillbirths plus deaths during the first year of life)**
  *[87 730(stillbirths) + 126 468 infant deaths =**214,198 fetal-infant deaths**]*

%SB	%ENND	%LNND	%PNND
87,730/214,198	67270/214,198	28,730/214,198	30,468/214,198
41 0%	**31 4%**	**13 4%**	**14 2%**

(**72 4%** PERINATAL DEATHS)

LESS DEVELOPED COUNTRIES (including China):

- **calculation of early neonatal deaths and stillbirths**

7,480,000 perinatal deaths x 434 = 3,246,320 ENND

7,480,000 perinatal deaths x 566 = 4,233,680 SB

- **calculation of number of live births and infant deaths**

4,600,000,000 (total population) x 027 (CBR) = 124,200,000 annual number of live births
124,200,000 x 068 (IMR) = 8,445,600 annual number of infant deaths

- **neonatal, early neonatal, late neonatal, and postneonatal deaths**

*4,984,000/8,445,600 = 59 0% neonatal deaths
*3,246,320/8,445,600 = 38 4% early neonatal deaths
*(4,984,000-3,246,320) /8,445,600 = 20 6% late neonatal deaths
*(8,445,600-4,984,000)/8,445,600 = 41 0% postneonatal deaths

- **proportion of fetal-infant mortality (i e , stillbirths plus deaths during the first year of life)**
  *[4 233 680(stillbirths) + 8 445 600 (infant deaths) =**12,679,280 fetal-infant deaths**]*

%SB	%ENND	%LNND	%PNND
4,233,680/12,679,280	3,246,320/12,679,280	1,737,680/12,679,280	3,461,600/12,679,280
33 4%	**25 6%**	**13 7%**	**27 3%**

(**59 0%** PERINATAL DEATHS)

AFRICA:

- **calculation of early neonatal deaths and stillbirths**

2,404,000 perinatal deaths x 434 = 1,043,336 ENND
2,404,000 perinatal deaths x 566 = 1,360,664 SB

- **calculation of number of live births and infant deaths**

732,000,000 (total population) x 041(CBR) = 30,012,000 annual number of live births
732,000,000 x 091 (IMR) = 2,731,092 annual number of infant deaths

- **neonatal, early neonatal, late neonatal, and postneonatal deaths**

*1,291,000/2,731,092 = 47 3% neonatal deaths
*1,043,336/2,731,092 = 38 2% early neonatal deaths
*(4,291,000-1,043,336)/2,731,092 = 9 1% late neonatal deaths
*(2,731,092-1,291,000)/ 731,092 = 52 7% postneonatal deaths

- **proportion of fetal-infant mortality (i e , stillbirths plus deaths during the first year of life)**
  *[1,360 664(stillbirths) + 2 731 092 (infant death)s =**4,091,756 fetal-infant deaths**]*

%SB	%ENND	%LNND	%PNND
1,360,664/4,091,756	1,043,336/4,091,756	247,664/4,091,756	1,440,092/4,091,756
33 3%	**25 5%**	**6 1%**	**35 2%**

(**58 8%** PERINATAL DEATHS)

ASIA

- **calculation of early neonatal deaths and stillbirths**

4,583,000 perinatal deaths x 434	=	1,989,022 ENND
4,583,000 perinatal deaths x 566	=	2,593,978 SB

- **calculation of number of live births and infant deaths**

3,501,000,000 (total population) x 024 (CBR)	=	84,024,000 annual number of live births
84,024,000 x 062 (IMR)	=	5,209,488 annual number of infant deaths

- **neonatal, early neonatal, late neonatal, and postneonatal deaths**

*3,386,000/5,209,488	=	65 0% neonatal deaths
*1,989,022/5,209,488	=	38 2% early neonatal deaths
*(3,386,000-1,989,022)/5,209,488	=	26 8% late neonatal deaths
*(5,209,488-3,386,000)/5,209,488	=	35 0% postneonatal deaths

- **proportion of fetal-infant mortality (i e , stillbirths plus deaths during the first year of life)**
  *[2,593 978(stillbirths) + 5,209 488 (infant deaths) =**7, 803,466 fetal-infant deaths**]*

%SB	%ENND	%LNND	%PNND
2,593,978/7,803,466	1,989,022/7,803,466	1,396,978/7,803,466	1,823,488/7,803,466
33 2%	**25 5%**	**17 9%**	**23 4%**

(**58 7%** PERINATAL DEATHS)

EUROPE

- **calculation of early neonatal deaths and stillbirths**

107,000 perinatal deaths x 434	=	46,438 ENND
107,000 perinatal deaths x 566	=	60,562 SB

- **calculation of number of live births and infant deaths**

728,000,000 (total population) x 011 (CBR) = 8,008,000 annual number of live births
8,008,000 x 011 (IMR) = 88,088 annual number of infant deaths

- **neonatal, early neonatal, late neonatal, and postneonatal deaths**

*66,000/88,088 = 74 9% neonatal deaths
*46,438/88,088 = 52 7% early neonatal deaths
*(66,000-46,438)/88,088 = 22 2% late neonatal deaths
*(88,088-66,000)/88,088 = 25 1% postneonatal deaths

- **proportion of fetal-infant mortality (i e , stillbirths plus deaths during the first year of life)**
  *[60,562(stillbirths) + 88 088 (infant deaths) =**148,650 fetal-infant deaths**]*

%SB	%ENND	%LNND	%PNND
60,652/148,650	46,438/148,650	19,562/148,650	22,088/148,650
40 7%	**31 2%**	**13 2%**	**14 9%**

(**71 9%** PERINATAL DEATHS)

NORTH AMERICA

- **calculation of early neonatal deaths and stillbirths**

39,000 perinatal deaths x 434 = 16,926 ENND
39,000 perinatal deaths x 566 = 22,074 SB

- **calculation of number of live births and infant deaths**

295,000,000 (total population) x 015(CBR) = 4,425,000 annual number of live births
4,425,000 x 007 (IMR) = 30,975 annual number of infant deaths

- **neonatal, early neonatal, late neonatal, and postneonatal deaths**

*26,000/30,975 = 83 9% neonatal deaths
*16,926/30,975 = 54 6% early neonatal deaths
*(26,000-16,926)/30,975 = 29 3% late neonatal deaths
*(30,975-26,000)/30,975 = 16 1% postneonatal deaths

- **proportion of fetal-infant mortality (i e , stillbirths plus deaths during the first year of life)**
  *[22 074(stillbirths) + 30,975 (infant deaths) =**53,049 fetal-infant deaths**]*

%SB	%ENND	%LNND	%PNND
22,074/53,049	16,926/53,049	9,074/53,049	4,975/53,049
41 6%	**31 9%**	**17 1%**	**9 4%**

(**73 5%** PERINATALDEATHS)

LATIN AMERICA AND THE CARIBBEAN

- **calculation of early neonatal deaths and stillbirths**

483,000 perinatal deaths x 434	=	209,622 ENND
483,000 perinatal deaths x 566	=	273,378 SB

- **calculation of number of live births and infant deaths**

486,000,000 (total population) x 026(CBR)	=	12,636,000 annual number of live births
12,636,000 x 043 (IMR)	=	543,348 annual number of infant deaths

- **neonatal, early neonatal, late neonatal, and postneonatal deaths**

*301,000/ 543,348	=	55 4% neonatal deaths
*209,622/ 543,348	=	38 6% early neonatal deaths
*(301,000-209,622)/ 543,348	=	16 8% late neonatal deaths
*(543,348-301,000)/ 543,348	=	44 6% postneonatal deaths

- **proportion of fetal-infant mortality (i e , stillbirths plus deaths during the first year of life)**
  *[273 378(stillbirths) + 543 348(infant deaths) = **816,726 fetal-infant deaths**]*

%SB	%ENND	%LNND	%PNND
273,378/ 816,726	209,622/ 816,726	91,378/ 816,726	242,345/ 816,726
33 5%	**25 7%**	**11 2%**	**29 7%**

(**59 2%** PERINATAL DEATHS)

OCEANIA

- **calculation of early neonatal deaths and stillbirths**

10,000 perinatal deaths x 434	=	4,340 ENND
10,000 perinatal deaths x 566	=	5,660 SB

- **calculation of number of live births and infant deaths**

29,000,000 (total population) x 019(CBR)	=	551,000 annual number of live births
551,000 x 024 (IMR)	=	13,224 annual number of infant deaths

- **neonatal, early neonatal, late neonatal, and postneonatal deaths**

*5,000/13,224	=	37 8% neonatal deaths
*4,340/13,224	=	32 8% early neonatal deaths

*(5,000-4,340)/13,224 = 5 0% late neonatal deaths
*84,224/13,224 = 62 2% postneonatal deaths

- **proportion of fetal-infant mortality (i e , stillbirths plus deaths during the first year of life)**
  *[5 660(stillbirths) + 13,224 (infant deaths) =**18,884 fetal-infant deaths**]*

%SB	%ENND	%LNND	%PNND
5,660/18,884	4,340/18,884	660/18,884	8,224/18 884
30 0%	**23 0%**	**3 5%**	**43 6%**

(**53 0%** PERINATAL DEATHS)

APPENDIX E

Summary Matrices for Institution-Based, Community-Based, and Multisample Perinatal Mortality Studies

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
NORTHEASTERN BRAZIL Ferraz EM Gray RH and TM Cunha (1990) *International Journal of Epidemiology* 19(1) 101 108		OBJECTIVE To determine risk factors for preterm birth and intrauterine growth retardation in Natal Brazil SAMPLE *CASES* N=429 preterm infants and 422 intrauterine growth retarded infants *CONTROLS* 2 555 infants of normal birth weight and gestational age *Cases and controls were selected from 11 483 singleton live births* STUDY DESIGN Nested case control study SOURCES OF DATA Maternal interview medical records and anthropometric measurements of mothers and infants METHODS **time frame** September 1984 to February 1986 Data were collected within 12 36 hours post delivery Gestational age was determined by physical examination using the *Capurro* score Percentiles of birth weight by gestational age were based upon the *Denver Reference Curve* Infants were divided into the following three groups (1) PRETERM LBW below 37 weeks and below 2500 grams (2) IUGR born at term and below 2500 grams (3) CONTROLS born at term and within the 10th and 90th percentile of birth weight by gestational age **definition of a case** liveborn infant weighing between 500 and 2499 g **definition of a control** liveborn infant weighing 2500 g or more	SAMPLE PREVALENCES Prevalence of LBW 10% Prevalence of preterm LBW 5 1% Prevalence of IUGR 4 9% **ADJUSTED ODDS RATIOS (OR) and ATTRIBUTABLE RISKS (AR) FOR PRETERM BIRTH** *Prepregnancy age <20 years* OR=1 4 (1 1 1 9) AR=7 1% *Maternal weight <50 kg* OR=2 3 (2 3 3 0) AR=20 5% *Past history of LBW* OR=2 4 (1 7 3 3) AR=12 2% *Smoking during pregnancy* OR=1 5 (1 2 2 0) AR=14 6% *Antenatal care* (<5 visits) OR=2 1 (1 7 2 7) AR=28 1% *Gestational illness* OR=5 3 (3 6 6 5) AR=15 5% *Vaginal bleeding (first trimester)* OR=3 3 (2 4 4 6) AR=13 4% *Intrapartum complications* OR=2 4 (1 8 3 2) AR=13 8% *Delivery at university hospital* OR=1 3 (1 0 1 7) AR= not available **ADJUSTED ODDS RATIOS (OR) and ATTRIBUTABLE RISKS (AR) FOR INTRAUTERINE GROWTH RETARDATION** *Prepregnancy nulligravidity* OR=2 0 (1 1 1 9) AR=25 6% *Maternal weight <50 kg* OR=2 3 (1 6 2 7) AR=17 8% *Maternal height <150 cm* OR=1 6 (1 3 2 1) AR=7 6% *Past history of LBW* OR=2 6 (1 9 3 6) AR=14 1% *Maternal education <4 years* OR=1 5 (1 1 1 9) AR=11 6% *Smoking during pregnancy* OR=1 5 (1 2 2 0) AR=14 8% *Antenatal care (<5 visits)* OR=1 4 (1 1 1 7) AR=11 6% *Gestational illness* OR=2 5 (1 6 4 0) AR=6 0% ****NOTE* Odds ratios for the above two outcomes used infants of normal birth weight & gestational age as the reference group

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********

COUNTRY/ REFERENCE	PMR (per 1000)	METHODOLOGY	STUDY RESULTS
SOUTHERN BRAZIL (Pelotas) Barros FC Huttly SRA Victora CG Kirkwood BR and JP Vaughan (1992) *Pediatrics* 90(2) 238 244	**Term, Normal Birth weight** 12 0 **IUGR** 70 0 **Preterm** 151 0 **Unknown GA** 51 0	OBJECTIVE To examine the effect of birth weight (BW) and gestational age (GA) on growth morbidity and mortality through the first four years of life SAMPLE N= 6 011 hospital births (5 914 live births) STUDY DESIGN Cohort (prospective) study SOURCES OF DATA Questionnaire vital registration METHODS **time frame** four years Data were collected at a perinatal evaluation and at follow up visits at 11 23 and 47 months A questionnaire was administered to the mother within 48 hours of delivery Information on socioeconomic variables and maternal factors were collected [GA was calculated based upon maternal recall of last menstrual period] Mortality information was obtained from the state s vital registration system and during visits to all hospitals cemeteries coroner services and registries throughout the city Mortality inquiries were also made during 2nd follow up visits in 1984 (all households were asked about deaths of young children the within past two years) Subjects were traced using the addresses given at birth Follow up rates were above 80% for all visits	LBW prevalence in the sample 9 0% LBW infants with known GA 63% IUGR 37% preterm Perinatal deaths among preterm babies equally distributed between fetal and early neonatal periods **LEADING CAUSES OF PERINATAL DEATH** *among preterm babies* immaturity (72 0%) *among IUGR babies* antepartum fetal deaths (64 0%) malformations (13 0%) **RISK FACTORS FOR PERINATAL DEATH** Not Available **RISK FACTORS FOR PRETERM BIRTH and IUGR** See article for adjusted and unadjusted odds ratios **INFANT MORTALITY RATES (per 1000) by CAUSES ACCORDING TO BIRTH WEIGHT AND GESTATIONAL AGE** *(ABW= appropriate birth weight)* (1) Perinatal *ABW Term* 4 *IUGR* 19 *Preterm* 93 (2) Respiratory Infections *ABW Term* 2 *IUGR* 14 *Preterm* 16 (3) Diarrhea *ABW Term* 2 *IUGR* 0 *Preterm* 11 (4) Other Infections *ABW Term* 2 *IUGR* 3 *Preterm* 13 (5) Malformation *ABW Term* 2 *IUGR* 21 *Preterm* 10 (6) Ill defined *ABW Term* 3 *IUGR* 7 *Preterm* 10 (7) Other *ABW Term* 0 *IUGR* 3 *Preterm* 0

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
EASTERN CARIBBEAN Boersma ER (1985) *Bulletin of the Pan American Health Organization* 19(1) 45 60	**RATES FROM 1980/1981** Antigua 31 6 Bahamas 31 8 Barbados 36 0 Dominica 29 4 St Lucia 37 4 St Vincent 37 5	OBJECTIVE To evaluate perinatal care in six Eastern Caribbean countries SAMPLE N = 18 896 hospital deliveries from six Caribbean countries STUDY DESIGN Retrospective study METHODS **time frame** one month (December 1981)	**LEADING CAUSES OF PERINATAL DEATH** *(ORs not presented in article)* *Antigua* perinatal asphyxia complications of prematurity *Bahamas* perinatal asphyxia complications of prematurity *Barbados* respiratory distress syndrome perinatal asphyxia infections congenital abnormalities *Dominica* complications of abnormal growth and maturity perinatal asphyxia *St Lucia* perinatal asphyxia *St Vincent* perinatal asphyxia infections **% LOW BIRTH WEIGHT** *Antigua* 8 2% *Bahamas* 6 7% *Barbados* 11% *Dominica* 5 9% *St Lucia* 7 6% *St Vincent* data not available

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
CHINA (Shanghai) Zhang J Cai W and H Chen (1991) *International Journal of Epidemiology* 20(4) 958 963	14 96	OBJECTIVE To examine the incidence and risk factors associated with perinatal mortality in Shanghai between 1986 and 1987 SAMPLE N = 75 756 births (n=1 134 perinatal deaths) from stratified random sample of secondary and tertiary institutions (n=29) Primary hospitals not selected due to small number of annual births/deliveries Study sample=39 86% all births in Shanghai during study period STUDY DESIGN Prospective multi site study METHODS **time frame** 1 October 1986 through 30 September 1987 Every stillbirth and live birth weighing >1000g (or when birth weight information was not available having a gestational age of at least 28 weeks) was documented Information of infant sex birth weight gestational age maturity plurality maternal age and causes of death were recorded at birth	**MORTALITY RATES FOR** antepartum fetal deaths (n=452) 5 97 per 1000 births intrapartum fetal deaths (n=156) 2 06 per 1000 births early neonatal deaths (n=526) 6 94 per 1000 births *Evidence of seasonality in perinatal mortality (highest in winter and early spring) *Possible artifactual effect of higher birth rates during those times of the year **RISK FACTORS FOR PERINATAL MORTALITY** *(ORs not presented in article)* male sex low birth weight preterm birth high parity multiple pregnancy (NOTE maternal age not found to have a substantial impact on perinatal mortality with the exception of mothers >35 years) **MAIN CAUSES OF ANTEPARTUM FETAL DEATH** Cord complications Intrauterine distress Congenital malformations **MAIN CAUSES OF INTRAPARTUM FETAL DEATH** Asphyxia Cord complications Congenital malformations **MAIN CAUSES OF EARLY NEONATAL DEATH** Asphyxia Congenital malformation Intracranial haemorrhage

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
ETHIOPIA (Addis Ababa) Naeye RI Tafari N Marboe CC and DM Judge (1977) *Bulletin of the World Health Organization* 55 63 65	65 3	OBJECTIVE To identify the causes of perinatal death SAMPLE N = 1 019 stillbirths and neonatal deaths in hospitals and clinics STUDY DESIGN Case control study SOURCES OF DATA Maternal interview hospital/clinic records physical examination of infant one day post delivery METHODS **time frame** one year (1974 1975) Autopsies and gross placental examinations were performed by medical students and deaths were assigned to the following categories amniotic fluid infection obstructed labor *abruptio placentae* congenital syphilis umbilical cord compression fetal hypoxia of unknown cause congenital anomalies placenta praevia large placental infarct premature rupture of membranes toxaemia of pregnancy twin transfusion syndrome birth trauma, viral hepatitis and cord knots or stenosis	Ratio of stillbirths to neonatal deaths=2 7 1 73% of perinatal deaths stillbirths after the 20th week of gestation **LEADING CAUSES OF PERINATAL DEATH** *[by perinatal mortality rates (PMRs) per 1000]* amniotic fluid infections 21 8 obstructed labor 9 5 abruptio placentae 5 5 congenital syphilis 4 9 fetal hypoxia of unknown cause 4 3 congenital anomalies 2 5 **NOTE* Risk factors were not presented in the article

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
EGYPT Serour GI Younis MN Hefnawi F El Bahy M Dagistany HF and Nawar (1981) *International Journal of Gynaecology and Obstetrics* 19 447 451	84 4	OBJECTIVE To study factors affecting perinatal mortality at Al Galaa Teaching Hospital SAMPLE N =6 990 deliveries n=580 perinatal deaths Women with normal deliveries discharged from hospital earlier than other women Random sample of women discharged on 2nd day postpartum followed up at home on the 8th day postpartum to record neonatal deaths STUDY DESIGN Retrospective study SOURCES OF DATA *International Fertility Research Program s Maternity Record 903 Form* perinatal death form METHODS **time frame** 21 months (March 1977 to November 1978) Data were collected using the *International Fertility Research Program s Maternity Record 903 Form* which documented information on medical and social aspects of the mother and the delivery An additional form was completed for each perinatal death which documented possible causes of death & postmortem exam results (when conducted)	**PERCENTAGE OF ALL CASES ATTRIBUTED TO SELECTED CAUSES** *(based upon postmortem examinations of 105 babies)* Anoxia 63 8% Maceration (autolyzed) 20 0% Major congenital anomalies 17 1% Cerebral birth trauma 2 9% **RISK FACTORS FOR PERINATAL DEATH** maternal age maternal education marital status residence antenatal care utilization haemoglobin level hospital status as paying or non paying patient registration status outcome of last pregnancy parity/family size gender of infant and birth weight *Increased perinatal mortality with maternal age (PMR=184 62 among women 40+years vs 59 29 among women <20 years) *Outcome of last pregnancy highest mortality for preterm stillbirths (384 6) followed by term stillbirths (363 6) preterm live births (196 4) spontaneous abortions (103 8) induced abortions (95 2) term live births (83 5) Perinatal mortality rate among never pregnant women=53 1 *General increase in perinatal mortality with increasing numbers of living children

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
GHANA Fiander A (1992) *Tropical Doctor* 22 82	103 0	OBJECTIVE To quantify perinatal mortality and identify causes of death at a 250 bed hospital in Bawku District Upper East Region Ghana (responsible for 15% of deliveries) SAMPLE N =1 637 deliveries (n=168 perinatal deaths) STUDY DESIGN Prospective study SOURCES OF DATA Information recorded by attending midwife following each perinatal death METHODS Information such as the mother s name parity date of death infant sex birth weight age at death and cause of death were recorded An attempt was also made to distinguish between fresh and macerated stillbirths	Stillbirths=67% perinatal deaths **MAIN CAUSES OF DEATH** asphyxia during labor (42 3%) prematurity (23 2%) intrauterine death prior to labor (17 3%) antepartum hemorrhage (8 3%) major congenital abnormality (6 0%) miscellaneous causes (2 9%) **RISK FACTORS FOR PERINATAL DEATH** Primigravidity grand multigravidity

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
GUATEMALA Bartlett A Paz de Bocaletti ME and MA Bocaletti (1990) *Health Policy and Planning* 8(4) 360 368		OBJECTIVES To (1) identify obstetric conditions associated with intrapartum/day one deaths in rural Guatemala (2) assess the usefulness of maternal characteristics as predictors of these deaths and (3) evaluate obstetric risk management strategies to reduce potentially preventable obstetric related perinatal mortality SAMPLE N = 13 964 consecutive births (n=597 perinatal deaths) [all infants born in Santa Maria de Jesus Sacatepequez Guatemala] STUDY DESIGN Prospective study SOURCES OF DATA Maternal interviews using a standardized procedure administered by a female Guatemalan physician METHODS **time frame** one year (October 1988 through September 1989) Pregnant women and their births were identified primarily through TBAs and family members Data were collected on the following maternal and family sociodemographic characteristics obstetric history After the delivery data were also obtained on labor/delivery conditions as well as newborn care **Definition of intrapartum death** stillborn infant and maternal report of fetal movement prior to labor	**AMONG MOTHERS OF INFANTS EXPERIENCING INTRAPARTUM/DAY ONE DEATH (n=23)** 30% primigravida 30% ≥ 3 previous pregnancies 43% prior adverse pregnancy outcome 70% illiterate Low positive predictive values (range 0 0 13) for intrapartum/day one deaths and maternal characteristics Occurrence of labor/delivery complication(s) stronger predictor of intrapartum/day one death than maternal characteristics Fetal malpresentation highest case fatality rate accounted for >50% of potentially preventable intrapartum/day one deaths

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
INDIA Bai NS Matthews E Nair PMC Sabarinathan K and C Harikumar (1991) *Journal of the Indian Medical Association* 89(4) 97 98	42 75	OBJECTIVE To study perinatal mortality among all inborn delivery at SAT Hospital Trivandrum South India over a one year period SAMPLE N = 13 964 consecutive births (n=597 perinatal deaths) STUDY DESIGN Prospective study SOURCES OF DATA Not reported METHODS **time frame** one year (April 1986 to March 1987) Study methodology was not discussed in the article For calculation of rates the investigators used the ICD 9 definition which includes babies <500g in the perinatal death group	**STILLBIRTH RATE**=24 41 per 1000 **EARLY NEONATAL MORTALITY RATE**=18 79 per 1000 *PMR among multiple pregnancies=156 65 per 1000 *(Incidence of multiple pregnancy in the sample=1 36%)* *9% perinatal deaths with birth weight <1000g Stillbirths= majority of deaths >2000g *Most deaths between the 1st and 24th hours of life **MOST COMMON CAUSES OF PERINATAL DEATH** birth asphyxia (31 28%) prematurity (15 6%) lethal congenital malformations (8 4%) infections (7 2%)

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********

COUNTRY/ REFERENCE	PMR (per 1000)	METHODOLOGY	STUDY RESULTS
KENYA Kavoo Linge and KO Rogo (1992) *East African Medical Journal* 69(4) 181 187	*Early perinatal mortality rate* 53	OBJECTIVE To analyze factors that influence early perinatal mortality in rural Kenya SAMPLE N = 2 171 deliveries and n=114 early perinatal deaths at Machakos District Hospital (eastern Kenya) STUDY DESIGN Prospective study SOURCES OF DATA Closed ended pretested questionnaire labor ward and neonatal unit records METHODS **time frame** four months *Study methodology not discussed in article* Questionnaires were administered to all mothers experiencing an early perinatal death Information on all stillbirths and early peri neonatal deaths were also obtained from the labor ward and neonatal unit on a daily basis **Definition of early perintal mortality** death occurring in the first 24 hours after delivery	**EARLY PERINATAL MORTALITY (EPMR) PER 1000 BY SELECTED FACTORS** **EPMR (per 1000) BY PLACE OF ANTENATAL CARE** Machakos Hospital 26 Health Center 59 Sub District Hospital 123 None 229 **EPMR BY GESTATION AT DELIVERY** less than 28 weeks 611 28 36 weeks 120 37 42 weeks 34 more than 42 weeks 76 **EPMR BY MODE OF DELIVERY** spontaneous vertex 30 caesarian section 84 breech 260 vacuum extraction 123 laparatomy 940 **EPMR BY DURATION OF LABOR** 0 12 hours 30 13 18 hours 77 over 18 hours 171 **EPMR BY PREGNANCY COMPLICATION** none 10 prolonged labor (>18 hours) 177 fetal distress 100 malpresentation 231 antepartum hemorrhage 210 obstructed labor 428 ruptured uterus 940 cord prolapse 625 premature rupture of membrane 125 **EPMR BY BIRTH WEIGHT** <1000 g 888 1000 1499 g 700 1500 1999 g 354 2000 2499 g 115 2500 2999 g 31

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********

COUNTRY/ REFERENCE	PMR (per 1000)	METHODOLOGY	STUDY RESULTS
MALAWI McDermott J Steketee R and J Wirima (1996) *Bulletin of the World Health Organization* 74(2) 165 171	68 3	OBJECTIVES To estimate the PMR in the study population identify/quantify risk factors associated with perinatal mortality compare these risk factors for their relative contribution to perinatal mortality and assess potential misclassification of late fetal deaths SAMPLE N=3 866 women with singleton pregnancies (n= 264 perinatal deaths) recruited during their first antenatal visit at one of four antenatal clinics in Mangochi District STUDY DESIGN Prospective population based study SOURCES OF DATA Mangochi Malaria Research Project (MMRP) dataset maternal anthropometry maternal interviews blood specimens METHODS **time frame** 1987 1990 Subjects received routine antenatal care tetanus toxoid malaria chemoprophylaxis Anthropometric measures were taken and sociodemographic information was obtained from maternal interviews Enrollees were monitored through delivery and at least one year follow up (bi monthly visits) Multiple pregnancies were excluded from the analysis of risk factors for perinatal mortality	Analysis included women who met the following criteria (1) singleton births of gestational age ≥28 weeks with known outcomes for day seven (2) complete data on potential risk factors **RISK FACTORS FOR PERINATAL MORTALITY** PMR among nulliparous women (92 1 per 1000)= 1 6 times PMR of multiparous women (56 7 per 1000) No significant interaction between parity and other variables tested by the investigators Nulliparous women 65% more likely than multiparous women to deliver in a health facility (p=0 0004) **OR (95% C I) For Risk of Perinatal Death ALL WOMEN** Reactive syphilis serology OR=3 48 (2 58 4 70) Late fetal/neonatal death previous birth OR=2 76 (1 81 4 30) Maternal stature <150 cm OR=1 86 (1 35 2 63) Enrollment hematocrit <25gm% OR=1 72 (1 06 2 78) Nulliparity OR =1 62 (1 22 2 16) Maternal weight <50 kg OR=1 53 (1 15 2 04) Home delivery OR=1 42 (1 06 1 88) Low socioeconomic status OR=1 42 (1 03 1 97) Illiteracy OR=1 33 (0 96 1 84) **POPULATION ATTRIBUTABLE RISKS** Reactive syphilis serology 24 8% Previous late fetal/neonatal death 13 9% Nulliparous 24 6% Home delivery 16 2% Maternal height <150cm 10 5% Low socioeconomic status 22 7% **MULTIVARIATE ANALYSES** *(based upon adjusted ORs from a model that included variables listed below)* Reactive syphilis serology 3 39 (2 49 4 61) Late fetal or neonatal death previous birth 3 27 (2 08 5 15) Nulliparity 2 38 (1 77 3 21) Maternal height <150 cm 1 74 (1 24 2 44) Home delivery 1 47 (1 11 1 94) Low socioeconomic status 1 41 (1 03 1 94) **MISCLASSIFICATION OF NEONATAL DEATHS** There is evidence of differential misclassification Among home deliveries infants dying within the first day of life more likely to be classified as late fetal deaths 62% of perinatal deaths among home deliveries were reported as late fetal deaths (compared to 50% in health facilities)

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
SAUDIA ARABIA (Jeddah) Milaat WA and CDV Florey (1992) *International Journal of Epidemiology* 21(1) 82 90	31 5	OBJECTIVES To estimate the perinatal mortality rate and identify antenatal and intrapartum risk factors SAMPLE n= 323 perinatal deaths n=486 controls STUDY DESIGN Case control study SOURCES OF DATA questionnaires official logbooks of vital events in three governmental statistical health offices in Jeddah METHODS All live births occurring during the Islamic calendar years of 1393 (4 February 1973 to 24 January 1974) 1400 (21 November 1979 to 8 November 1980) and 1408 (26 August 1987 to 13 August 1988) were abstracted from the government logbooks Mothers were interviewed by the principal investigator during their hospital stay using the pre tested maternal questionnaire Information on biological socioeconomic and obstetric factors were abstracted from medical records **Definition of cases** all deliveries occurring during the 40 week study period which ended in either a stillbirth or early neonatal death in the hospital **Definition of controls** the first two live vaginal singleton deliveries at or after 7 00 am each day served	*Caesarean section rate for University Hospital=9 3% (based upon labor room logbook) *No significant difference between cases and controls with respect to infant sex **CAUSES OF PERINATAL DEATH (n = 323 perinatal deaths)** Unknown (birth weight < 2500 g) 20 7% Trauma/mechanical 18 6% Congenital anomaly 18 0% Antepartum hemorrhage 10 5% Unknown (birth weight > 2500 g) 7 7% Pre eclampsia 7 1% Maternal disorder 3 4% Other causes Iso immunization 0 4% Antenatal & intranatal infection 2 2% Neonatal infection 11 4 **RISK FACTORS for PERINATAL DEATH** *Birth weight* ≥2500g (reference category) 1500 2499g 23 2 (12 7 42 0) [p<0 001] <1500g >>100 (1 88 >>100) [p< 0 05] *Labor complications* No (reference category) Yes 5 3 (3 26 8 56) [p< 0 001] *Mother s age* <20 years (reference category) 20 34 years 2 5 (0 88 7 00) ≥ 35 years 6 0 (1 69 21 0) [p<0 01] *Parity* not a significant predictor of perinatal death **PRETERM BIRTH AND PERINATAL DEATH** Preterm babies (32 36 weeks gestation) 70% of cases versus 22% of controls Very preterm babies (28 32 weeks gestation) 27% all perinatal deaths Risk of perinatal death among these infants 19 times greater than among full term infants **LOW BIRTH WEIGHT** 69% of cases versus 7% of controls

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********

COUNTRY/ REFERENCE	PMR (per 1000)	METHODOLOGY	STUDY RESULTS
SOUTH AFRICA (Cape Town) Domisse J (1991) *South African Medical Journal* 80 270 275	29 9 (RANGE 12 0 in low risk peripheral midwife obstetric units to 80 0 in the high risk referral centre)	OBJECTIVES To (1) develop appropriate strategies to combat perinatal mortality (2) assign priority to research and (3) create baseline data for future comparative studies SAMPLE N = 27 460 births (n=854 perinatal deaths) STUDY DESIGN Prospective study SOURCES OF DATA Not reported METHODS Every perinatal death was jointly evaluated by an obstetrician and a neonatologist using the *Whitfield* and *Hey* cause of death classification systems Other aspects of the study methodology were not presented in the article	*Ratio of stillbirths to neonatal death = 2 3 1 *20% of stillbirths and 26% of early neonatal deaths among unbooked patients *73% of perinatal deaths gestational age <37 weeks **STILLBIRTHS OBSTETRIC CAUSES** Abruptio placentae 22 5% Hypertension 7 0% Infection 6 4% IUGR 4 5% Trauma 5 4% Premature rupture of membranes 2 3% All others 7 5% Unexplained 43 0% **STILLBIRTHS- FETAL CAUSES** Prenatal hypoxia 36 0% Infection 7 5% Congenital abnormality 5 6% All others 4 7% Unidentified 47 0% **EARLY NEONATAL DEATHS OBSTETRIC CAUSES** No cause identified 62 9% Hypertension/proteinuria 8 0% Premature rupture of membranes 6 4% Trauma 5 0% Infection 5 0% Abruptio Placentae 4 0% IUGR 4 0% Other 4 7% **EARLY NEONATAL DEATHS NEONATAL CAUSES** Immaturity 37 0% Prenatal hypoxia 23 0% Infection 14 0% Congenital abnormality 11 0% Respiratory distress 10 0% Birth trauma haemorrhage 3 0% Metabolic cause 3 0% Other 1 0% Unknown 2 0%

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
VANUATU Maouris P (1994) *Papua New Guinea Medical Journal* 37 178 180	34 6 Excluding emergency referral cases from other islands 30 4	OBJECTIVES To (1) establish accurate figures of perinatal mortality for the referral population of Vila Central Hospital (VCH) (2) determine cause of death and (3) identify possible improvements in management SAMPLE N = 1 445 total births (live births and all perinatal deaths [n=23 stillbirths n=27 early neonatal deaths) occurring in 1992 STUDY DESIGN Prospective study SOURCES OF DATA Not reported METHODS **time frame** one year Cause of death was assigned at monthly perinatal morbidity meetings attended by the obstetrician midwives and the pediatrician	**Stillbirth Rate**=16 0 per 1000 **Early Neonatal Mortality Rate**=18 6 per **Low Birth Weight Prevalence**=10% **CAUSES OF PERINATAL MORTALITY AT VCH (n=50)** Birth Asphyxia 30% Prematurity related 20% Unexplained stillbirth 20% Congenital abnormality 12% Cord accidents 6% Meconium aspiration 4% IUGR 4% Neonatal infections 4% **RISK FACTORS** Not presented in article

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
ZIMBABWE (Bulawayo) Aiken CGA (1992) *The Central African Journal of Medicine* 38(7) 263 281	36 0	OBJECTIVE To investigate the causes of perinatal mortality at Mpilo Maternity Hospital in Bulawayo Zimbabwe SAMPLE N= 10 881 deliveries 3 272 neonatal admissions (n=466 stillbirths n=379 early neonatal deaths) STUDY DESIGN Prospective study SOURCES OF DATA Maternal histories antenatal and intrapartum examinations examination of babies before and after death METHODS **time frame** 12 months (August 1989 through September 1990) Study methodology was not discussed in detail **Definition of stillbirths** fetal deaths delivered at or after 28 weeks gestation **Definition of neonatal deaths** babies dying before discharge from hospital Autopsies were performed on 90% of deaths weighing at least 1000g and 21% of deaths to babies <1000g They were seldom performed on stillbirths	**CAUSES OF PERINATAL DEATH** Congenital Syphilis 20 5% Birth Asphyxia 18 8% Unexplained Stillbirths 11 8% Hyaline Membrane Disease 11 5% Neonatal Septicaemia 10 8% Congenital Malformations 7 7% Pregnancy Induced Hypertension 5 4% Placental Abruption 4 9% Congenital Infection 2 2% Other Causes 6 4% **CAUSES OF STILLBIRTH (n=456)** Congenital malformations 7 3 % Placental abruption 8 8% Pregnancy induced hypertension 9 9% Birth asphyxia 23 8% Congenital syphilis 21 7% Other causes 7 1% Unexplained stillbirths 21 5% **CAUSES OF EARLY NEONATAL DEATHS (n=379)** Congenital malformations 8 2% Birth asphyxia 12 7% Congenital syphilis 19 0% Early onset septicaemia 10 3% Late onset septicaemia 11 1% Meconium aspiration syndrome 3 2% Hyaline membrane disease 25 6% Other causes 10 0% 11% of mothers booking at antenatal clinics positive syphilis serology Highest stillbirth rate (50 0/1000) mothers 25 39 years Highest neonatal rate (34 4/1000) mothers 20 24 years 50% of deaths due to asphyxia caused by prolonged/obstructed labor 25% due to prolapsed cord breech delivery complications and retained second twin 42% of stillbirths weighed ≥2500g 51% of neonatal deaths weighed <1500g No significant variations in perinatal mortality due to birth asphyxia unexplained stillbirths and congenital malformations by maternal age **RISK FACTORS** Not presented in article

INSTITUTION BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
ZIMBABWE (Bulawayo) Aiken CGA (1992) *Archives of Diseases in Childhood* 67 595 599		OBJECTIVES To determine the contribution of maternal HIV infection to perinatal mortality SAMPLE N= 441 perinatal deaths (n=220 neonatal deaths and n=221 stillbirths) at Bulawayo occur at Mpilo Maternity Hospital [NOTE subset of the same sample described in the previous matrix entry] STUDY DESIGN Retrospective study SOURCES OF DATA Specimens collected during the antenatal period for serological testing METHODS **time frame** seven months Blood specimens which were initially taken from all neonatal deaths and the mothers of stillbirths for syphilis serology testing were anonymously tested for HIV 1 antibodies Patients were not matched with their test results until the end of the study to avoid bias in the assignment of cause of death	***HIV positive rate** 19 5% of perinatal deaths (15 4% stillbirths 23 6% neonatal deaths) ***HIV infected mothers** 2 1 times more likely than uninfected mothers to have a perinatal death 1 6 times more likely to have a stillbirth 2 7 more likely to have a neonatal death **HIV POSITIVE RATE (%) BY CAUSE OF PERINATAL DEATH** Congenital malformations 8 1% Birth asphyxia 8 1% Pregnancy induced hypertension 8 1% Placental abruption 8 1% Other non infections causes* 8 1% Hyaline membrane disease 15 0% Congenital syphilis 17 4% Unexplained stillbirths 22 4% Neonatal septicaemia 39 3% Congenital infection 72 2% *Other non infectious causes of stillbirth postmaturity diabetes placenta previa and cord knot *Other non infectious causes of neonatal death meconium aspiration syndrome birth trauma kernicterus milk aspiration and posthaemorrhagic hydrocephalus

COMMUNITY BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
BANGLADESH (Matlab) Fauveau V Wojtytniak B Mostafa G Sarder AM and J Chakraborty (1990) *International Journal of Epidemiology* 19(3) 606 612	75 0	OBJECTIVE To assess perinatal mortality as a monitoring tool for the evaluation of the community based Family Planning and Health Services Programme in Matlab Bangladesh SAMPLE N = 60 050 births (n=4 486 perinatal deaths occurring in the study population) from segment of the community targeted for the Family Planning and Health Services Programme (1977) STUDY DESIGN Prospective (longitudinal surveillance) two group study SOURCES OF DATA verbal autopsy METHODS **time frame** eight years (1979 1986) Surveillance of the study population was accomplished using one female Community Health Worker (CHW) from each village who made bi weekly visits to each household to document vital events Each CHW was accompanied by a male Health Assistant once per month to conduct home interviews and complete registration forms in households where a vital event had occurred The **verbal autopsy** method was employed to document aspects relevant to both stillbirths and early neonatal deaths	**Perinatal mortality rates** significant decline during study period (1979 82 0/1000 to 1986 65 0/1000) **Stillbirth rate** 37 0/1000 **Early neonatal mortality rate** 38 0/1000 Perinatal mortality rate for males 13% higher than for females (gender differential for stillbirths 17% gender differential for early neonatal deaths 9%) No gender differential observed for causes of stillbirths or early neonatal deaths (exception neonatal tetanus [OR_{m1} =4 3 (1 4 13 5)] **CAUSES OF STILLBIRTH** Unknown 28% Disorders due to very small size at birth 25% Obstructed/prolonged labor 20% Maternal medical problems (e g sepsis eclampsia) 13% Malpresentation at term 12% Multiple birth 2% **CAUSES OF EARLY NEONATAL DEATH** Disorders due to very small size at birth 63% Birth trauma/hypoxia 31% Neonatal tetanus 8% Unknown 4% Other neonatal disorders 3% Acute respiratory infection 2% Malformation/accident 2% U shaped relationship between perinatal mortality and a) increasing gravidity b) increasing maternal age Seasonal variation in perinatal mortality highest between August and December ***NOTE*** The definition of early neonatal death did not include deaths occurring to infants on the 7th day postpartum The category very small at birth is likely to be inflated because the investigators were unable to distinguish between preterm and IUGR infants nor were they able to identify underlying causes of death as maternal or fetal in the case of stillbirths Limitations associated with gestational age assessment make it problematic to identify all stillbirths using the study definition of birth of an infant after 28 week gestation (for whom no sign of life was observed after delivery)

COMMUNITY BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
CHINA (Shunyi County) Yan RY McCarthy BJ Ye HF Qu CY Li Z Chen TX and D Kowal (1989) *The Risk Approach in Perinatal Health Shunyi County People s Republic of China* 13 26	25 9	OBJECTIVES To quantify health problems that pose the greatest risk to infant health and identify those areas that require the greatest resources SAMPLE Pregnancies of all women in seven selected townships in Shunyi County N = 1 914 pregnant women and their 1 928 infants (n=50 cases of perinatal mortality) STUDY DESIGN Prospective study (surveillance) SOURCES OF DATA home based medical record for prenatal care (information on maternal sociodemographics medical and obstetric history prenatal/ postnatal care maternal health during pregnancy birth status and infant morbidity) METHODS **time frame** October 1983 through September 1993 At her first prenatal visit each woman was issued a medical card that documented characteristics and conditions related to the pregnancy She was responsible for bringing her medical record to all subsequent visits The TBAs collected the card at the woman s last postpartum visit (42 days post delivery) and submitted it to the township hospital for data analysis	Of the 50 perinatal deaths 23 stillbirths and 27 early neonatal deaths **THE TWO LEADING CAUSES OF PERINATAL DEATH** congenital malformations (30%) and asphyxia (20%) Causes of late fetal death unidentified in 70% of cases **CAUSES OF EARLY NEONATAL DEATH** congenital anomalies (41%) asphyxia (37%) Low birth weight prevalence in study population 5% **FACTORS THAT HAD THE GREATEST IMPACT ON PERINATAL MORTALITY** Seventeen risk factors were identified highest relative risks for birth defects abnormal fetal health rate and low birth weight (40 2 27 4 and 20 5 respectively) * **POPULATION ATTRIBUTABLE RISK** Five risk factors with the greatest impact (as measured by population attributable risks) low birth weight (49 0%) birth defects (37 1%) hypertensive disorders of pregnancy (33 6%) breech versus lie presentation (27 4%) and asphyxia at birth (24 3%) **The authors do not state whether reported risk estimates were adjusted or unadjusted*

COMMUNITY BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
INDIA (Maharashtra) Daga & Daga (1993) *Journal of Tropical Pediatrics* 39 83 85	60 0	OBJECTIVES To (1) assess the relationship between selected obstetric and socioeconomic factors and perinatal outcome and (2) decide priorities in perinatal mortality prevention SAMPLE N = 5 201 pregnancies in 1 900 women from a larger study population of N=1 954 households (9 684 individuals) Ten clusters (villages/subcentres) from nine primary health centres [population size in each cluster 500 4 000] Every other household selected as a study unit STUDY DESIGN Cross sectional study SOURCES OF DATA 1987 baseline survey implemented by the Rural Neonatal Care Programme METHODS **time frame** one year (1987) Data were collected by medical interns and health workers Other aspects of the data collection process are not specified in the article	**CAUSES OF PERINATAL DEATH** Not presented in article **TOP FIVE RISK FACTORS FOR PERINATAL MORTALITY** (Based upon highest odds ratios Attributable risks also presented) *Mother s occupation (housewife or agricultural vs skilled/semi skilled)* OR = 14 7 (7 3 29 1) AR = 0 47 (0 01 0 97) *Intranatal problems (prolonged labor/malpresentation) present vs absent* OR = 13 5 (6 7 27 0) AR = 0 0 0004 (0 038 0 039) *Age of mother (≤18 yrs or ≥35 yrs vs 19 34 yrs)* OR = 9 5 (3 93 22 87) AR = 0 01 (0 06 0 08) *Antenatal care (availed vs not availed)* OR = 4 4 (1 7 9 9) AR = 0 46 (0 43 0 49) *Postnatal problems (hemorrhage fever) present vs absent* OR = 3 8 (1 2 11 0) AR = 0 004 (0 002 0 007)

COMMUNITY BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
INDIA *(Uttar Pradesh)* Misra Thakur Kumar and Tandon (1993) *Journal of Tropical Pediatrics* 39 41 44	121 1	OBJECTIVE To determine the magnitude of perinatal mortality with specific emphasis on high risk pregnancies SAMPLE N = 1 065 pregnant women from a community of approximately 30 000 in Lucknow district Uttar Pradesh STUDY DESIGN Prospective study SOURCES OF DATA MCH (i e maternal and child health) card interviews with the mothers relatives and health officials in attendance at the delivery METHODS Risk factors and postnatal events were recorded on a MCH card Pregnancy outcomes and causes of death were ascertained via the interviews	**Stillbirth Rate** 26 1 **Early Neonatal Death Rate** 97 4 *Causes of perinatal death are not presented in the article **RISK FACTORS FOR PERINATAL DEATH** **20% of women were identified with the following high risk factors** *Inadequate ANC* OR=2 23 AR=13 *Bad obstetric history* OR=3 1 AR=20 *Prolonged labor* OR=4 09 AR=27 *Gravida 5 or more* OR=2 00 AR=10% **[Risk factors with low attributable risk and insignificant statistical value** multiparity (gravida ≥5) primipara with age <18 and >30 years and last birth interval <18 months]

COMMUNITY BASED EPIDEMIOLOGICAL STUDIES **********			
COUNTRY/ REFERENCE	**PMR (per 1000)**	**METHODOLOGY**	**STUDY RESULTS**
NIGERIA (Northern) Akpala CO (1993) *Journal of the Royal Society of Health* June 1993 124 127	58 6	OBJECTIVE To identify maternal and social indicators of perinatal mortality in Danchadi district in Sokodo State of Nigeria SAMPLE N=1 484 births (n=87 perinatal deaths) in two villages (Danchadi and Dabaga) STUDY DESIGN Prospective study SOURCES OF DATA Key informants for birth/death ascertainment structured maternal questionnaire administered during an interview METHODS **time frame** nine month period Data were collected from each of the two villages by three female health workers Perinates were followed up prospectively On day eight field workers visited infants to determine their vital status Causes of death were assigned using the *Aberdeen Classification System*	Stillbirths were the majority of perinatal deaths (61 out of 87) **MATERNAL AGE** Babies born to very young mothers (ages 10 14 years) highest perinatal mortality (375 per 1000) Babies whose mothers were between 20 and 24 years lowest perinatal mortality (30 3 per 1000) Statistically significant difference in maternal age specific perinatal mortality rates (p<0 001) **PARITY** First deliveries highest perinatal mortality (96 5 per 1000) Second and third births lowest mortality (30 5 per 1000 and 27 7 per 1000 respectively) Statistically significant association between parity and perinatal mortality (p<0 01) **MATERNAL EDUCATION** Mothers with no formal education PMR=63 1 per 1000 Mothers with primary education PMR=29 2 per 1000 Mothers with post primary education the lowest mortality (25 6 per 1000) Statistically significant relationship between maternal education and perinatal mortality (p<0 05) **BIRTH WEIGHT** LBW prevalence in this population 8 8% Low birth weight (LBW) infants PMR= 192 3 per 1000 compared to 42 3 per 1000 among babies of normal birth weight (RR=4 0) **CAUSES OF DEATH** Birth trauma responsible for 48% of all perinatal deaths Unexplained death 19 5% and 14 9% of deaths to premature and mature infants respectively Other causes toxemia (9 2%) antepartum haemorrhage (5 8%) congenital deformity (1 0%) and maternal disease (1 0%)

COMMUNITY BASED EPIDEMIOLOGICAL STUDIES **********

COUNTRY/ REFERENCE	PMR (per 1000)	METHODOLOGY	STUDY RESULTS
PAKISTAN (Karachi) Fikree FF and RH Gray (1996) *Paediatric and Perinatal Epidemiology* 10 86 96	54 1	OBJECTIVES To (1) estimate the level of perinatal mortality in eight squatter settlements of Karachi using information from a demographic survey (2) identify perinatal mortality risk factors and prevention strategies SAMPLE N=6 936 births (n=375 perinatal deaths) STUDY DESIGN Cross sectional study SOURCES OF DATA Maternal interviews (using a truncated pregnancy history demographic survey METHODS **time frame** August and September 1989 Every household within the eight settlements was contacted (response rate=98 0%) Two questionnaires were administered at each interview (1) household composition mortality/migration patterns socioeconomic patterns and (2) parental education/occupation household assets household construction materials/facilities + truncated pregnancy history (documenting demographic events occurring during the 5 years preceding survey) The pregnancy history was administered to all ever married women between the ages of 15 54 years	**ADJUSTED ODDS RATIOS** *(from regression model that included variables listed below)* *Maternal Education* illiterate 1 4 (1 0 2 1) Attributable risk=28 9 (27 8 30 0) primary 1 3 (0 8 2 0) more than primary reference category *Maternal Occupation* gainfully employed 1 8 (1 3 2 4) Attributable risk=7 3 (4 8 9 8) not gainfully employed (reference category *Paternal Age (years)* <25 0 7 (0 4 1 2) 25 34 (0 8 1 6) 35 49 reference category ≥50 2 1 (1 4 3 1) Attributable risk=5 7 (2 1 9 1) *Household Assets* ≤4 1 8 (1 1 2 7) 5 8 reference category Attributable risk=46 3 (45 2 47 3) *Maternal Age (years)* <20 0 8 (0 4 1 6) 20 24 1 2 (0 9 1 6) 25 29 reference category 30+ 1 3 (0 9 1 8) *Pregnancy Order* primigravid 2 4 (1 4 3 8) Attributable risk=14 8 (13 1 16 5) 2 3 1 2 (0 9 1 7) 4 6 reference category 7 8 0 9 (0 6 1 3) 9+ 1 4 (0 9 2 0) *Outcome of Previous Pregnancy* stillbirth/abortion 3 2 (2 2 4 7) Attributable risk=10 4 (5 5 15 0) livebirth reference category *Birth Interval (months)* <24 1 8 (1 2 2 6) Attributable risk=17 4 (15 9 18 8) 24 35 reference category *Maternal Knowledge of Family Planning* yes 0 7 (0 6 1 0) Attributable risk=5 2 (3 7 6 7) no reference category *Health Care at Delivery* TBA/relative reference category midwife/lady health visitor 1 8 (0 9 3 6) nurse 0 9 (0 6 1 2) physician at home 2 2 (0 7 6 5) physician at hospital 1 4 (1 1 1 8) Attributable risk=8 3 (6 7 9 8) *Sex of Newborn* male 1 8 (1 4 2 2) Attributable risk=28 4 (27 5 29 3)

SAMPLING FROM BOTH HOSPITALS AND COMMUNITIES **********

COUNTRY/ REFERENCE	*PMR (per 1000)*	*METHODOLOGY*	*STUDY RESULTS*
NEPAL Geetha T Chenoy R Stevens D and RB Johanson (1995) *Paediatric and Perinatal Epidemiology* 9 74 89	**HOSPITAL POPULATIONS** Maternity Hospital 48 0 Patan Hospital 23 7 **COMMUNITIES** Jumla 96 2 Lalitpur 42 5	OBJECTIVE To ascertain the causes of perinatal mortality SAMPLE N= 14 967 births (n=716 perinatal deaths) STUDY DESIGN Prospective multi center study SOURCES OF DATA Perinatal audit verbal autopsy questionnaire (adapted from WHO certificate of cause of perinatal death) METHODS **time frame** one year (1 August 1989 to 31 July 1990) Trained midwives abstracted information from medical records and conducted maternal interviews The perinatal audit was initiated two months before implementation of the survey **Classification of perinatal deaths** The *Aberdeen* (obstetric) and *Wigglesworth* (fetal/neonatal) classification systems were employed with the following minor modifications (1) birth trauma category was eliminated from both systems because it is a rare diagnosis (2) all infants with infections were classified under the neonatal infection category since it was not feasible to distinguish between antepartum intrapartum and postpartum infections (3) post maturity and multiple pregnancy were added to the miscellaneous section of the Aberdeen classification All deaths to hospital babies less than 1500g and rural babies less than 34 weeks gestation were classified as due to prematurity regardless of whether these cases suffered from conditions such as asphyxia, birth trauma, or postpartum infection Unless stated otherwise all fresh stillbirths were attributed to intrapartum asphyxia	**PERINATAL MORTALITY, BY STUDY SITE** Maternity Hospital *stillbirths* 298 *neonatal deaths* 203 *perinatal deaths* 501 *total births* 10 436 Patan Hospital *stillbirths* 42 *neonatal deaths* 24 *perinatal deaths* 66 *total births* 2 783 Jumla *stillbirths* 44 *neonatal deaths* 79 *perinatal deaths* 123 *total births* 1 278 Lalitpur *stillbirths* 11 *neonatal deaths* 15 *perinatal deaths* 26 *total births* 470 **MAJOR CAUSES OF DEATH (Wigglesworth Classification)** Intrapartum asphyxia low birth weight and infection were the most common causes (NOTE many deaths were unexplained) Number of deaths attributed to peripartum infections was higher in the rural communities **MAJOR CAUSES OF DEATH (Aberdeen Classification)** In hospital based populations pre eclampsia In community based populations malpresentation maternal infection More than 30% of deaths were due to unexplained/unclassifiable causes **RISK FACTORS** *Not reported in article*

SAMPLING FROM BOTH HOSPITALS AND COMMUNITIES **********			
COUNTRY/ REFERENCE	*PMR (per 1000)*	*METHODOLOGY*	*STUDY RESULTS*
JAMAICA Greenwood R Golding J McCaw Binns A Keeling J and D Ashley (1994) *Paediatric and Perinatal Epidemiology* 8 (suppl) 143 157	38 0 *[The authors did not sort this analysis by location (i e hospital vs community]*	OBJECTIVE To identify aetiologic factors (social biological environmental behavioral medical and medical care) leading to perinatal death SAMPLE Two overlapping samples all births in Jamaica over a two month period (September through October 1986) and all stillbirths (weighing >500g) and neonatal deaths during a 12 month period (September 1986 through October 1987) N=10 507 total births during the cohort months (n=2 020 perinatal deaths during the 12 month death observation period) Twin births/deaths excluded Final sample= 9 919 singleton survivors and 1 847 perinatal deaths STUDY DESIGN Prospective population based study SOURCES OF DATA Maternal interviews using a pre coded standardized questionnaire antenatal and clinical records METHODS **time frame** Death sample One year (September 1986 through October 19867 Birth sample Two months (September 1986 through October 1986) The present analysis examined all social biological environmental behavioral medical and medical care variables using logistic regression analysis The final model included variables related to past obstetric history For each variable the reference group was the most frequent category of the variable	**RISK FACTORS FOR PERINATAL DEATH** *Union (marital) status* [housewives at lowest risk] *Number of adults in household* [the more the higher the risk] *Number of children <11 years* [the more the lower the risk] *Use of toilet facilities* [shared with other households increased the risk] *Maternal height* [tall women at reduced risk] *Mother s report that she was trying to get pregnant* *Maternal alcohol consumption* [drinkers had lower risk] *Maternal syphilis* [higher risk] *Bleeding before 28 weeks or more* [higher risk] *First diastolic blood pressure* [80 mm+ at higher risk] *Highest diastolic blood pressure* [100 mm+ at increased risk] *Highest proteinuria* [++ or more at increased risk] *Vaginal discharge/infection* [untreated at increased risk] *Pre eclampsia diagnosed in antenatal period* [increased risk] *Maternal diabetes* [increased risk] *Start of antenatal care* [first trimester at reduced risk] *Iron taken* [reduced risk] *Type of perinatal care available in parish of residence* [reduced risk if consultant obstetricians and paediatricians available at all times] *Number of miscarriages and terminations* [the more the higher risk] *Previous stillbirth* [higher risk] *Previous early neonatal death* [higher risk] *Previous Caesarean section* [higher risk] Haemorrhage infection and hypertension were prominent in this study An adverse relationship between poor socioeconomic status and perinatal survival was not observed in this study

SAMPLING FROM BOTH HOSPITALS AND COMMUNITIES **********			
COUNTRY/ REFERENCE	*PMR (per 1000)*	*METHODOLOGY*	*STUDY RESULTS*
SUDAN Taha TE Gray RH Abdelwahab MM Abdelhafeez AR and AB Abdelsalam (1994) *International Journal of Gynecology and Obstetrics* 45 109 115	**HOSPITALS** 85 4 **COMMUNITIES** 29 4	OBJECTIVE To determine levels and risk factors for perinatal mortality in Central Sudan SAMPLE **Hospital Study** N= 5 328 births (n=197 stillbirths 812 early neonatal deaths) *Definition of a case* A stillbirth weighing less than 500g *Definition of a control* A live born infant weighing greater than 2500g No early neonatal deaths were included in the hospital study because of difficulties in ascertaining survival status after hospital discharge **Community Study** N= 1 592 midwife assisted home deliveries *Definition of a case* stillbirth or a death within the first week of life *Definition of a control* infant who survived the first week STUDY DESIGN Nested case control study SOURCES OF DATA Rates estimated from deaths identified through surveillance and from pregnancy histories Laboratory specimens maternal and infant blood smears/films for malaria parasites METHODS **time frame** one year (1989 through 1990) In the hospital based component the attending midwife measured birth weight immediately after delivery and obtained blood and tissue specimens Trained study workers interviewed mothers on the following areas sociodemographic characteristics medical/obstetric history and past perinatal deaths A senior nurse obtained anthropometric measurements from both the mother and child In the community based study a trained study worker supervised four to six village midwives (per center) who measured birth weight immediately after birth and conducted two home visits per women During the first visit information on sociodemographic characteristics medical/obstetric histories and anthropometry were collected The second visit entailed assessment of the infant s vital status No laboratory specimens were collected	**In hospital sample** Fresh stillbirths 63 5% Macerated stillbirths 36 5% No socioeconomic factors significantly associated with stillbirths Major risk factors for perinatal mortality similar for the hospital and community samples **MAJOR RISK FACTORS** (factors with the highest adjusted ORs) *HOSPITAL* birth defects (OR=12 2 [4 7 31 4]) delivery complications (OR=10 5 [5 2 20 9]) prior fetal loss >3 (OR=2 6 [1 0 6 6]) maternal weight <50 kg (OR=2 3 [1 1 4 8]) malaria attack during first trimester (OR=2 1 [0 8 5 7]) Highest attributable risks maternal weight (30 1%) use of hematinics (23 5%) insecticide/pesticide exposure (22 4%) and prior fetal loss (18 9%) *COMMUNITY* birth defects (OR=15 2 [4 2 54 9]) insecticide/pesticide exposure (OR=3 1 [1 3 7 4]) infant sex (OR=2 7 [1 2 5 8]) maternal weight <50 kg (OR=2 6 [1 2 5 3]) birth interval <18 months (OR=2 3 [0 9 5 6]) prior fetal loss >3 (OR=1 8 [0 7 4 2]) ********** *NOTE* This is not a true community based study because the sample from the community study was derived from six health centers However the authors report that the health centers are the only source of antenatal care in the area) **********

SAMPLING FROM BOTH HOSPITALS AND COMMUNITIES **********			
COUNTRY/ REFERENCE	*PMR (per 1000)*	*METHODOLOGY*	*STUDY RESULTS*
TANZANIA (Northwestern) Walraven GE Mkanje RJ van Roosmalen J van Dongen PW and WM Dolmans (1994) *Tropical and Geographical Medicine* 46(1) 11 13	**HOSPITAL POPULATION** 35 0 **COMMUNITY** 98 0 **TOTAL SAMPLE** 68 0	OBJECTIVE To compare perinatal mortality in home births (attended by a traditional birth attendant (TBA) or a relative) with hospital births attended by trained medical personnel SAMPLE N=447 pregnant women (from hospital and communities) N= 421 births with known outcome (n=12 stillbirths and n=17 early neonatal deaths) Hospital based sample N = 3 056 women (3174 deliveries 2 929 live births 245 stillbirths 45 early neonatal deaths) STUDY DESIGN Prospective study SOURCES OF DATA structured questionnaire standard Tanzanian antenatal card METHODS **time frame** one year (1990) All births occurring in five rural villages in Kwimba district were documented Village selection was based upon consent of village leaders and community members the level of motivation of village health workers based in those villages and distance to Sumve District Hospital Information on home deliveries obtained postpartum from a structured questionnaire (administered during interviews by TBAs) Information on hospital based deliveries was obtained from a questionnaire completed by the trained delivery attendant Study investigators conducted fortnightly antenatal clinics in the villages Each woman received a standard Tanzanian antenatal card (which documents maternal antenatal and intrapartum risk factors) during her first antenatal visit **Classification of perinatal mortality** was based upon the Standard Perinatal Mortality classification for international comparison (1976) which is defined as all stillbirths and first week deaths of infants weight 1000g The authors noted that when birth weight assessment was not feasible a case was determined by gestational age (at least 28 completed weeks) Gestational age was assessed by menstrual history and fundal height measurements	Birth weight determined for 419 of the 427 neonates (98 1%) Home deliveries 53% Among perinatal deaths 76% home deliveries Women who delivered at home significantly fewer years of schooling than women who delivered in the hospital (p<0 01) **RISK FACTORS FOR PERINATAL MORTALITY** Perinatal mortality stratified for risk level three times higher in home births than in dispensaries or hospitals Among low risk pregnancies perinatal mortality was five times higher for home deliveries compared to institutional deliveries ORs for other risk factors not presented in the article **CAUSES OF DEATH** were not discussed explicitly in the article

APPENDIX F

Perinatal Mortality Intervention Studies

COUNTRY	SOURCE	SYNOPSIS OF THE INTERVENTION STUDY
BANGLADESH	Rahman S (1982) *Journal of Tropical Pediatrics* 28 163 165	**OBJECTIVE** To assess the effect of tetanus toxoid immunization and traditional birth attendants (TBAs) in the reduction of neonatal mortality in rural Bangladesh **STUDY DESIGN** Community based prospective study **SAMPLE** N= 2 482 mothers of live born infants (subjects selected using simple random sampling) **INTERVENTION** Nine unions divided into three study groups *Group1* (n=713) Trained TBAs (trained in proper labor/delivery procedures high risk screening maternal nutrition) *Group2* (n= 771) Tetanus Toxoid administered to pregnant women *Group3* (n=998) Controls (NOTE No additional information provided on nature/duration of the intervention) **RESULTS** Although tetanus toxoid immunization reduced the incidence of tetanus neonatorum TBA training was found to be more critical in reducing neonatal mortality due to respiratory distress syndrome and birth injury TBAs also played a critical role in reducing gastroenteritis and infections during the postnatal period Neonatal mortality rates (per 1000) GROUP 1= 23 84 GROUP 2= 38 91 GROUP 3= 85 17 No differences were noted between study groups in terms of the median maternal age (approximately 25 years) **LIMITATIONS** Neither the study methodology nor the content of the training program were well explained There was a possible contamination effect within the control area

COUNTRY	SOURCE	SYNOPSIS OF THE INTERVENTION STUDY
BOLIVIA	O Rourke K et al (1995) An evaluation of the impact of community organization of women on perinatal outcomes in rural Bolivia [accepted for publication in *Bulletin of the Pan American Health Organization 1997*]	**OBJECTIVE** To assess the impact of community organization of women on perinatal outcomes **STUDY DESIGN** Case control studies conducted pre intervention (1988 1990) and post intervention (1991 1993) to identify all births perinatal neonatal and maternal deaths For every death (i e case) two controls randomly selected from the population of infants born during the same year and who survived for at least 28 days Pre test questionnaire administered to 287 mothers (or other family members when the mothers could not be located) at home (collected information on sociodemographic characteristics obstetric history and details regarding most recent childbirth) Same questionnaire administered to a different sample of women during the post intervention phase **SAMPLE** Pre intervention N=639 total births (i e controls + peri neonatal deaths) post intervention N=708 total births **INTERVENTION** Women were taught how to identify prioritize and solve their health problems during four educational sessions (three to four hours each) held in the community **RESULTS** Pre intervention peri neonatal mortality 130 0/1000 births This figure declined by 65% during the post intervention period Demographic characteristics of the women from each of the two study periods were analyzed to ascertain whether changes in the populations surveyed could explain improvements in perinatal mortality However no statistically significant changes were observed in maternal literacy language spoken or whether the house had a latrine or a dirt floor The authors report a statistically significant improvement in antenatal care utilization (49% pre intervention vs 64% post intervention) and a statistically significant decline in the percentage of births attended by TBAs (24 5% pre intervention vs 14 7% post intervention) No statistically significant differences in the timing of newborn care at delivery (coded as attended immediately vs attended after placenta delivery) were observed between the two study periods (65 8% pre intervention vs 59 4% post intervention) However a significant increase in the percentage of infants breastfed during the first year of life was observed (25 3% pre intervention vs 50 3% post intervention) **LIMITATIONS** No control *community* was selected therefore the degree to which changes in mortality may be attributed solely to the intervention (i e program impact) cannot be assessed In addition the authors did not disaggregate peri neonatal mortality into stillbirths early neonatal deaths and late neonatal deaths Methods used to identify/recruit women were not specified nor were specifics regarding the types of facilitators or educational techniques used

COUNTRY	SOURCE	SYNOPSIS OF THE INTERVENTION STUDY
Ec UADOR	Sloan NL et al (1994) *The Lancet* 344 782 785	**OBJECTIVE** To compare the effect of the Kangaroo Mother Method (KMM) with standard neonatal treatment on morbidity growth and cost of care for infants weighing less than 2000g at birth **STUDY DESIGN** (**time frame** between November 1991 and December 1992) Prospective randomized control trial in a hospital based population **SAMPLE** N=275 infants (experimental group n=128 control group n=147) Inclusion criteria singleton infant born at the Isidro Ayora Maternity Hospital with (1) birth weight less than 2000g (2) no serious congenital abnormalities or respiratory infectious or metabolic diseases (3) temperature between 36 5 and 37 0 degrees centigrade for the 24 hours prior to enrollment (4) acceptable tolerance of food and (5) stable weight (i e among infants with birth weights less than 1750 g no decrease in weight for at least 72 hours) Each infant (1) assigned to either the experimental (KMM) or control (standard incubator care) group using a simple random technique (2) followed up for sixth months **INTERVENTION** Hospital nurses provided basic training in the care of LBW infants for both study groups Mothers received instructions on basic hygiene and immediate notification of hospital staff if the infant exhibited breathing or feeding problems Mothers in the control group were instructed about the incubator or thermal crib proper breastfeeding techniques maintenance of warmth and how to arrange and maintain the infant s crib after hospital discharge Mothers in the KMM group also received breastfeeding counseling and were taught how to keep the infant close to their breast when feeding and sleeping The nursing staff repeated instructions and demonstrations to each group on selected weekdays Household visits were made when mothers did not bring the infants in for scheduled visits to determine vital status The nurse interviewer documented the infant s condition feeding practices and compliance with instructions at each follow up clinic visit Follow up visits also entailed clinical examinations and medical histories **RESULTS** Incidences of severe morbidities (in particular lower respiratory tract infections) were significantly lower in the KMM group compared to the control group Because exclusive breastfeeding was strongly promoted in both study groups no differences in infant feeding patterns were observed In addition there were no significant differences in growth indices Neonatal care costs were higher in the control group due to the use of incubators Costs associated with the KMM were related to the greater amount of time spent in the clinics Although KMM group consisted of women and infants of lower socioeconomic status the investigators noted no significant differences between the two study groups with respect to maternal health status Apgar scores and infant size at birth or gestation **LIMITATIONS** The investigators used an unconventional definition of low birth weight In addition they only assessed neonatal morbidity not mortality and only made comparisons between intervention and control groups not pre and post intervention

COUNTRY	SOURCE	SYNOPSIS OF THE INTERVENTION STUDY
INDIA	Kumar R (1994) *Transactions of the Royal Society of Tropical Medicine and Hygiene* 88 159 160	**OBJECTIVE** To assess the effect of a training program on the resuscitation practices of traditional birth attendants (TBAs) in Chandigarh India **STUDY DESIGN (time frame** 1989 1991) Study design not reported **SAMPLE** N=80 100 TBAs underwent training **INTERVENTION** The intervention entailed a continuing training program at four local villages for one day per month Training sessions covered resuscitation methods such as drainage of secretions physical stimulation by flicking at the soles of the feet cleaning the mouth by a finger wrapped in gauze mouth to mouth breathing cardiac massage and prevention of heat loss by wrapping the baby in multiple layers of cloth In addition 31 TBAs underwent advanced training in the use of the mucus extractor and bag and mask ventilation **EVALUATION METHODOLOGY** Two trained field workers made fortnightly visits to the villages and checked local vital registers to document births Interviews were conducted with family members and/or TBAs who assisted with the delivery and detailed verbatim birth histories were taken for stillborn and asphyxiated babies Fresh stillbirths and asphyxiated babies were diagnosed by a panel of experts that reviewed the birth histories During the 18 month study period TBAs assisted 93 7% (1 884 babies) deliveries with 30 resulting in fresh stillbirths and 31 in asphyxiated babies The author was unable to collect information on two of the stillbirths **FINDINGS** Traditional and modern resuscitation methods were used in 51% of cases modern methods only in 22% and traditional methods only in 3% No resuscitation effort was made in 24% of cases Twenty one cases were attended by TBAs who received advanced training and the bag and mask and mucus traps were used in 42 6% and 33 3% of cases respectively Warming of the placenta and the use of onion juice in the nose were more often performed among conventionally trained TBAs The author concludes that the training was effective in altering TBA practices **LIMITATIONS** The study groups were not clearly defined In addition information on TBA resuscitation practices was obtained from family members which may be subject to recall biases

COUNTRY	SOURCE	SYNOPSIS OF THE INTERVENTION STUDY
INDIA	Daga SR et al (1993) *Indian Journal of Pediatrics* 60 627 630	**OBJECTIVE** To assess the effectiveness of the anganwadi worker in bridging the gap between the *dai* and the health worker in rural India **STUDY DESIGN (time frame** 1988) Prospective study design Methodology unclear **SAMPLE** Unknown **INTERVENTION** Anganwadi workers received in service training at monthly meetings and practical instruction during field visits with emphasis on the prevention detection and treatment of hypothermia Specific duties included ensuring borderline LBW/preterm infants were kept warm at home and ensuring that very small infants were referred to the hospital **RESULTS** Survival of neonates/infants and overall MCH performance improved during the study period This effect was sustained two years post intervention Infant mortality decreased from 145 7 per 1000 in 1986 87 (pre intervention) to 45 1 per 1000 in 1990 91 Birth registration also improved during the study period In addition more beneficiaries for immunization were identified **LIMITATIONS** The study methodology is not well explained In addition the authors did not select intervention and control groups to assess program impact

COUNTRY	SOURCE	SYNOPSIS OF THE INTERVENTION STUDY
INDIA	Daga SR (1989) *Journal of Biosocial Science* (suppl 10) 127 136	**OBJECTIVE** To reduce neonatal mortality through the use of simple low cost interventions **STUDY DESIGN** Unknown (methodology not stated in article) **SAMPLE** Unknown [implemented at the neonatal intensive care unit at the Institute of Child Health (Bombay India)] **INTERVENTION** There were four main features of the intervention (1) provision of warmth through inexpensive room heaters (2) mother s milk as the sole source of nutrition (3) mother s participation in the care of the baby (4) minimal handling and minimal interventions (after initial stabilization of the sick infant) There were also six supportive aspects of care (a) establishment of a warm chain (starting from labor room) (b) stabilization of nursery admissions (c) establishment of perinatal audit sessions (d) development of management schedules for the common problems of respiratory distress asphyxia etc (e) teaching/training of staff nurses at neonatal unit and on the labor ward and (f) use of postnatal care ward as an intermediate care unit Babies of similar weight age and health problems were kept in the same cubicle Adequacy of temperature in the cubicle was assessed via rectal temperature and color/warmth of the sole of the foot **RESULTS** The author observed a highly significant decline between 1978 79 and 1980 in total and birth weight specific mortality (percent mortality for infants <1000g=84 6% in 1978 79 versus 50 0% in 1980 1000g 1250g= 71 4% in 1978 79 versus 62 5% in 1980 1260g 1500g=66 6% in 1978 79 versus 13 6% in 1980 1510g 2000g=6 9% in 1978 79 versus 6 0% in 1980 >2000g=4 5% in 1978 79 versus 8 4% in 1980) The author also notes that declines were particularly evident in mortality after the first 72 hours of life [Note however that percent mortality actually increased among infants in the highest birth weight category] Use of the mothers nursing skills allowed health personnel to attend to infants who required the most medical attention Nursery stay (in days) was reduced across all birth weight categories No new equipment instruments furniture or staff members were added and the intervention proposed in this article was cost effective **LIMITATIONS** The study methodology was unclear No comparison group was used to evaluate effect of intervention on neonatal survival Infant mortality not neonatal mortality indicators were presented

COUNTRY	SOURCE	SYNOPSIS OF THE INTERVENTION STUDY
INDIA	Agarwal A et al (1991) *Indian Journal of Medical Research* [B]94 277 280	**OBJECTIVE** To assess the impact of anaemia prophylaxis during pregnancy on maternal haemoglobin serum ferritin and infant birth weight **STUDY DESIGN (time frame** 1987 88) Quasi experimental study design (methodology is unclear) **SAMPLE** N=418 pregnant women at 16 24 weeks of gestation recruited from six subcentres of Baranasi district Three subcentres randomly designated as the study group remaining three assigned to the control group Comparability in terms of socioeconomic status (as measured by per capita income) parity status and age distribution between the two groups **INTERVENTION** Pregnant women received physical and anthropometric examinations to identify possible complications that may have a negative impact on pregnancy outcome In addition the women were subjected to blood tests in order to determine haemoglobin levels Women with levels <7 0 g/dl were treated and excluded from the study The study group received 60 mg iron supplements and 500 ug folic acid supplements (total number of tablets received 100 per woman over a 100 105 day period) on a daily basis **RESULTS** Baseline differences in haemoglobin and anthropometric measures between the study group and control group were not statistically significant However 100 day iron supplementation produced a highly significant increase in haemoglobin and serum ferritin levels Increased maternal haemoglobin and serum ferritin due to supplementation was associated with higher infant birth weight (2 88± 0 41 kg in study group vs 2 59 ± 0 34 kg among controls) **LIMITATIONS** Premature infants were excluded from the study despite their increased likelihood of mortality The authors did not investigate the impact of supplementation on mortality They also did not address the role of the increased medical surveillance during the antenatal period on the outcome of study participants

COUNTRY	SOURCE	SYNOPSIS OF THE INTERVENTION STUDY
MALAWI	Steketee RW et al (1996) *American Journal of Tropical Medicine and Hygiene* 55(1) 33 41	**OBJECTIVE** To compare the efficacy of two antimalarial drugs Chloroquine (CQ) and Mefloquine (MQ) in preventing LBW due to prematurity and IUGR **STUDY DESIGN (time frame** 1987 1990) Non randomized clinical trial **SAMPLE** N=1 766 live born singletons with known birth weight born to women enrolled at four antenatal clinics in central Mangochi District Malawi **INTERVENTION** During her first visit each woman was systematically assigned to one of four treatment regimens (1) CQ 25 mg over two days 30 mg weekly (2) CQ 25 mg over two days repeated every four weeks (3) CQ 300 mg weekly (4) MQ 750 mg as a single dose 250 mg weekly All women who made their first antenatal visit on the same day were assigned to the same prophylaxis regimen Each dose of the study medications was given either at the clinic or at home (if the woman missed her clinic visit) under the observation of study personnel Women were monitored during the last six weeks of their pregnancies **RESULTS** MQ was more effective in treating placental malaria infection than CQ (i e MQ prophylaxis demonstrated a statistically significant protective effect against LBW) particularly during high malaria transmission season This relationship persisted when controlling for parity infant sex HIV status and maternal weight Mean birth weight within the sample was 2 905 $\pm$ 461 g LBW incidence was 16 8% Thirty four percent of LBW infants were preterm LBW and 66% were IUGR LBW 6 9% of the entire sample were preterm and 82 6% of these preterm infants were of LBW The proportion of LBW was 12 5% among babies born to women on MQ compared to 15 5% among babies born to women on CQ Effective malaria prevention was associated with a 5 14% decrease in the risk of LBW and 30% reduction in preventable LBW Babies whose mothers had placental malaria were 1 7 times more likely to be LBW

COUNTRY	SOURCE	SYNOPSIS OF THE INTERVENTION STUDY
MEXICO (MEXICO CITY)	Coria Soto IL et al (1996) *International Journal for Quality in Health Care* 8(1) 13 28	**OBJECTIVE** To assess the effectiveness of antenatal care (ANC) in preventing IUGR and LBW due to preterm delivery (PD) in Mexico City **STUDY DESIGN (time frame** 1984) Hospital based case control study **SAMPLE** N=1 395 births (n=654 controls n=503 IUGR babies and n=238 LBW due to preterm delivery) **INTERVENTION** *NOTE No intervention was administered but this study was included to examine the potential effectiveness of ANC in the prevention of IUGR preterm delivery and ultimately perinatal mortality* Antenatal care was assessed for both its frequency and content **RESULTS** Women with an inadequate number of ANC visits had 63% greater odds of IUGR than women who received an adequate number of visits Content of ANC demonstrated no independent effect on IUGR prevention With respect to risk of preterm delivery poor content of ANC was associated with an almost two fold increase in risk With respect to frequency of visits 11% and 9% reductions were associated with an adequate number of ANC visits for IUGR and PD respectively 89% of the sample sought at least one antenatal consultation 75% of mothers received ANC that was deemed good in terms of content The authors also note that 18% of preterm births could be prevented through the implementation of the following six procedures during ANC visits (1) measurement of blood pressure (2) assessment of height (3) assessment of weight (4) urine samples (5) blood samples and (6) pelvic examination
SOUTH AFRICA	Ward HRG et al (1995) *South African Medical Journal* 85(3) 147 50	**OBJECTIVE** To evaluate the role of the Identification Cause and Avoidable Factor (ICA) Solution method of perinatal audit (a component of a perinatal mortality intervention in Port Elizabeth South Africa) **STUDY DESIGN (time frame** two years January 1991 through December 1992) Hospital based retrospective study (perinatal audit) **SAMPLE** N=11 660 deliveries in *year one* of the study N= 10 925 deliveries during *year two* of the study (n=1 060 perinatal deaths over the study period) Rural referrals not included in the sample **INTERVENTION** The intervention is not specified but the purpose of the article was to demonstrate that the perinatal audit identifies areas amenable to intervention which in turn may become targets of specific interventions **RESULTS** The major areas identified by the ICA method as possible targets of intervention were intrapartum asphyxia intrapartum trauma and infection (in particular syphilis) Appropriate intervention (not specified in the article) lowered the perinatal mortality rate by 23% This reduction was found to be statistically significant **LIMITATIONS** Although this study presents evidence that suggests that the ICA Solution method facilitates a reduction in perinatal mortality it does not identify the components of appropriate intervention In addition specifics regarding the audit are absent from the article and completeness of medical records was not assessed

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South Africa	Wilkinson D (1991) *South African Medical Journal* 79(4) 552 553	**OBJECTIVE** To present evidence for a reduction in avoidable perinatal deaths through the introduction of various intervention strategies **STUDY DESIGN (time frame** seven months in 1989) Institution based prospective study **SAMPLE** N=2 193 consecutive hospital/clinic births (n=90 perinatal deaths) **INTERVENTION** This article lacks an explicit discussion of the intervention However the authors report that strategies included development of a community obstetrics guide midwifery training in neonatal resuscitation proper procedures in blood collection and management of pregnancy complications such as anemia Perinatal audits were also employed in this study though specifics regarding this component are unclear **RESULTS** Perinatal mortality was reduced by approximately one third during the study period (from 60 per 1000 to 41 per 1000) **LIMITATIONS** The study methodology is not well explained The author also made no statement regarding whether reductions may be attributed to specific activities versus a constellation of services
Sudan	Ibrahim SA et al (1992) *International Journal of Gynecology and Obstetrics* 39 117 122	**OBJECTIVE** To assess the role of the village midwife in detecting high risk pregnancies and newborns (measured specifically in terms of impact on perinatal neonatal and maternal mortality) *[Village midwife a woman usually illiterate who is nominated by her community to receive specialized midwifery skills and attends midwifery school for one year to receive certification to practice domiciliary midwifery]* **STUDY DESIGN (time frame** 1985 1988) Community based prospective study **SAMPLE** N=6 275 deliveries monitored over a three year period **INTERVENTION** The main thrust of the intervention was to upgrade skills of village midwives via in service training (initiated during second year of the study) Other aspects of the intervention included establishment of weekly village midwife clinics establishment of a system of referral from the midwife to the rural/central hospital instruction in maternal and infant anthropometric measurement detection of anemia edema involvement of village midwives in immunization ORT and health education activities regular meetings with the research team (content of meetings not specified) Specifics regarding midwifery training are not stated in article **RESULTS** The authors observed a 25% reduction in poor pregnancy outcomes (e g late fetal deaths neonatal deaths abortion (not specified in article whether spontaneous or induced or both) in the third year of the study relative to first two years of the study and 28% of mothers who experienced a stillbirth or neonatal death also experienced adverse outcomes for the prior pregnancy **LIMITATIONS** The authors did not randomize subjects and no control group was selected As a result the degree to which reductions in perinatal mortality may be attributed solely to the intervention is questionable

COUNTRY	SOURCE	SYNOPSIS OF THE INTERVENTION STUDY
ZAMBIA	Hira SK et al (1990) *Genitourinary Medicine* *66* 159 164	**OBJECTIVE** To assess the effectiveness of new health education methods and prenatal syphilis screening in reducing adverse pregnancy outcomes More specifically (1) demonstrate new education methods eliciting antenatal (ANC) attendance by the 16th week of gestation among 75% of attenders (2) implement/evaluate prenatal syphilis screening by a) performing screening on all attenders at first visit and again during third trimester and b) effectively treating all seropositive women and their partners (3) demonstrate sustained improvements in pregnancy outcome (one year after program implementation) **STUDY DESIGN** (**time frame** intervention phase=February 1986 through January 1987) Institution-based two group pretest posttest study design Study group three periurban health centers in Lusaka (each with population N=20 000) Control group three comparable periurban health centers (all of comparable in size and socioeconomic status) **SAMPLE** Target population prenatal care attenders (During pre intervention phase 150 women from each of the six centres recruited when they presented for delivery at the University Teaching Hospital During the post intervention phase 806 women from the three study centres and 1 274 women from the three control centres recruited) **INTERVENTION** New methods of health education aimed at improving early attendance during pregnancy were directed at the three intervention sites On site syphilis screening was performed twice during pregnancy and all seroreactive women and their partners received treatment **RESULTS** Investigators observed an improvement in the percentage of ANC initiation before the 16th week of pregnancy (9 4% to 42 5%) though this improvement was far below the study objective of 75% Adverse pregnancy outcomes attributable to syphilis reduced to a rate of 28 3% in the intervention group compared with a rate of 72 4% for adverse outcomes at control centres (differences were highly statistically significant) Cost of prenatal screening= US$0 60 Cost of averting each adverse outcome= US$12