DETERMINANTS OF ADVERSE PREGNANCY OUTCOMES

A Case Study in Selected Rural Areas of West Java, Indonesia

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DECLARATION

Unless it is indicated otherwise, this thesis is my own original work.

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ABSTRACT

The study addresses the determinants of adverse pregnancy outcomes, especially neonatal deaths and stillbirths, in developing countries. The study is conducted in the Indramayu Regency of West Java Province, Indonesia. A wide range of quantitative and qualitative methods was employed to study this important public health issue.

Using community-based longitudinal data derived from the Indramayu Health and Family Planning Prospective Study and the MotherCare Study (1990 to 1993), a series of bivariate and multivariate analyses was conducted. It was found that the level of neonatal deaths and stillbirths in the study area was higher than the national average. Socio-demographic as well as bio-medical factors were significantly related to the high level of neonatal deaths and stillbirths. While school attendance had the direct effect of reducing the risk of stillbirth, teenage pregnancy increased the risk of neonatal death through the indirect effects of short pregnancy intervals and low birth weight.

Neither the maternal nutritional depletion theory, nor the excess of preterm deliveries in the short pregnancy interval group explained the mechanism through which a short pregnancy interval increased the risk of neonatal death. It is likely that an intra-familial mortality effect was the causal mechanism.

The findings suggest that efforts to alleviate the level of neonatal deaths and stillbirths should not only focus on medical initiatives but also on specific social interventions. Although extensive public health campaigns and the provision of adequate maternal and child health care are necessary, they alone are not sufficient. Social interventions designed to promote late marriage and delay of first birth through improving women's education are required to enhance medical efforts to reduce the high level of neonatal deaths and stillbirths in the study area or areas with similar conditions.

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ABBREVIATIONS AND GLOSSARY OF TERMS

ABBREVIATIONS:

Balita	(*Bawah lima tahun*) Under five years of age
HAI	(*Haid*) In menstrual period
IDHS	Indonesian Demographic and Health Survey
IUGR	Intrauterine growth retardation
LBW	Low birth weight
LMP	Last menstrual period
N/A	Not applicable
Polindes	(*Pondok Bersalin Desa*) Village-based maternity home
Posyandu	(*Pos Pelayanan Terpadu*) Integrated health service post
Puskesmas	(*Pusat Kesehatan Masyarakat*) Community health centre
Repelita	(*Rencana Pembangunan Lima Tahun*) Five-Year Development Plan
SRS	Survey Registration System
TAH	(*Tidak haid*) Not in menstrual period
TBA	Traditional birth attendant
TT	Tetanus toxoid immunization
WHO	World Health Organization

GLOSSARY OF TERMS:

Abruptio placentae: refers to the separation, prior to the onset of labour, of a normally situated placenta. Abruptio placentae may be associated with toxaemia, with such symptoms as haemorrhage and constant uterine contraction which is occasionally tetanic in nature.

Adverse pregnancy outcome: refers to an unfavourable pregnancy outcome that can occur to either the mother or the foetus.

Angka kematian balita: the under-five mortality rate. It is calculated as the number of deaths of infant and children under five years of age per thousand live births.

Antenatal period: refers to the period from the date of conception until just before the delivery.

Antenatal care (also called prenatal care): is a series of interventions provided to a pregnant woman during the course of her pregnancy with the goal of improving her chances of a favourable pregnancy outcome.

Bidan desa: village-based midwife.

Child mortality rate: the number of deaths of children aged 1 to 4 during a year per thousand survivors to age one.

Congenital anomaly: the intrauterine development of an organ or structure that is abnormal in form, structure or position.

Cord cutting instrument: an instrument used for cutting the umbilical cord. It includes both hygienic instruments, such as sterilized scissors, and unhygienic instruments, such as the use of bamboo.

Departemen Kesehatan R.I: Ministry of Health, Republic of Indonesia.

Dinas Kesehatan Kabupaten Indramayu: the Indramayu Regency Health Services.

Early neonatal death: the deaths of live born infants before seven days of infant life.

Foetal malpresentation: abnormal presentations of the foetus that occurred during delivery. These include breech, footling, transverse, sinciput, face, brow and any other presentations that were not vertex, occiput anterior, or occiput posterior.

Gestational age: the duration of gestation is measured from the first day of the last normal menstrual period (LMP) and is expressed in completed days or weeks.

Gestational bleeding: refers to vaginal bleeding that is experienced by a pregnant woman.

Infant cyanosis: refers to the blue colour due to lack of oxygen and excess of carbon dioxide in the blood. This symptom is also referred to as asphyxia. The Apgar score is often used to assess the degree of neonatal asphyxia.

Infant mortality: refers to the death of infants during the first year of life.

Infant mortality rate: the number of deaths of infants under age one per thousand live births during the year.

Inter-pregnancy interval: refers to the interval between the date of conception of the most recent pregnancy and the date of the termination of the preceding pregnancy.

Intrapartum period: refers to the period during labour and delivery.

Intra-Uterine Growth Retardation: refers to infants born at term, from 37 to 41 weeks of pregnancy, with a weight below 2500 grams.

Kader kesehatan: an outreach community health worker.

Kantor Statistik Kabupaten Indramayu: the Indramayu Regency Statistical Office.

Late neonatal death: the deaths of live born infants occurring after the first week of life but within one month of birth.

Live birth: any child who cried or breathed after birth, even if only for a few moments or hours.

Low birth weight: infants who weigh less than 2,500 grams at birth.

Neonatal death: deaths occurring in the first month after birth. It is the sum of early neonatal deaths and late neonatal deaths.

Neonatal asphyxia: see infant cyanosis.

Neonatal jaundice: refers to the yellow discolouration of body tissue and fluid by bile pigments. In normal circumstances, the jaundice colour will disappear as the liver function begins to eliminate it from the body. In some cases however, the jaundice can be due to other causes such as infection (infective jaundice) and obstructive jaundice.

Parity: the number of children ever born alive to a woman. By this definition, infants who died shortly after birth would be included.

Perinatal period: refers to the period from the sixth month of pregnancy to one month after childbirth.

Perinatal mortality rate: refers to the number of late foetal deaths (stillbirths) and early neonatal deaths, i.e. before day seven, per 1,000 total births.

Placenta previa: refers to implantation of the placenta in the lower uterine segment. It can also be described as placenta previa centralis, lateralis, marginalis, or partialis. Placenta previa presents to the mother and the foetus the risk of excessive blood loss and of premature caesarean delivery.

Post-term: refers to gestational age greater than 42 weeks.

Post-partum period: in this study, this period begins from the date of birth and continues until 42 days following birth.

Premature infants: those infants whose gestational age is less than 37 weeks.

Prematurity: is defined as birth below 37 weeks of gestation with a weight below 2500 grams.

Preterm: occurring before 37 weeks of pregnancy.

Primigravidae: women pregnant for the first time.

Stillbirth: a baby born after 28 weeks of gestation, which shows no heartbeat, respiration or movement at any time after delivery.

Undang-Undang Perkawinan: the Marriage Laws.

CHAPTER ONE

INTRODUCTION

Perinatal and infant mortality have long been used as indicators of health status and the level of care available to both mothers and babies. They have also been used as proxy measures of socio-economic development.

Despite the efforts that have been made in reducing the level of infant and perinatal death, these mortality rates in developing countries, including Indonesia, remain high. A number of studies have shown that stillbirth (late foetal death) accounts for half of all perinatal deaths. Similarly, neonatal deaths represent a large proportion of infant mortality (Bhatia, 1989; Khorshed et al., 1990). Considering the magnitude of the proportion of neonatal deaths in infant mortality, and the use of stillbirth and neonatal deaths as indicators of the effectiveness of maternal and child health programmes, it is important to understand the factors associated with these deaths.

The risk approach used in maternal and child health services has played an important role in reducing adverse pregnancy outcomes, such as perinatal morbidity and mortality in many countries (WHO, 1978:14-7). The risk approach is basically a managerial tool to assist with a flexible and rational distribution of available resources, based on measurements of both individual and community risk. A pilot study of risk approach in perinatal health in Shunyi County in China revealed that it significantly reduced the level of perinatal mortality (Ying Yan et al., 1989:4).

A risk approach strategy has also been adopted by maternal and health services in Indonesia. However, an overall review of the results of this strategy in terms of an improved problem-solving capacity within the health services has not yet been undertaken (Alisjahbana, 1988:81). The high rates of perinatal mortality in Indonesia suggest that improvements in the adaptation of the risk approach to local conditions in maternal and child health services are needed.

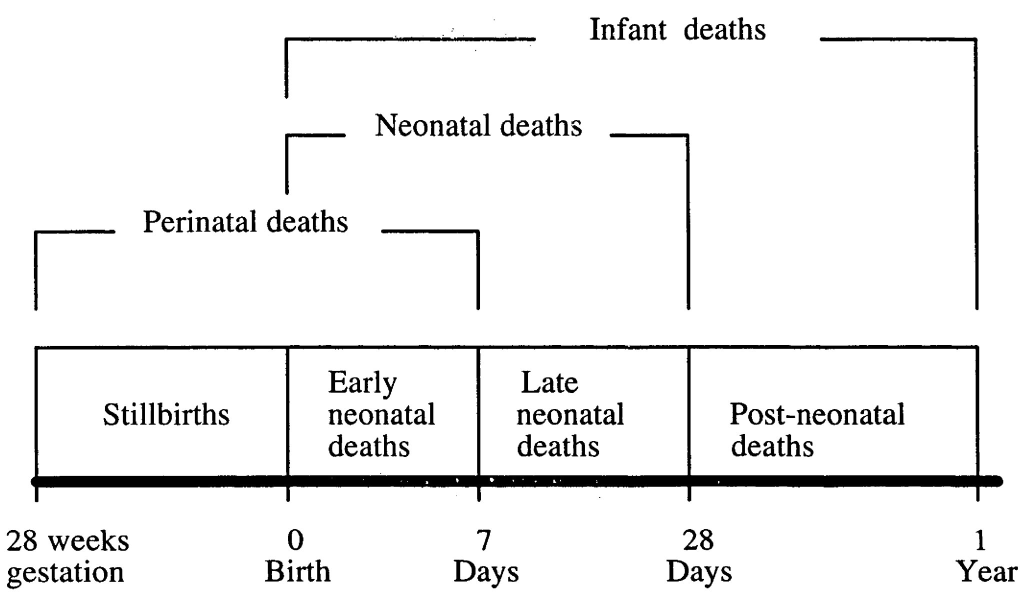
A determination of risk factors and their frequency in each setting is required in order to develop an appropriate response that does not impose an unnecessary burden on the health system. The identification of these factors thus constitutes an initial step in applying the risk approach to the delivery of perinatal health services. Such information can contribute to improving local strategies and determining appropriate maternal and child health services.

The present study aims to provide more information about the determinants of adverse pregnancy outcome, especially in relation to the components of perinatal mortality: stillbirth and neonatal death. The inclusion of socio-demographic as well as bio-medical factors in the analysis allows an examination of the relative contribution of each factor in predicting the outcome. The study will provide useful information for planners in their efforts to reduce the high level of perinatal mortality in developing countries, and particularly in West Java, Indonesia, where the data was collected.

In order to orientate the reader towards the aims of the study, the outcome variables are described briefly. The term *perinatal* denotes the period surrounding the time of birth and is defined as starting from about twenty eight weeks of gestational age (with a birth weight of at least 1,000 grams) and ending seven days after birth (Monterroso and Koblinsky, 1990:1). Therefore, *perinatal mortality* includes both stillbirth (late foetal death) and early neonatal death. The focus of the present study is not on perinatal mortality as a whole but rather on its components, stillbirth and early neonatal death. As will be explained in Chapter Two, by definition only early neonatal deaths, those occurring during the first week of life, should be included in the calculation of perinatal death. Late neonatal deaths, those occurring after the first week of life but within one month of birth, would be excluded. However, due to the small number of cases, late neonatal death was included in the analysis, and it was combined with the early neonatal death into neonatal death.

Stillbirth refers to death occurring in foetuses (intrauterine) of gestational age of 28 weeks or more, while *neonatal death* pertains to the death of a live-born baby who dies within 28 days of birth. Thus, neonatal death covers both early and late neonatal deaths. Figure 1 depicts a time-line chart showing the age groups associated with each type of death.

Figure 1. Time-Line Chart of Stillbirths and Infant Deaths



This chapter describes the background to the study, its aims, the conceptual framework adopted, and a review of relevant literature.

1.1 Background

Pregnancy and childbirth usually bring great happiness to a woman and her family, when the outcome of the delivery is a healthy mother and infant. However, in some cases pregnancy may have a bad outcome because pregnancy and childbirth carry certain risks to both the mother and baby. These include the possibility of serious obstetric problems that may even result in the death of the mother and/or the baby.

The level of perinatal death, that is deaths associated with pregnancy, is often used as an indication of the extent of pregnancy wastage and the accessibility to adequate health care by the mother and her newborn child. The perinatal mortality rate in Indonesia is high, even by regional standards. A study of perinatal mortality and morbidity in South-East Asia between 1976 and 1978 indicated that the level of perinatal mortality in Indonesia was 45.0 per 1,000 births, slightly lower than in India but higher than in Thailand (WHO, 1984:66).

Based on studies conducted in the United States population, it was observed that, historically, the rate of neonatal death was higher than the rate of stillbirth. However, in 1978 it was observed that the relation had reversed, and stillbirth rates have exceeded neonatal death ever since (The US National Center for Health Statistics 1988 cited in Little and Weinberg, 1993:1188). The relative contribution of neonatal deaths and stillbirths to perinatal mortality has been found to vary, both in other countries and within Indonesia. A perinatal mortality study conducted in seven rural areas of Indonesia between 1990 and 1991 found that the highest level of perinatal mortality occurred in Bali, Yogyakarta, and Aceh, 35.6, 35.4, and 34.8 per 1,000 births respectively. In Aceh the high rate was due mainly to early neonatal death, while in Bali and Yogyakarta it was due to the high proportion of stillbirths (Alisjahbana, 1994:22). As will be further described in Chapter Three, the level of stillbirth in the Indramayu study was considerably higher than the national average. These findings suggest the need to study the role and causes of stillbirth more thoroughly.

Neonatal deaths, comprising both early and late neonatal deaths, are known to represent a large proportion of infant mortality. In developing countries, it has been estimated that neonatal deaths account for 50 to 60 per cent of all deaths during infancy (Perera 1983 cited in Bhatia, 1989:136). In Indonesia, the level of foetal and neonatal deaths remained constant despite a rapid decline in infant mortality during the period of 1980-1985 (Budiarso, 1988:93). The most common health initiatives directed toward reducing the high level of infant mortality have focused on diarrhoeal and immunizable diseases. In the development literature, these initiatives are popularly described as the GOBI (growth monitoring, oral rehydration therapy, breast-feeding promotion, and immunizations) strategy. UNICEF has estimated that infant mortality rates could be reduced by five per cent annually by using this approach (Bhatia, 1989:136). However, a study on the role of immunization in the reduction of infant and child mortality in

Bangladesh found that, while the immunization program had reduced mortality significantly during the ages one to four years, it had little impact in reducing infant mortality (Koenig et al., 1991:101). Given the different nature of the causes of neonatal deaths and deaths during later infancy (post-neonatal death), it is not surprising that the GOBI strategy has had little effect on infant mortality, especially the neonatal component. This suggests that program strategies should take into account the relative contributions of each of the components of infant deaths. Thus, in order to accelerate efforts to reduce the level of infant mortality in Indonesia, it is important to study the determinants of neonatal death in more detail.

Some studies have found that certain bio-medical, socio-economic and demographic factors are associated with perinatal death. These include socio-economic background, obstetrical and gynaecological history, nutritional status, complications during pregnancy and child birth, and poor accessibility to prenatal health services (WHO, 1984:69; Bakketeig et al., 1984:99-140). Other studies have found that gestational age together with birth weight serves as a powerful predictor of perinatal survival (Wilcox and Skjaerven, 1992; Golding and Shenton, 1990).

Studies of the links between birth spacing and infant mortality (including neonatal death) have generally arrived at the same conclusion, that short birth intervals increase the risk of death and illness among infants and older children (Cleland and Sathar, 1984:413; Hobcraft et al., 1985:370). The assessment of birth-spacing effects on child survival may be confounded by a variety of factors, including prematurity, breast-feeding patterns, preceding child mortality, poor parenting skills, and socio-economic status (Miller et al., 1992:305).

Where gestational age data is available, the assessment of 'spacing effects' is usually carried out using the inter-pregnancy interval rather than the birth interval. However, inaccurate gestational age data will produce an inverse relationship between the inter-pregnancy interval and the length of gestation. It is also possible that short inter-pregnancy intervals will be linked with longer gestations, and conversely (Miller, 1994:361).

It is generally accepted that pregnancy is assumed to begin at the date of the woman's last normal menstrual period (LMP). The duration of gestation is measured from the first day of the last normal menstrual period and is expressed in completed days or weeks (WHO ICD 9, 1977:764). This measurement of gestational age is usually problematic, particularly in developing countries where women often do not obtain antenatal care until late in pregnancy, and their recall period is long. Often, the LMP date may not be recorded at all (Miller, 1994:360).

The accuracy of LMP data can be verified by several methods, such as the use of ultrasound estimates of foetal size or physical and neurological examination of the newborn baby (Lubchenco, 1976:9). However, such methods are not available to pregnant women in rural communities in Indonesia, and, even if they were, they would be very expensive. It was therefore necessary to devise a means of verifying the quality of gestational age data, appropriate to the particular community setting of this study.

Studies have found that some socio-demographic background variables and use of health services factors are important predictors of perinatal mortality. Depending on their objectives, some studies have suggested that the provision of obstetric emergency services is more effective than socio-economic initiatives in reducing perinatal mortality (Edouard, 1990:3; Costello, 1993:1-2). Although the clinical dimension is important, the socio-demographic environment is also important. Some of the leading causes (intervening variables) of mortality are highly correlated with socio-demographic antecedents, and the use of available health services is influenced by user characteristics.

One study in the United States compared the relative strength of the association of a set of structural (social, economic, and political) variables and a set of health services variables with state-level infant, neonatal, and post-neonatal mortality. After controlling for the effects of the health services variables, structural factors remained significantly associated with infant mortality (Bird and Bauman, 1995:28). This finding indicates that the relationship between structural variables and infant mortality is not entirely explained by health service variables. It also implies that initiatives directly affecting structural or other mediating variables, other than health services, may be required to achieve adequate reductions in the level of infant mortality. Some pregnancy complications contributing to perinatal mortality are associated with socio-demographic antecedents. If these socio-demographic risk factors can be identified and modified to promote the health of the mother and her foetus, then scarce maternal and child health resources can be more appropriately allocated. Pregnancy wastage can also be prevented at the same time.

Few perinatal mortality studies have been conducted in developing countries, most having been carried out in developed countries, where they are usually conducted in hospital settings. Thus the results do not necessarily reflect the true situation at the community level, particularly rural communities in developing countries.

So far, most initiatives designed to reduce perinatal mortality have been focussing on medical interventions, and research on this area has also been dominated by medical models which emphasized the importance of biological causes (Popkin et al., 1993:359). Using this approach, it leaves the problems associated with socio-demographic determinants of perinatal mortality intact. Similarly, few studies conducted in developing countries take into account the confounding effect of prematurity when assessing the relationship between birth-spacing and infant mortality. This is largely due to a lack of appropriate data on gestational age (Miller et al., 1992:305).

The present community-based study focuses on adverse pregnancy outcomes, particularly in relation to stillbirth and neonatal death. The purpose of this study is to shed more light on the role that some major socio-demographic variables, reproductive history, pregnancy care behaviour and other factors may play in predicting the occurrence of the outcome variables. The inclusion of socio-demographic factors, together with some bio-medical factors in the analysis enables an examination of the net effects of socio-demographic variables on perinatal mortality in the presence of other potential risk factors.

The study examines separately factors which may be associated with the occurrence of stillbirth and neonatal death. The separation of late foetal death (stillbirth) and early neonatal death makes it possible to examine the relative contribution of each to variations in the total. As explained, due to the small number of cases, late neonatal death was included in the analysis, and it was combined with the early neonatal death into neonatal death.

Following identification of the immediate predictors of the outcome variables, an exploratory analysis of the determinants of the prominent intervening variables is then carried out. This analysis aims to provide an understanding of how the background variables affect the outcome variables through intervening variables. The use of a prospective design facilitates an examination of factors both before and during pregnancy periods that may influence the occurrence of adverse pregnancy outcomes.

Particular attention is given to the validation of the gestational age data which was measured from the date of last menstruation period. This is to improve the accuracy of the assessment of spacing effects using the inter-pregnancy interval. The study develops a special method for validating the gestational age data that is thought to be particularly applicable to community settings, where more sophisticated techniques, such as ultrasound estimates, are unavailable or too expensive.

1.2 Aims and Research Questions

Aims of the study.

The general aim of the study is to provide information about risk factors for stillbirth and neonatal death. Such information would be useful for developing appropriate strategies to improve the delivery of maternal and child health, particularly in community-based settings. Specifically, the study aims to:

a. develop an appropriate method for validating the quality of gestational age and birth weight data;

b. investigate the factors that are associated with stillbirth and neonatal death at each period of pregnancy and over the whole duration of pregnancy;

c. assess the relationships between some maternal background factors and the intervening variables, and

d. identify inconclusive findings that need further study.

Research questions.

This study is more concerned with exploration than verification. Therefore, instead of formulating clear-cut hypotheses, a number of research questions will be considered. Answers to these questions will contribute to efforts to reduce the incidence of stillbirth and neonatal death. The following questions are under investigation:

a. What are the levels of stillbirth and neonatal death in the study area compared to those in other areas of Indonesia?

b. Does the quality of gestational age and birth weight data require validation? If so, what is the appropriate validation procedure?

c. What are the important determinants of stillbirth and neonatal death at each period of pregnancy and over the entire period of pregnancy?

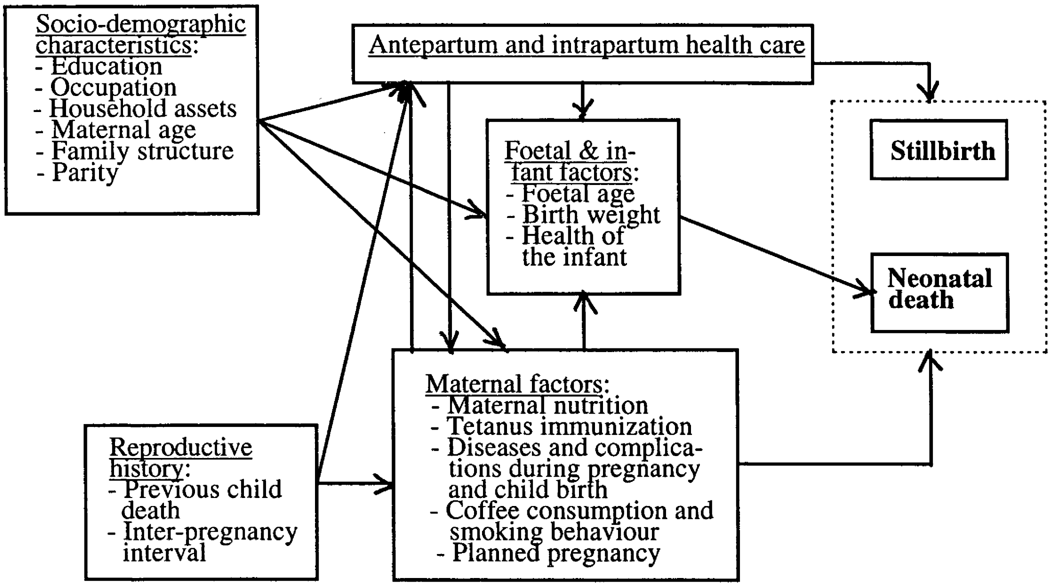
d. Are the relationships between the determinants of stillbirth and neonatal death confounded by certain selected potential confounders?

e. How does maternal socio-demographic background affect stillbirth and neonatal death through certain mediating variables?

1.3 Conceptual Framework and Literature Review

The framework in figure 2, adapted from Buetow's, and the World Health Organization's framework for the study of the risk factors of perinatal mortality, simplifies the complex interaction through which some proximate factors determine the occurrence of adverse pregnancy outcomes in the context of developing countries (Buetow, 1990:62; WHO, 1978:16).

Figure 2 A Conceptual Framework for the Study of the Determinants of Stillbirth and Neonatal Death.



As will be further explained in Chapter Two, the term *adverse pregnancy outcome* refers to an unfavourable pregnancy outcome that can occur to either the mother or the foetus. This includes stillbirth and neonatal death.

In the conceptual model, the occurrence of stillbirth and neonatal death are shown to be the result of the direct and indirect effects of five groups of proximate factors. Socio-demographic factors together with past reproductive history are assumed to affect the outcome variable indirectly through interactions with three other groups of factors. Foetal and infant factors are simplified to become an intervening variable through which four other proximate factors, including socio-demographic characteristics, influence the outcome variable.

As the study could not cover the whole range of factors potentially responsible for the occurrence of the outcome variables, the following literature review focuses on the role of the selected explanatory variables in predicting the occurrence of the outcome variables, stillbirth and neonatal death. These include certain socio-demographic characteristics, reproductive history, maternal factors, antepartum and intrapartum health care, and foetal and infant factors.

In the present study which uses data from the Indramayu Health and Family Planning Prospective Study, information was not collected about specific causes of stillbirth and neonatal deaths. A perinatal morbidity and mortality study conducted in 1978 in South-East Asia, including Indonesia, revealed that the most frequent causes of perinatal death were prematurity, birth asphyxia, infection, birth injury, cerebral haemorrhage, congenital malformation, feeding problems, and other respiratory conditions (WHO, 1984:69).

Socio-economic characteristics.

Other research has indicated that both the community and family levels of socio-economic status influence infant mortality, including perinatal mortality. This present study emphasis only the role of familial socio-economic characteristics in influencing the occurrence of stillbirth and neonatal death.

(1) Education

Education is a socio-economic characteristic that can exert an environmental influence on infant mortality rates. Some studies conducted in developing countries have found a consistent inverse relationship between the educational level of the mother and infant mortality (Caldwell et al., 1983:198; Caldwell, 1986:204).

A similar inverse association was also observed between education of the mother and the rate of neonatal mortality (Badari et al., 1991:99). On the other hand, a study conducted in 1982 in rural Thailand found that social differentials (including maternal education) in infant survival result in differences in post-neonatal rather than neonatal mortality. The authors further commented that this finding was generally consistent with the demographic assumption that post-neonatal mortality is more the result of the infant's environment rather than innate biological factors (Frenzen and Hogan, 1982:400).

There are a number of theoretical pathways through which maternal education may influence child and infant survival. These are largely indirect. For example, educated women have been found to make greater use of health services for themselves and their children. Multivariate analysis of data from several Demographic and Health Surveys suggested that the better survival prospects of children of better-educated mothers is mediated through better prenatal care, having completed tetanus-toxoid immunization during pregnancy and to have their deliveries attended by trained personnel (Hobcraft, 1993:172). A similar finding was also observed in a study conducted in Peru in 1986 (Elo, 1992:62). In general, these suggest that maternal education has a positive influence on the use of health-care services.

The effect of education on infant mortality may also be the result of interactive effects with other socio-economic factors. For example, higher educational attainment may be associated with higher income. Thus, a baby born to a better educated mother may also benefit from better living and nutritional conditions and greater access to efficient health care (Guzman, 1989:138).

Another socio-economic factor additively correlated with maternal education is the provision of health services. Caldwell, in a re-analysis of data from two Nigerian villages, found that the change in infant and child mortality was 20 per cent when the only intervention was easy access to adequate health facilities for illiterate mothers, 33 per cent when education was a factor without health facilities, and 87 per cent when both were available (Caldwell, 1986:204). This finding may suggest that education enhances the optimum use of health services.

(2) Occupational and household assets

In this study, occupational and household assets are used as proxy indicators of household income. Although many factors contribute to better access to prenatal health care and maternal nutrition, it is hypothesized that better income will lead to better access to prenatal health care and good nutrition. This hypothesis is well supported in the literature. A study of infant mortality conducted in Boston found an inverse relationship with income when neonatal mortality was stratified by income group. Neonatal mortality in the most affluent group was 42.5 per cent lower than that in the poorest group (Andrenyak, 1989:25).

(3) Maternal age

Maternal age is also associated with infant mortality. Teenage pregnancy and pregnancy among older women have been found to be associated with an increased risk of infant and perinatal mortality (Andrenyak, 1989:20; Naeye and Tafari, 1983:213; Bakketeig et al., 1984:127).

Teenage pregnancy seems to be associated with high perinatal risk mediated through low birth weight and preterm delivery (Kline et al., 1989:277). Similar findings were also observed in other studies conducted in South America, Canada, the United States, England and Wales. In these studies a higher risk of neonatal and infant mortality occurred in babies born to mothers under the age of 20 or over 30 (Ransome-Kuti, 1983:55).

A study of the determinants of preterm delivery and intrauterine growth retardation in North-East Brazil revealed that, along with other factors, a maternal age of less than 20 years was significantly related to preterm delivery (Ferraz et al., 1990:105).

Both biological and social hypotheses relate pregnancy in young women with adverse pregnancy outcomes. The biological hypothesis points to the immaturity of the pelvic opening as an obstacle to childbirth. However, a study conducted by Leppert et al. (1985:626) found that adolescents were actually at a lower risk of having cephalopelvic disproportion as an indicator for a caesarean section when one was necessary.

Adolescent pregnancy is subject to nutritional deficiency due to biological causes. The nutrition of a very young pregnant woman must provide for the demands of both the growth of the foetus and herself. If the total energy need is not met, the foetus may suffer from intra-uterine growth retardation (Kline et al., 1989:277). The effect of insufficient nutrition is stronger in late pregnancy when most foetal weight gain normally occurs (Miller, 1989:240). However, a study of reproductive risks for teenagers concluded that none of the study factors provided strong evidence of biological effects peculiar to youth (Strobino 1987 cited in Kline et al., 1989:278). Some authors believe that the effect of young maternal age is not due to biological disadvantage but rather is the result of socio-economic factors (Andrenyak, 1989:20).

Young age can be used as a proxy for other factors that influence pregnancy outcomes. Pregnant adolescents tend to have a lower socio-economic status and often do not receive adequate antenatal care. After controlling for the effects of maternal socio-economic background and adequacy of antenatal care, pregnant adolescents do not have a greater physiological risk than older women with similar socio-economic characteristics (Geronimus, 1986:1420).

A population-based study, conducted in the United States between 1980 and 1984, examined the relationship between maternal age and the incidence of low birth weight at term, and found that while the unadjusted odds ratios of maternal age to the risk of term low birth weight decreased with advancing maternal age, the adjusted odds ratios increased. This indicates the presence of a clustering of known risk factors for term low birth weight in teenage mothers which confound the association between maternal age and the risk for term low birth weight (Lee et al., 1988:86). However, as noted by the authors, this study lacked controls for other factors known to be associated with intrauterine growth retardation such as maternal poor nutrition and pregnancy complications. In addition, the tendency for teenage mothers to report imprecise gestational age may also distort the classification of pregnancy at term.

While the effect of teenage pregnancy seems to operate on the increased risk of perinatal death through socio-economic disadvantage, the effect of older pregnancy especially in women aged above 35 years is mediated through biological mechanisms. A study using data from the Collaborative Perinatal Project conducted in a selected United States population indicated that the perinatal mortality rate progressively increased from 25 per 1000 births at maternal age ages 17 to 19 years to 69 per 1000 births for women aged 40 and above (Naeye and Tafari, 1983:213). The study found that older mothers were more often hypertensive than younger mothers. Ninety-two per cent of the perinatal mortality increase was due to stillbirths attributed to maternal factors rather than foetal abnormalities.

Another pregnancy complication related to advancing maternal age is low uteroplacental blood flow. This contributes to the occurrence of placental growth retardation, abruptio placentae, and placenta praevia (Naeye and Tafari, 1983:215). As a result of this complication, the birth weight of full term infants decreased, without a matching decrease in birth length or head circumference.

(4) Parity

Studies that relate parity and perinatal mortality are usually conducted cross-sectionally. The U-shaped parity and perinatal mortality relationship reveals higher mortality for first births, lower mortality for second births, and increasing mortality for third and subsequent births (Bakketeig et al.,1984:125). However, this pattern is subject to bias due to pooling across sibships. Perinatal mortality is lower for second births compared with subsequent births in this cross-sectional analysis, largely due to the dominant contribution to second births made by women having only two births. These women have lower overall perinatal mortality rates. The higher mortality of third or fourth births is due to women who have larger sibships and who also have higher perinatal mortality rates.

A similar study conducted the analysis longitudinally, reducing the bias introduced by the cross-sectional approach. However, this is still subject to bias due to self-selection, whereby mothers who experience perinatal death tend to have larger sibships to replace infants lost in the adverse outcome. Conversely, mothers tend to stop childbearing after a successful pregnancy outcome. In a longitudinal study over a short period of observation, results based on currently attained sibship size may not reflect the results that would be obtained based on completed sibship size. By contrast, a longitudinal study over a longer time span is more likely to be affected by secular trends in perinatal mortality rates. In summary, both cross-sectional and longitudinal designs are subject to bias. It has been suggested that births within larger sibships are more likely to have higher overall perinatal mortality rates, and that perinatal mortality decreases with increasing parity within each sibship group (Bakketeig et al., 1984:127).

The effect of parity on infant mortality is often examined simultaneously with other demographic factors such as maternal age. Perinatal mortality usually increases with maternal age for a given parity. A community-based study on perinatal mortality conducted in Bangladesh found that perinatal mortality follows an asymmetrical U-shaped relationship when maternal age increases, as well as when gravidity (parity) increases (Fauveau et al., 1990:609). The combinations of 'age-gravidity' which correspond to the lowest risk are: for second or third pregnancy at ages 20 to 24, fourth or fifth pregnancy at ages 25 to 29 and sixth or seventh pregnancy at ages 30 to 34 (Fauveau et al., 1990:608).

(5) Inter-pregnancy interval

The term inter-pregnancy interval refers to the interval between the date of conception of the most recent pregnancy and the date of termination of the preceding pregnancy. This variable is used to assess the 'birth spacing effect' on infant mortality when gestational age data is available.

Most studies of spacing effects have shown that a short birth interval has a deleterious effect on the survival of the infant, and the effect is greatest during the neonatal period. For example, a study conducted in Bangladesh revealed that the death rate during the first month of life was lowest when the interval of the last pregnancy was between 12 to 24 months (Swenson, 1981:301). Hull and Gubhaju (1986:117), in their multivariate analysis of infant and child mortality in Java and Bali found that in the period of 1962-71 the most important determinants of the differences in infant and child mortality was the length of the preceding birth interval. The higher risks were observed for the mothers with birth interval of less than 18 months.

Various theories have been developed to explain the mechanisms through which short birth interval affects infant and child survival. These include maternal depletion, sibling competition, and the increased risk of infectious disease transmission. Women with a short birth interval tend to have insufficient time to restore their nutritional reserves for the demands of pregnancy and lactation, which is thought to affect foetal growth. The sibling competition theory asserts that the newborn baby has to compete with another young sibling for scarce household resources and the mother's care. The infectious disease theory maintains that even though the short birth interval has no direct effect on disease transmission, close contact between the older sibling and the younger child facilitates disease transmission, placing the younger child at greater risk of becoming ill more frequently (Boerma and Bicego, 1992:243-245).

The three hypothesized mechanisms through which birth-spacing affects mortality operate only when the preceding sibling survives. The maternal depletion effect would be weaker if the preceding child died because the physiological demands of lactation would be removed after the sibling's death. Similarly, the sibling competition and disease-transmission effects would disappear if the preceding child died. An analysis of birth-spacing effects on child survival using data from 17 Demographic and Health Surveys found that, after controlling for the survival status of the preceding child, there was no increase in the effect of short intervals on mortality when the previous child was still alive. This does not suggest that sibling competition has no effect, but indicates that the effects of higher intrafamilial mortality risks are stronger than the effects of sibling competition (Boerma and Bicego, 1992:253).

Using data from Mexico collected between 1986 and 1988, Gribble (1993:145) examined the relationship between birth interval and birth weight, taking into account the role of gestational age as a potential confounder. He found that the relationship between short birth interval and low birth weight was not confounded by gestational age. Hence the finding provides little support for the maternal depletion theory that explains the way the short birth interval affects low birth weight. The author suggested that, although gestational age may be a confounding factor in developed countries, it may have no effect in developing countries.

However, Gribble's finding has been strongly disputed by Miller (1994:362); a heated debate surrounds Gribble's conclusion that there was no excess of pre-term births among very short birth intervals. Miller commented that, in view of this, it was not surprising that gestational age did not confound the relationship between birth interval and low birth weight. Using vital registration data from Hungary and Sweden, Miller showed that short birth intervals included an excess of infants of short gestational age. Therefore, the higher mortality rates observed for this group were at least partially attributable to prematurity, rather than to short birth interval *per se*. Miller argued that the lack of convincing evidence of the quality of the gestational age data used in Gribble's study may be responsible for the difference in its findings.

The foregoing discussion suggests that the use of valid gestational age data is very important in obtaining valid estimates of the role of birth weight and birth interval in affecting pregnancy outcomes.

(6) Family structure

The family is the primary agency for protecting and maintaining the health of its members. The role structure of family life contributes to varied patterns of variations in health care practices among members. An individual person's distinctive role obligations within the family may influence his or her behaviours concerning sickness (Pratt, 1976:24-25).

Decisions about seeking health treatment are usually largely negotiated within the family. As the background of families differ, each family develops its own characteristic pattern of health care practices. In an area where extended families are common, decisions concerning health care practices in those families may differ systematically from those made in nuclear families. The role that family structure plays in affecting the occurrence of adverse pregnancy outcome is examined in this study.

Reproductive History.

In this study, due to data limitations, only history of previous child death and previous pregnancy loss are included in the analysis as a proxy for reproductive history.

As mentioned, the survival of an older sibling modifies the birth-spacing effect on the next child's mortality. A perinatal study of 107,495 mothers conducted in Norway from 1967 to 1976 found that mothers experiencing a perinatal death at the first birth had a relative risk for a subsequent perinatal death of 4.5. In addition, the risk of perinatal death further increased if the mothers had two previous perinatal deaths (Bakketeig et al., 1984:130).

A study in Matlab, Bangladesh, of the confounding effect of a sibling's neonatal mortality risks on birth spacing found that the neonatal deaths of siblings were associated. The association was stronger for pairs of immediate siblings than for those farther apart (Zenger, 1993:486). This suggests that family mortality effects may be an important predictor of the survival of the index child. A study of the risk factors for infant mortality in nineteenth-century Sweden similarly found that family-level mortality experience was the single most powerful predictor of infant mortality. The study suggested that the probability of an infant dying was not only related to the mortality of the immediately preceding sibling, but for higher-order index-children as well (Lynch and Greenhouse, 1994:129).

Biological characteristics, genetic factors, and the family environment are among the factors that contribute to family mortality effects (Zenger, 1993; Lynch and Greenhouse, 1994; Madise and Diamond, 1995). Therefore, in studying the determinants of infant mortality, particularly the role of birth-spacing, previous child mortality and previous pregnancy loss should be taken into account.

Maternal Factors.

The maternal factors covered in this study include maternal nutrition, maternal tetanus immunization, disease during pregnancy and complications at delivery, coffee consumption and smoking behaviour, and pregnancy care behaviour. A description of each of these factors follows.

(1). Maternal nutrition

Maternal nutrition both before and during pregnancy is known to affect pregnancy outcome (Bendich and Keen, 1993; Anderson and Krasovec, 1991:1). Weight gain, which reflects maternal nutrition during pregnancy, has been recognized as an important predictor of pregnancy outcome. In their study in a Filipino population, Siega-Riz and Adair (1993:364) found that higher total weight gain correlated with longer gestational duration, lower prepregnancy body mass index, a longer pregnancy interval, taller maternal stature, and relatively high dietary energy intakes.

An assessment of numerous studies conducted between 1970 and 1984 found a causal effect of weight gain on intrauterine growth retardation (IUGR) (Kramer, 1987a:693). Many studies have also found that weight gain during pregnancy affects foetal, perinatal, and neonatal mortality. A report on the United States Collaborative Perinatal Project based on follow-up observations of 55,000 pregnancies between 1959 and 1966 showed that optimal weight gains were different for women who began pregnancy at different weight-for-height levels. The lowest perinatal mortality rate was observed among underweight women who attained weight gains between 12.3 and 13.6 kg (Naeye, 1979:5).

Although numerous studies have shown a significant association between maternal nutrition and pregnancy outcome, a recent study assessing the effect of maternal nutrition on spontaneous preterm birth found otherwise (Kramer et al., 1992:574). It suggested that previous studies which found a significant association between maternal nutrition and preterm birth were methodologically flawed. The shortcomings included the use of total gestational weight gain rather than net rate of gain in maternal tissue, and the use of unreliable gestational age data in defining preterm birth. The latter problem leads to potential misclassification of some growth-retarded infants as preterm and vice versa. Apart from the debate concerning the usefulness of maternal nutritional status as an important predictor of adverse pregnancy outcome, particularly preterm birth, it was suggested that the findings based on studies in developed countries may not be representative for developing countries.

In the present study total pregnancy weight gain and rate of weight gain were initially used as predictors for an adverse pregnancy outcome. However, because most of the pregnancies in the study area were detected only at four months or more of gestational age, the measured pre-pregnancy weight was not thought to reflect the actual pre-pregnancy weight. Therefore, maternal height and mid-arm circumference were used as proxy measures of maternal nutrition, particularly at the beginning of pregnancy.

Maternal anthropometry such as weight gain is not the only indicator of improvement in nutritional status of pregnant women. Deficiencies in some nutrients, especially iron and folate deficiencies and also iodine deficiency, may increase the risk of adverse pregnancy outcomes. Nutritional anaemia would also be included as one of factors in assessing the effects of maternal nutrition on the adverse pregnancy outcomes.

(a). Maternal height

Maternal height is an anthropometric measure that has been used to assess the risk of low birth weight, perinatal and infant mortality, and the duration of lactation. In addition to its usefulness in predicting the risk of a woman developing an adverse infant outcome, maternal height is also accepted as a clinical indicator for the risk of obstetric complications, including cephalopelvic disproportion and prolonged labour (Krasovec, 1991:93).

Some studies have found that height does not have a direct effect on birth weight but that its effect is mediated through maternal weight (Krasovec, 1991:94). However, others have found that maternal height has an independent effect on pregnancy outcomes, such as birth weight. Studies conducted elsewhere found that, after controlling for other factors, maternal height and infant birth weight were significantly related to infant mortality (Krasovec, 1991:94).

A number of studies have examined the cut-off points of maternal height in assessing the risk of various outcomes. For example a study in India found that a maternal height cut-off of 145 cm was appropriate for predicting the risk of low birth weight. However, when the analysis was stratified into income groups, maternal height was associated with the incidence of low birth weight only for the medium-income group. For the lower-income group, the highest incidence of low birth weight was observed in women with heights of less than 145 cm or more than 155 cm (Krasovec, 1991:98).

(b). Maternal arm circumference

The use of arm circumference as an indicator of maternal nutritional status has recently received greater attention. This is due to its usefulness in predicting pregnancy outcome and its greater practicability compared to other anthropometric measures. In an assessment of various maternal anthropometric indicators for predicting the risk of low birth weight conducted in Brazil, arm circumference at any time during pregnancy was found to be comparable to pregnancy weight gain for gestational age in predicting birth weight (Lechtig 1988 cited in Krasovec, 1991:120).

A study in Bangladesh in 1989 showed that, while maternal weight and weight changes during pregnancy were only slightly better than arm circumference in explaining foetal and infant mortality, sensitivity/specificity analyses across a range of cut-off points indicated that arm circumference was slightly better than height and weight changes during pregnancy in predicting foetal and infant mortality (Krasovec, 1989 cited in

Krasovec, 1991:122). A study conducted in India in 1978 found that while there was a significant difference between the mean arm circumference of nonpregnant rural and urban women, there was no significant association between arm circumference and maternal age, or between arm circumference and height. This study further suggested that arm circumference can be a useful proxy indicator of weight in nonpregnant women (Tibrewala and Shah, 1978 cited in Krasovec, 1991:120).

Some studies have found little change in maternal arm circumference during pregnancy, and therefore its measurement is independent of gestational age (Hull, 1983 and Husaini et al., 1986 cited in Krasovec and Anderson, 1991:153). For example, a study conducted in Indonesia found that the overall decrease of arm circumference during pregnancy was only approximately 0.6 cm (Husaini et al., 1986 cited in Krasovec and Anderson, 1991:125). In developing countries, pre-pregnancy weight is usually not available because pregnant women attend prenatal care only in advanced stages of pregnancy, or not at all. In these circumstances, arm circumference measured at the first visit can be used as an indication of a woman's pre-pregnancy nutritional status (Krasovec and Anderson, 1991:155).

Some studies have found cut-off points of arm circumference between 22 and 24 cm to be useful for predicting low birth weight. For example, Lechtig found that an arm circumference of 23.5 cm during pregnancy had a sensitivity of 77 per cent and a specificity of 71 per cent for predicting low birth weight in Brazil (Lechtig 1988 cited in Krasovec and Anderson, 1991:153). Krasovec (1989), in an examination of the sensitivity and specificity of arm circumference in predicting foetal and infant mortality in Bangladesh, found cut-off values of arm circumference between 22.5 and 23.5 cm at any time during pregnancy to have reasonable sensitivity and specificity (cited in Krasovec and Anderson, 1991:126).

(c.) Nutritional anaemia

Anaemia is a common complication in pregnancy, particularly in the developing world where risk factors leading to nutritional anaemia, such as a lack of adequate nutritional intake, ignorance and taboos persist. Anaemia can be defined as a reduction below normal in the number of red corpuscles per millilitre, the quantity of haemoglobin and the volume of packed red cells per 100 ml of blood (Ojo and Briggs, 1982:164-5). It was estimated that over half of women of childbearing age in Africa have haemoglobin levels below 11g/dl (WHO 1992 cited in Rooney 1992:18).

In mid-pregnancy, the haemoglobin level falls slightly as a result of physiological haemodilution so that the proportion of women with a haemoglobin level below any given cut-off point will be larger amongst pregnant than non-pregnant women (Rooney, 1992:18). Higher haemoglobin is important in maximising foetal growth and in providing pregnant women with adequate reserves in the event of excess blood loss during delivery. It was found that haemoglobin levels below 10.4 g/dl were associated with adverse pregnancy outcomes such as preterm delivery and perinatal mortality (Murphy et al., 1986 cited in Murata et al., 1992:23).

Routine administration of iron and other nutrients supplementation is important in preventing the development of anaemia in large numbers of women with borderline iron deficiency, or to correct mild anaemia in many (Rooney, 1992:18). However, some studies have found that the benefits of iron supplementation are not so clear. This is partly due to the fact that anaemia may be only indirectly associated with poor outcomes. Women with anaemia could be from low socio-economic status groups and thus receive inadequate prenatal care. These factors may explain the greater risks of preterm deliveries and perinatal mortality rather than anaemia *per se* (Murata et al., 1992:23).

(2). Tetanus immunization

Neonatal tetanus is caused by contamination of the umbilical cord stump with spores of *Clostridium tetani*. Contamination is due to the use of unhygienic methods for ligation and dressing of the severed cord. The organism grows in the necrotic tissue and releases a toxin which results in muscle spasm. The occurrence of neonatal tetanus reflects antenatal care (tetanus immunization), delivery practices, and environmental contamination as sources of tetanus spores (Gray, 1989:40).

According to the World Health Organization, neonatal tetanus is endemic in ninety countries throughout the world. In some developing countries, it is responsible for half of neonatal mortality and a quarter of infant mortality. Even with treatment, the case-fatality ratio can be up to 80 to 90 per cent (Whitman et al., 1992:248).

Neonatal tetanus can be prevented through immunization and hygienic delivery practices. According to the World Health Organization a five-dose immunization schedule is required to prevent neonatal tetanus. By the fifth dose, 99 per cent of women retain protective antibodies against tetanus for the duration of their childbearing years (Whitman et al., 1992:252).

A high coverage of tetanus toxoid (TT) immunization in women of child bearing age is very effective in preventing neonatal tetanus. For example, a mass campaign to immunize all women 10 to 45 years old in the Pidie district of Indonesia, resulting in coverage levels of 84 per cent, brought about an 85 per cent reduction in neonatal tetanus mortality (Whitman et al., 1992:252).

(3) Maternal disease during pregnancy and complications at delivery

Maternal diseases and complications during pregnancy and childbirth have deleterious effects on both the mother and the foetus. A study conducted in 1977-1978 using data from the Swedish Medical Birth Registry found that diabetic mothers and preeclampsia were associated with an increased risk of perinatal mortality. Delivery complications associated with an increased risk of perinatal mortality included placental complications (placenta praevia or abruptio placentae), uterine rupture, complications with the umbilical cord, and prolonged labour (Bakketeig et al., 1984:131).

Vaginal bleeding during pregnancy is also associated with adverse pregnancy outcome. Some studies have reported that about 50 to 60 per cent of pregnancies with heavy vaginal bleeding during early pregnancy may result in a spontaneous abortion. Despite the presence of vaginal bleeding, some pregnancies continue; however, evidence suggests that a pregnancy that is complicated by bleeding may lead to several perinatal complications including preterm delivery, low birth weight and perinatal death (Berkowitz et al., 1983:165).

In the present study, data were also collected on maternal diseases and complications. However, the data collected did not directly relate to diseases and complications defined in the International Classification of Diseases. The available data referred only to the presence of specific symptoms the respondents were asked about during the course of pregnancy and childbirth. Thus, they could only be used as a proxy for pregnancy disorders. The type of symptoms and complications in delivery included in the analysis are explained in Chapter Two.

(4) Coffee consumption and smoking behaviour

Many studies have examined the relationship between maternal drinking or smoking habits and pregnancy outcome. Some have found that an inverse relationship exist between them (Armstrong et al., 1992; Woolbright, 1994). In the present study, due to the very small proportion of mothers with alcohol drinking habits, only coffee consumption and smoking habits are included in the analysis.

(a). Coffee consumption

Caffeine is the predominant pharmacologically active component of coffee. Studies conducted in animal populations, such as mice and rabbits, have shown that caffeine has teratogenic effects, including cleft palate and ectrodactyly, the absence of fingers. These effects are observed only when the subjects are exposed to more than 50 mg/kg caffeine per day which is equivalent to about 25 cups of coffee (Bertrand et al. 1970 cited in Narod et al., 1991:1109). The teratogenic effects of caffeine observed in mice have raised concerns about the possibility of similar effects in human beings.

Narod et al. (1991:1112) reviewed studies relating coffee consumption during pregnancy to the occurrence of low birth weight. They concluded that coffee consumption during pregnancy has a small effect in reducing birth weight. The observed effect is most likely to be relevant for women who are already at risk of having a low birth weight baby due to other factors.

The study of the relationship between coffee consumption during pregnancy and low birth weight is complicated by the fact that many socio-demographic, medical, and behavioural characteristics influence birth weight. Coffee consumption may be associated with some of these factors. Although existing studies do not show any direct effect of coffee consumption on adverse pregnancy outcome, an excessive consumption of coffee during pregnancy may have a contributory effect on increasing the risk of having a baby of low birth weight (Narod et al., 1991:1113).

(b). Smoking behaviour

Many studies have identified a negative relationship between maternal smoking behaviour and pregnancy outcome. For example, Woolbright (1994:331-5) found that, after controlling for the effects of a mother's educational attainment, age, marital status, race, and trimester of prenatal care initiation, smoking during pregnancy was associated with an elevated risk of infant death, low birth weight, and prematurity.

While the effects of smoking on birth weight and prematurity have been established, a direct relationship between smoking during pregnancy and perinatal death has not yet been shown. Differences in research findings have led to a debate as to whether the effect of smoking during pregnancy on perinatal death is due to the effect of smoking *per se*, or to the characteristics of women who smoke (Bakketeig et al., 1984:123).

In view of empirical findings about the effects of smoking on the pregnancy outcome, especially on low birth weight and prematurity, any study of adverse pregnancy outcome should control for the effect of smoking behaviour.

(5). Maternal attitude toward pregnancy

Most pregnancies can be considered to be happily anticipated by the couple concerned. However, in certain situations, some pregnancies may be unwanted at the time of conception. Such negative attitudes towards a pregnancy may be a result of strict abortion controls and failure to control fertility despite efforts to avoid pregnancy. Some studies have identified an inverse relationship between negative attitudes toward a pregnancy and the pregnancy outcome. Myrhman (1988) found that unwanted pregnancy increased the risk of low birth weight, while Kafatos and Pantelakis (1982) found that unwanted pregnancy was a risk factor for perinatal morbidity and mortality (both cited in Bustan and Coker, 1994:411). Bustan and Coker (1994:413) found that infants born to women whose pregnancies were unwanted were more than twice as likely to die in the neonatal period than those where the pregnancies were wanted.

One possible explanation for this is that women with unwanted pregnancies are less likely to seek early and adequate prenatal care (Weller et al., 1987:407; Joyce and Grossman, 1990:13). Late and inadequate prenatal care may be responsible for the adverse outcome. In the present study, whether the pregnancy was planned or not is included in the model as a control variable for the analysis of the determinants of the outcome variables.

Antepartum and intrapartum health care.

The care received by a pregnant woman before and at the delivery is important to both the mother and her infant. Adequate post-natal care is also important for managing babies in need of special care, such as premature babies. In addition, it is important in ensuring infant immunization. However, this is less relevant for the perinatal deaths that are the focus of this study. Due to limitations of the data, only antepartum and intrapartum care were included in the analysis.

(1). Antepartum health care

The term antepartum, or prenatal, health care denotes that received by a pregnant woman prior to delivery. The care provider may be a traditional birth attendant or professional such as a midwife or doctor.

Antepartum care refers to a series of interventions provided to a pregnant woman during the course of pregnancy with the objective of improving her chances of a favourable outcome (Nagey, 1989:516). Better access to adequate antenatal health services should promote better pregnancy outcomes. One major objective of antenatal services is to screen predominantly healthy pregnant women to detect those at high risk, and to follow up the screening with timely intervention (Rooney, 1992:10). Some studies have found that an early initiation and the number of antenatal visits were correlated with better pregnancy outcome (Quick et al., 1981; Gortmaker, 1979; Donaldson and Billy, 1984).

An important issue with antenatal care is its adequacy. The Kessner adequacy of prenatal care index is widely used as a measure of the degree of utilization of antenatal care. Items evaluated in the Kessner index include the trimester or month in which the care began, and an index relating the frequency and timing of visits to gestational age. Based on this index the adequacy of care is classified into adequate, intermediate, and inadequate categories (Kessner et al., 1973:59). The adequate category requires that the woman commences antenatal care in the first trimester and receives nine antenatal care visits over a normal-length pregnancy.

Despite its wide use, Kotelchuck (1994:1414-9) has argued that the Kessner index is seriously flawed. It is heavily weighted toward the timing of prenatal care initiation, and does not distinguish between this and poor subsequent utilization. The index also measures utilization for full or post-term pregnancies inaccurately. The lack of documentation on the coding scheme used in the Kessner index is also problematic since the different coding conventions regarding missing data can result in major differences in the measurement of prenatal care adequacy. To correct these limitations, Kotelchuck developed a modified version of the Kessner index, a new feature of which is the independent assessment of antenatal care utilization after initiation, adjusted for the full range of gestational ages.

However, the utilization indices developed by Kessner and Kotelchuck do not measure the adequacy of the content of antenatal care, only its utilization. It is therefore difficult to assess whether any improvement in adverse pregnancy outcome is due to the utilization of antenatal care or to other factors related to the care. This is particularly the case for antenatal care programmes in developing countries, where the services available differ widely in quality.

The number of pregnancy complications screened for during routine antenatal care is not sufficient to explain the improvement in pregnancy outcome afforded to women who obtain prenatal care. It is possible that women who are destined to have a favourable pregnancy outcome are also more likely to seek and obtain prenatal care in the first place. However, if such self selection is not involved, then the act of care may itself contribute to the improved outcome (Nagey, 1989:525).

The assessment of the benefit of antenatal care is further complicated by the fact that numerous factors influence adverse pregnancy outcomes. In developing countries, assessment of the importance of antenatal care may be further confounded by knowledge of, distance from, access to and utilization of other health services, including those for delivery (Rooney, 1992:12). Efforts to assess the benefit of antenatal care services should take into account other factors which may confound the relationship between the use of antenatal care and pregnancy outcome.

(2). Intrapartum health care

It has been identified that the survival of a neonate is determined to some extent by foetal development, the delivery process, and adjustment to the postnatal environment (Popkin et al., 1993:359). Although most pregnancies end with a normal delivery, the provision of adequate intrapartum health care (obstetric care) is important. This is particularly so for handling emergency problems such as birth asphyxia/trauma which may result in intrapartum foetal death.

An important element in maternal health care is that every woman should receive adequate assistance from any trained provider during labour, irrespective of whether the birth takes place at home or in a maternity centre (Royston and Armstrong, 1989:166). A perinatal and maternal mortality study conducted during 1975 to 1982 in Indiana involving members of a religious group that avoided obstetric care revealed that the rates of perinatal and maternal mortality were about three times and 100 times higher respectively than the statewide rates (Kaunitz et al., 1984:826). This finding indicates the importance of obtaining birth assistance from trained personnel. However, in developing countries only a small proportion of pregnancies are attended by trained personnel. In Asia, based on 1983 figures, only fifty per cent of pregnancies were attended by trained persons (Royston and Armstrong, 1989:167).

A low proportion of pregnancies attended by qualified personnel was also found in the Indramayu Study. More than seventy per cent of pregnancies were assisted by traditional birth attendants. Unsafe delivery practices, such as the use of unhygienic cord cutting instruments which are common among untrained traditional birth attendants may increase the risk of tetanus neonatorum.

Due to the lack of resources for providing safe delivery and the presence of traditional beliefs related to pregnancy and childbirth, the incorporation of traditional birth attendants into local health systems, where they could be given regular training, could be the immediate solution. The findings from some studies have suggested that such training and adequate supervision after training would be important elements in ensuring the adoption of safe methods when assisting with delivery (Royston and Armstrong, 1989:168-169).

Another important element in a safe delivery is easy access to emergency obstetric services whenever obstetrical problems arise. The accessibility of these services is known to be the factor that differentiates the level of maternal mortality between low and high maternal mortality countries, and even between rural and urban areas of the same country (Royston and Armstrong, 1989:172). In an attempt to minimize the risk of adverse pregnancy outcome to both mother and her baby, the WHO has set out the minimum elements of obstetric care that are essential at the first referral level for saving mothers' lives (WHO, 1991:8-36). These include the provision of surgical obstetrics, anaesthesia, medical treatment, blood replacement, manual procedures and monitoring labour, management of women at high risk, family planning support, and specific neonatal care. The provision of these functions within the geographic and economic reach of the community would greatly reduce the incidence of adverse pregnancy outcomes, including perinatal mortality.

Foetal and infant factors.

(1). Foetal age

The length of gestation is usually used to measure the age of a foetus, reflecting its growth and maturity. Infants who are delivered prematurely are at greater risk of death, and if they survive, may suffer from severe neurological impairment (Kline et al., 1989:182).

The WHO has categorized foetal age at delivery into preterm (less than 37 completed weeks), term (37 to 41 weeks), and post-term (more than 41 weeks) (WHO ICD 9, 1977:764). These classifications are subject to bias when gestational age is imprecisely recorded and can lead to wrong conclusions when assessing the relationship between birth-spacing and low birth weight, due to the confounding effect of gestational age.

Foetal age has an important effect on infant survival because it is also strongly associated with birth weight. Foetal age is the necessary antecedent of foetal growth which produces birth weight. Despite the importance of foetal age as the antecedent of birth weight, many researchers emphasize the study of birth weight as the major contributing factor to infant survival rather than foetal age. Some studies have also indicated the importance of birth weight as the major predictor for infant mortality. For example, Susser et al. (1972:204) found that birth weight, regardless of gestational age, accounted for more than 90 per cent of the variance in perinatal mortality, whereas length of gestation accounted for only four to six per cent.

Wilcox and Skjaerven (1990:380-2) have argued that such an analysis obscures the role of gestational age in affecting infant survival. Shorter gestational age is in itself a cause of low birth weight, and that part of the contribution of gestational age to mortality is removed by a standardization procedure. The usual analytic method in which birth weight is compared at different gestational ages does not consider the benefit of extended gestation to a preterm baby. They concluded that a baby can benefit as much from an increase in gestational age as from an increase in its weight relative to the weights of others at the same gestational age. A similar study analysing simultaneously the effect of birth weight and gestational age on neonatal mortality revealed that, in each birth-weight group, mortality decreased as gestational age increased: for each gestational age group, heavier infants had a lower mortality rate (Cooper et al., 1993:78).

These findings suggest the need to study gestational age together with birth weight. One reason why birth weight is more commonly studied in relation to prematurity than gestational age is the poor quality of gestational age data derived from the date of the last menstruation period (Kline et al., 1989:168). This problem arises due to the women's uncertainty about the date of the last normal menstrual period (LMP). In addition to recall bias, foetal age defined by LMP can be in error for at least two physiological reasons: the estimated length of gestation can be too short when bleeding in early pregnancy is mistaken for the last menstrual period, or too long when conception follows an extended follicular phase (Wilcox and Skaerven, 1992:379). Despite these shortcomings, the use of the LMP in the determination of gestational age is considered to be valid (Kramer et al., 1988; Hakim et al., 1992). However, in order to minimise bias due either to women's uncertainty about the date of LMP or to physiological reasons, LMP-based gestational age data should be validated. As will be explained in Chapter Four, the present study develops an appropriate method of validating the Indramayu gestational age data, employing recorded birth weight and menstrual histories, together with the standard of birth weight by gestation.

(2). Birth weight

Birth weight is widely recognized as the most important indicator of infant health and survival. It can be regarded as the final pathway for the expression of many factors embedded in the social and biological processes leading to birth (Kline et al., 1989:170). Paneth et al. (1982 cited in Kline et al., 1989:171) in a comparative study between populations, found that adjusting for birth weight alone provided good control of confounding by almost all the factors antecedent to birth weight, whether socio-economic or nutritional.

Some studies found that low birth weight was one of the major predictors of mortality and morbidity during infancy in both developed and developing countries (McCormick, 1985:88; Ferraz et al., 1990:101). Low birth weight infants were more susceptible to various health disorders such as neurodevelopmental problems and respiratory tract infections (Morrell, 1990:1). Yerushalmy (1967:169), in a stratified analysis, demonstrated that the relative risk of neonatal mortality ranged from 2.8 to 141.0 when infants of low weight and full term gestation were compared with other infants.

Despite the close association between low birth weight and risk of death, low birth weight itself is not a cause of death. It only an indication of risk. The risk of death associated with low birth weight is not the same for all causes of death. Hartford (1992:3) found birth weight to be an exceptionally high risk factor for the leading causes of neonatal death, immaturity and asphyxia-related conditions. In addition, birth weight is also a high risk factor for infections and congenital conditions, the risks being substantially higher in the neonatal than in the postneonatal period.

The World Health Organization, in the ninth revision of the International Classification of Diseases, defined low birth weight as less than 2500 grams (up to, and including 2499 g) (WHO, 1977:763). In some studies, however, further classification of low birth weight has also been used. For example, 'very low birth weight' has been used for infants weighing 2000 grams or less, and also for those weighing 1500 grams or less (Alberman, 1984:86).

Low birth weight can be a result of intra-uterine growth retardation, a baby being small for its gestational age, or short-gestation, prematurity. For the purpose of analysis, prematurity is usually defined as birth below 37 weeks of gestation with a weight below 2500 grams. The term Intra-Uterine Growth Retardation is applied to infants born at term and below 2500 grams (Ferraz et al., 1990:102). Where the gestational or foetal age is uncertain, the period of time over which growth has taken place cannot be known precisely. Low birth weight due to growth retardation on the one hand, and to premature delivery on the other, poses reasonably similar risks for perinatal mortality (Kline et al., 1989:210). From a policy point of view, it is not important whether the child is preterm or growth retarded. What is important is how low birth weight can be prevented, and its adverse effects minimized (Gribble, 1993:134).

(3). Infant's health condition at birth

Along with maternal obstetrical condition such as complications during pregnancy and at delivery, infant health condition at birth also constitutes a factor that puts the infant at a moderate to high risk of developing poor perinatal outcomes (Molfese, 1989:1).

The Apgar scoring system is often used to assess an infant's overall condition during the first minutes after birth. The assessment is based on heart rate, respiratory effort, muscle tone, reflex irritability, and color. Each of these signs is rated on a scale of 0 to 2, with a total score below 5 representing high risk. The assessment is made at the end of the first minute and at five minutes after birth (Molfese, 1989:165). The Apgar scoring system was not used in the Indramayu study and remains rare in developing countries.

In the Indramayu Study, information on problems that might appear soon after birth, such as body colour, especially a blue or yellow appearance, breathing problems, feeding problems, vomiting and shivering, was collected as a proxy for an infant's health condition at birth. This information was based on respondents' observations and was gathered during the first day after birth or as soon as possible after that. Based solely on these symptoms, it is difficult to determine the disease or disorder that might be suffered by the infant. As will be explained in Chapter Two, the symptoms are included in the analysis of the determinants of neonatal death and each is treated as an individual explanatory variable.

(4). The use of colostrum and initiation of breastfeeding

Studies that relate the effect of breastfeeding to infant survival usually come to the same conclusion that breastfeeding enhances child survival. A review study conducted by VanLandingham et al. (1991:134) concerning the contraceptive and health benefits of breastfeeding concluded that breastfeeding provides health benefits for young children in developing countries, and that these benefits remain strong after controlling for potentially confounding variables.

From a medical point of view, breastfeeding can be initiated soon after birth. If both the mother and her baby are physically able, the first feed can be given within 30 minutes of birth. A clinical study has shown that the suckling reflex is strongest within 20 to 30 minutes after birth, and if the infant is not fed at that time, this diminishes and does not resume until the end of the second day of life (Worthington-Roberts et al., 1981:203).

A study conducted by Holland (1987 cited in VanLandingham, 1991:132) using data from the Malaysian Family Life Survey found that during the first two months, infants who never breast-fed were 12 times more likely to die than infants who were breast-fed. However, this study is subject to bias due to the effect of baby health problems at birth that may result in suckling difficulties. It is possible that death causes weaning rather than the reverse. To overcome the bias, in Holland's study, the babies who never breast-fed due to the baby's death were excluded from the analysis. This treatment, however, would create bias in another direction, in terms of lessening the estimated effect (Vanlandingham et al., 1991:133).

Feeding in the neonatal period usually causes no problem as most mothers are willing to breast feed, however in some cases feeding, especially the use of colostrum, could be a problem. Colostrum is the form of human milk that is produced in the first few days after birth. It is typically yellow in colour due to its relatively high carotene content. Colostrum has been found useful in facilitating the establishment of *Bifidus* flora in the digestive tract of the newborn and the high content of antibodies found in colostrum may assist in providing protection against various gastro-intestinal infections (Worthington-Roberts, 1981:172).

In certain communities, particularly in rural areas of Indonesia, there is a belief that the first milk, colostrum, has a deleterious effect and therefore should not be given to a newborn baby. A qualitative study of post-partum care behaviour conducted in the study area in 1992 found that some mothers believed that colostrum had a negative impact on babies and therefore it was regarded as inappropriate to be given to the newborn. Instead of colostrum, honey was usually given to make the baby healthy (Utomo et al., 1992:67).

In the present study, information on breastfeeding practices used in the analysis of the determinants of neonatal death includes the initiation of breastfeeding and use of colostrum. The initiation of breastfeeding is not used as a direct potential predictor of neonatal death but rather as a proxy indicator of baby's health condition at birth that may influence the occurrence of neonatal death.

CHAPTER TWO

RESEARCH METHODS

This chapter describes the methods used in the study. It includes a discussion of study design, the study site, the study population and respondents, sampling methods, and methods of data collection. The approach taken in data processing and analysis is also explained in detail. Finally, the strengths and limitations of the study are outlined.

2.1 Study Design

The present study uses data from the Indramayu Health and Family Planning Prospective Study. As will be further explained, the present study also uses data originated from the MotherCare Study which was linked in the core Indramayu Study since 1990. This is a prospective community-based study aimed at examining the bio-social correlates of pregnancy outcome. A prospective design permits the collection of observational data over a given extended period and therefore the use of data from the MotherCare study will enables the researcher to examine the relationships between adverse pregnancy outcome and various factors before and during the course of pregnancy.

2.2 Data Sources and Sampling Methods

The data used in the present study were originated from several sources. One of the sources was the Indramayu Health and Family Planning *Prospective Study, a collaboratory study between the University of Indonesia, Ministry of Health, the Indonesian Family Planning Coordination Board and the John Snow Inc. The Indramayu study collects and updates demographic information of about 10,000 randomly selected households and their household individual members at a regular interval of every three-months. This study has been conducted, since 1989, in two sub-districts of Indramayu Regency, Gabus Wetan and Sliyeg, in West-Java Province. As will be further explained, this study used a survey registration system (SRS) as the principal data collection method. The project interviewers were responsible for collecting the data. The sample size for each sub-district was 5,000 households, 10,000 households in total, which were selected using the following procedures:

a. All households were listed and mapped by segment, according to information provided by the Indramayu Statistical Office. A segment is a geographical area consisting of 5 to 100 households. In this study, segments with less than 10 households were excluded.
b. From the segments, clusters of 10 households each were formed.
c. A systematic selection with a random start point was carried out to select 500 clusters or 5,000 households from each sub-district.

In addition to the core Indramayu study which employed the SRS, the present study also used data originated from the MotherCare project, which prospectively studied pregnancy-related health and health care behaviours of pregnant women and their babies. The project was linked in the core Indramayu study since 1990. The respondents were pregnant women who were identified through the SRS.

Based on the secondary data available, it was predicted that 400 pregnancies per year would be detected in each sub-district (Utomo et al., 1991:9).

A total of 1,563 pregnant women were identified in the MotherCare study which was conducted from April 1990 to December 1992. As the primary objective of the present study was to examine the relationship between the occurrence of adverse pregnancy outcome and certain selected risk factors, including socio-demographic background, obstetric complications, and pregnancy-related behaviours, only those respondents for whom a complete set of information had been collected during the course of pregnancy and for 42 days following pregnancy termination were included in the analysis. Using this criterion, it was necessary to disregard 91 respondents with incomplete information, so the resulting sample size for the study was 1,472 respondents. Since this part of the study also excluded abortion cases, the final sample size was reduced by 26 such cases, leaving a total of 1,446, 647 in Gabus Wetan sub-district and 799 in Sliyeg.

In order to ascertain whether the sample size would be sufficient to achieve the objectives, a calculation of sample size proposed by the World Health Organization was adopted (WHO, 1992:95). The formula for a sample size required to estimate a proportion at the 95 per cent confidence level is:

$$N = \frac{1.96^2 \, [\, P(1 - P) \,]}{E^2}$$

Where P = the proportion under study.

E = allowable margin of error, set for the purpose of this study at 3 per cent.

If the proportion of perinatal deaths is 50 per 1,000 total births (see Chapter Three), then P = 0.05, then

$$N = \frac{(1.96)^2(0.05)(1 - 0.05)}{(0.03)^2}$$

$$= 203$$

As the study sample size was much greater than that needed according to the formula, it was considered that it would be adequate to address the aims of the study.

2.3 Study Population and Respondents

The study population consisted of nuclear and extended households located in the two sub-districts of the Indramayu regency. The respondents for the study varied according to the source of the data used. For the core Indramayu study, the respondent was the head of the household or any other adult household member, at least sixteen years old, who could provide the information requested using the household member's follow-up module, module A (see section 2.5). For modules B and C, also referred to as the mother and child modules respectively, the respondent was the mother herself.

For the MotherCare study, which used the pregnancy module (module D), the respondents were the pregnant women. Where a pregnant woman could not provide a particular piece of information, for example, some questions related to the intrapartum period, then other relevant people, such as those who assisted in the delivery, were interviewed.

2.4 Variables Under Study

This section describes variables of particular importance in the study:

Dependent variable.

The term *adverse pregnancy outcome* is used to denote any unfavourable pregnancy outcome that can occur to either the mother or the foetus. This study is concerned only with adverse foetal outcomes especially low birth weight and perinatal death.

The perinatal period begins at 28 weeks of gestational age and ends 7 days after birth. For international comparisons, it is generally accepted that the term *perinatal* *mortality rate* refers to the number of late foetal deaths (stillbirths) and early neonatal deaths, that is before day seven, per 1,000 total births (Bakketeig et al., 1984:101). In calculations of perinatal statistics, the World Health Organization in the ninth revision of the International Classification of Diseases recommended the inclusion of all foetuses and infants who weigh at least 1,000 grams at delivery or, in the absence of birth weight, with a gestational age of 28 weeks or a body length of 35 cm (crown-heel) (WHO ICD 9, 1977:766). By this definition, only early neonatal deaths, those occurring during the first week of life, should be included in the calculation of perinatal death. Late neonatal deaths, those occurring after the first week of life but within one month of birth, would be excluded. However, as mentioned in Chapter One, due to the small number of cases, late neonatal death was included in the analysis, and it was combined with the early neonatal death into neonatal death.

Despite the existence of this definition, the classification of perinatal mortality is often applied inconsistently in various countries (Bakketeig et al., 1984:100-101). Initially, the WHO definition of perinatal mortality was to be adopted in this study; however, its application would have resulted in a smaller number of cases, creating difficulties for the data analysis. Therefore, the term perinatal death was taken to include late neonatal deaths between seven and 28 days following birth. In justification, it should be emphasized that the analysis which follows treats stillbirths and neonatal deaths separately, to enable comparison with other studies. The separate analysis of these components of perinatal mortality also allowed an examination of possible differences between the predictors of stillbirth and neonatal death.

The division of perinatal mortality into stillbirths and neonatal deaths may also result in misclassification. For example a baby who dies shortly after birth may be reported inadvertently as a stillbirth. In most developing countries, where information on gestational age is often not available, the classification of stillbirth is not clear-cut. Despite the possibility of misclassification, the factors causing stillbirth and neonatal deaths merit a thorough, separate study. In the Indramayu data collection, care was taken to obtain accurate stillbirth data. This was accomplished by the use of probing questions and the intensive training of interviewers.

The definitions of stillbirth and neonatal death used in the present study were adopted from Hoffman et al. (1984:493). The term *stillbirth* is defined as the intrauterine deaths of a foetus of gestational age 28 weeks or more. The corresponding stillbirth rate is the number of stillbirths per 1000 total births. The term *total births* refers to the number of late foetal deaths (stillbirths) plus live births.

A *neonatal death* is defined as a live-born baby who dies within 28 days of birth. The neonatal mortality rate is the number of these deaths per 1,000 live births.

<u>Independent variables</u>.

The independent, or explanatory, variables for the analysis of the determinants of adverse pregnancy outcome were selected according to biological as well as statistical considerations. Theoretically, the selected explanatory variables are either risk or protective factors for the adverse pregnancy outcome. While a protective factor is merely a risk factor expressed inversely, it is sometimes natural to express one factor as a risk factor and another as protective, according to the natural ordering of the factors' categories.

As explained in Chapter One, a number of factors were identified as potentially important predictors of the adverse pregnancy outcomes. They include socio-demographic characteristics, maternal biological factors, foetal and infant factors, and pregnancy care behaviour. In the Indramayu study, data related to these factors were collected prospectively during the course of pregnancy until 42 days after the delivery. The information included socio-demographic characteristics, a history of previous pregnancy outcomes, nutritional status, pregnancy care behaviour including the use of antenatal care services, certain indices of morbidity, medicament use, birth weight, gestational age, complications with the delivery, type of birth attendant, pregnancy outcome, and the health of the newborn baby.

The independent variables were grouped into four categories: pre-pregnancy, antepartum, intrapartum, and post-partum. This grouping facilitated the identification of the relative importance of the independent variables for each period of pregnancy in determining the risk factors for the adverse pregnancy outcome. For example, the exclusion of current pregnancy conditions in the assessment of pre-pregnancy variables is useful in identifying the risk that women will develop an adverse pregnancy outcome. Thus, it provides information to enable women to be placed in high or low priority groups for antenatal care at the time of their first antenatal visit.

As mentioned, most of these factors were treated as independent variables for explaining the occurrence of adverse pregnancy outcome. However, at certain stages of the analysis, some of them were also treated as dependent variables.

(1). Pre-pregnancy period

The independent variables which relate to the period before the pregnancy was initiated include socio-demographic characteristics and history of previous pregnancy. The operational definitions of these variables are as follows:

(a). Inter-pregnancy interval

This term refers to the interval between the date of conception of the most recent pregnancy and the date of the termination of the preceding pregnancy. By this definition, only women who have had at least two pregnancies have inter-pregnancy intervals.

In the Indramayu study, about 30 per cent of the cases were primigravida. If these cases had been excluded from the analysis, the results might have been distorted as primigravida characteristics may exert an influence on the outcome variable. In order to include such cases, inter-pregnancy interval was divided into three categories: (1) less than 18 months, (2) eighteen months or more, (3) primigravida. As will be explained in Chapter Five, the categorisation of inter-pregnancy interval was further converted into dummy-coded variables.

(b). Maternal age

The age of the mother was recorded in completed years at the beginning of pregnancy. Maternal age is calculated as the difference between the hypothesised date of conception and mother's date of birth, converted to years. Maternal age was classified into categories for analysis.

(c). Educational background of the mother (respondent) and her husband

Educational attainment was classified into: no formal education, elementary school either completed or not completed, junior high school, senior high school, and diploma or university degree. For the purposes of analysis, educational background was actually collapsed into only two categories: *no formal schooling* and *attended any* *formal school.* This conversion into a dichotomous variable was because the proportion of respondents (and also their husbands) who completed high school or above was small. In addition, it also facilitated variable reduction which was conducted using a factor analytic technique which requires interval measurement, and the dichotomous category fulfils the requirement.

(d). Occupational background of the mother and her husband

A question related to occupation was asked of both the mother and her husband. Information obtained included work status, whether currently employed or not, and the employment sector of those engaged in paid employment. For analytical purposes maternal occupation was simplified into maternal working status in terms of whether or not the mother was currently engaged in paid employment. Most of the women's husbands were engaged in employment so occupation was translated into employment sector, with the two categories, labourer and farmer, being sufficient for analytical purposes.

(e). Family structure

In this study, family structure was categorised into nuclear and extended family. A nuclear family comprises a couple and their children, whereas an extended family includes other relatives.

(f). Parity

This term denotes the number of children ever born alive. The variable was collapsed into three groups: no child, one or two children, and three or more children. At a certain stage of the analysis, parity was converted into gravidity with the categories nulliparous, a woman who has never born a live child, and multiparous.

(g). Household assets

This variable was used as a proxy indicator of economic status. Information on household assets was collected by questioning respondents about the ownership of items such as a television, radio or radio cassette, bicycle, and motorcycle. A score was attributed to each of these items based on the local price of the item: the higher the price, the higher the score. The scores for each of the items were then totalled to obtain a household assets score. For the purpose of analysis, the total household assets score was collapsed into three categories: low, medium, and high.

(h). Maternal height and mid-arm circumference

A number of studies have identified maternal anthropometry as an important potential predictor of adverse pregnancy outcome. These maternal anthropometric measurements include pre-pregnancy weight and height, arm circumference, and weight gain during pregnancy. Anthropometric measurements are used as proxy indicators of maternal nutrition before and during pregnancy.

In this study, information was collected on pre-pregnancy weight and weight gain during pregnancy. However, the validity of these variables is subject to doubt for reasons already discussed, mainly that most pregnant women were detected only after the fourth month of pregnancy. Information on maternal height, recorded in centimetres was collected by the use of the standard adult height board. For the purposes of analysis the height was classified into two categories: below 145 cm, and 145 cm and above.

Mid-upper left arm circumference was measured with an insertion-type arm circumference tape. For analytical purposes, this variable was categorised into two groups: below 23.5 cm, and 23.5 cm and above. As mentioned in Chapter One, the use of this cut-off point for mid-arm circumference was considered to have reasonable sensitivity and specificity. In addition, it corresponds with the cut-off point recently used in a campaign in Indonesia aimed at preventing adverse pregnancy outcome due to chronic malnutrition (*Direktorat Bina Gizi Masyarakat, Dep.Kes.RI.*, 1995:4).

(i). Previous pregnancy loss

Information about previous pregnancy loss was divided into two variables: preceding pregnancy outcome and history of previous pregnancy loss. Preceding pregnancy outcome covers only the outcome of the immediately preceding pregnancy. The history of previous loss covers all pregnancy outcomes. Thus, the frequency of mothers who had an adverse pregnancy outcome is greater in the history of previous pregnancy loss variable than in the preceding pregnancy outcome variable. The type of pregnancy loss could be an abortion or a stillbirth. As with the inter-pregnancy interval, in order to include primigravida cases, the categorisation consisted of mothers who had (1) experienced pregnancy loss, (2) never experienced pregnancy loss, and (3) primigravida.

(j). Previous child death

This variable was defined as whether or not there has been a child death in the family. In the data set, death of the child from the immediately preceding pregnancy cannot be separated from the total child deaths which might have been experienced. In order to take into account the primigravida cases, the same three categorisations were also applied.

(k). Planned pregnancy

Planned pregnancy was defined as whether or not the current pregnancy was planned. Information about maternal attitude toward pregnancy was collected when the pregnancy was detected.

(2). Antenatal period

This is the period from the date of conception, or more strictly the beginning of the last menstrual period, until just before the delivery. The independent variables related to this period included tetanus immunization, diseases during pregnancy, trimester of first antenatal care visit, the type of provider sought at the first antenatal care visit, frequency of antenatal visits during pregnancy, haemoglobin level, smoking behaviour, and alcohol and coffee consumption.

(a) Tetanus toxoid (TT) immunization

As in other parts of Indonesia, the pregnant women in the study area were supposed to receive two doses of TT immunization before the eighth month of pregnancy with a minimum of one month between doses. For analytical purposes, this variable was divided into two categories: never received TT immunization and received one or two TT immunizations. In this study, the 'received' category refers only to the current pregnancy, the information on TT immunization of previous pregnancies being unavailable.

(b). Disease during pregnancy

Information was gathered on disease symptoms experienced by the women during the antenatal period. These included persistent headache, fever and shivering, a burning sensation during urination (urinary tract infection-related symptoms), swelling of limbs/face (antepartum swelling), and vaginal bleeding (antepartum vaginal bleeding).

The information was collected retrospectively every month during the course of pregnancy and was referred to one month before the time of interview.

It is very difficult to identify specific diseases from the reported symptoms. Therefore, each symptom was treated separately as one variable. The monthly symptom data were converted into trimester data. Each variable was initially grouped into three categories:

- *None*, if the woman had never experienced the particular symptom during the antenatal period;

- *Occasionally*, if the woman had ever experienced the symptom in any one trimester;

- *Frequently*, if the symptom was experienced in more than one trimester.

Later, these three categories were recoded into two: *none* and *ever*, with 'ever' covering the last two.

(c). Trimester of first antenatal visit

This refers to the timing of antenatal care initiation. Information on antenatal care was actually collected retrospectively on the basis of a monthly visitation cycle. The timing of antenatal care initiation was grouped into three categories: first trimester, second trimester, and third trimester. At a later stage of the data analysis, in order to include cases without any antenatal care, this variable was converted into dummy variables representing those women who made the visit in the first trimester, the second or third trimester, and those who had no antenatal care at all.

(d). Provider sought at the first antenatal care

The type of provider sought at the first antenatal care visit was represented by two categories: *traditional birth attendant* and *non-traditional birth attendant*. The non-traditional birth attendant category included both midwife and physician.

(e). Frequency of antenatal care

This variable denotes the frequency of the antenatal visits that a woman made during the course of her pregnancy, and was represented by three categories: none, one to three visits, and more than three visits.

(f). Haemoglobin level

The haemoglobin (HB) value was used as a means of measuring anaemia among the pregnant women, using the HemoCue system from HemoCue AB, Sweden. The blood sample, which is obtained by a finger prick, is drained into a cuvette by capillary action and mixed with reagents. A photometer calculates the HB concentration in g/dl. All readings must be done within 10 minutes of filling the cuvette. The project midwives were responsible for testing the blood samples.

The measurement of HB level was meant to be conducted at three monthly intervals during pregnancy. However, some of the HB measurements were conducted at closer intervals. For this reason, only the last HB measurement was used.

The cut-off point adopted to classify whether or not the women were considered to be severely anaemic was 11 g/dl. Therefore the haemoglobin variable was categorised as dichotomous: (1) *below* and (2) *equal to or above 11 g/dl.*

(g). Smoking behaviour

Information on smoking behaviour was collected regularly on the three monthly visit and broken into three categories: never smoked, smoked occasionally, and smoked frequently. The *frequent* category was assigned to women who smoked regularly throughout the pregnancy. At a later stage of the analysis the *occasional* and *frequent* categories were combined into one category.

(h). Alcohol and coffee consumption

As with smoking behaviour, information on alcohol and coffee consumption was collected every three months. These two variables were also grouped into three categories: never, occasionally, and frequently; the *occasional* and *frequent* categories later being combined.

(3). Intrapartum period

The intrapartum period denotes the period just before and during labour. The independent variables that were included in the analysis of the intrapartum period were: type of cord cutting instrument, the use of special instruments for delivery, foetal presentation, congenital anomaly, sex of baby, preterm delivery, type of birth attendant, and any disease found just before delivery, such as intrapartum bleeding and intrapartum swelling.

(a). Cord cutting instrument

Unclean cord cutting instruments may lead to infection. This is particularly the case with traditional birth attendants who often still use traditional instruments, such as bamboo, for cutting the cord. This variable had two categories: (1) *use of bamboo* and (2) *other instruments*, such as scissors and blades, for cutting the cord.

(b). Use of special instruments for the delivery

Complicated deliveries usually require special instruments. This variable was categorised as: use of special instruments and no use of special instruments. Forceps delivery and caesarean sections were included in the use of special instruments category.

(c). Foetal presentation

This variable denotes the position of the baby just before and during childbirth. It was categorised as: *normal* or *abnormal* presentation. A normal presentation refers to a cephalic presentation in which the head emerges first from the birth canal. The abnormal presentation refers to any other than cephalic presentation, such as breech and transverse presentations.

(d). Congenital anomaly

This refers to a malformation or disorder that is present at birth, such as deformed body parts. This variable was categorised as: *yes*, indicating that the baby suffered from an abnormality, and *no*.

(e). Sex of baby

This variable was categorised as: *male* and *female*.

(f). Preterm delivery

This refers to a birth that occurred at a gestational age of less than 37 completed weeks. A dichotomous variable was used to describe whether or not the baby was delivered preterm.

(g). Birth attendant

Most deliveries in the study area were assisted by traditional birth attendants. Some deliveries were assisted by medical professionals such as midwives, or by a combination of traditional birth attendants and professionals. In some stage of analysis this variable was categorised as: *traditional birth attendant only* and *a combination of traditional birth attendant and medical professional.*

(h). Diseases (symptoms) just before or at the delivery

These refer to abnormalities experienced by the mother just before or at the time of childbirth and included swelling (intrapartum swelling) and abnormal vaginal bleeding (intrapartum bleeding). Each was treated as a separate variable and categorised as present or not present.

(4). Post-partum period

This period begins from the date of birth and continues until 42 days following childbirth. The independent (explanatory) variables that were considered relevant to this period included birth weight, use of colostrum, breast-feeding initiation, giving some other liquid before colostrum, and any health problems observed in the baby in the first few days of life.

Information on these variables was collected retrospectively twice during the post-partum period, on the eighth and on the forty-second days following childbirth. Information collected in the first interview covered the period from the first to the eighth day after birth. An exception was birth weight data, which was to be collected immediately following childbirth.

(a). Low birth weight

The World Health Organization recommends that birth weight should be recorded within the first hours of life (WHO ICD 9, 1977:763). Since that was not done in this study, it was necessary to examine at what number of days after birth the measurement of the weight of the baby could still be regarded as a valid measure of the actual birth weight. As will be further explained in Chapter Four only babies whose weight was measured within less than seven days are regarded as having valid birth weight data for the analysis of the determinants of neonatal death.

For analytical purposes, the cut-off point used for categorising a low birth weight baby was 2,500 grams. In order to minimise a large reduction of the cases to be included in the analysis due to missing cases, for example, missing cases where the birth weight was measured at more than six days after birth (27.3 per cent), three categorisations were then used; low birth weight, normal birth weight, and invalid birth weight. The latter represents those who were weighed at more than six days.

(b). Use of colostrum

This refers to the initial form of milk produced immediately before and after childbirth. A dichotomous variable was used to describe whether the mother gave the colostrum to her baby or not.

(c). Breast-feeding initiation

While a baby should be put to breast three or four times during the first 24 hours, this is not always done in Indonesia, for cultural reasons as well as illness that might be encountered by the baby. It is of particular interest to examine whether or not delayed breast-feeding may affect neonatal survival. A dichotomous variable was used to describe whether or not the baby was breast-fed in the first 24 hours.

(d). Giving some liquid before breastfeeding was initiated

A traditional practice in the study area is to give a liquid, such as honey, to newborn infants before breastfeeding. Some mothers adhered to this practice. In order to assess whether this traditional practice affects neonatal survival, due to the introduction of unclean liquid, a dichotomous variable was used to describe whether or not the mother gave any other liquid before breastfeeding was initiated.

(e). Baby's health conditions

This refers to the health condition of a baby at birth. The information collected related to certain symptoms experienced by the newborn during the first few days of life, particularly on the first day after birth. The symptoms included vomiting, difficulties in breast-feeding, shivering, breathing problems, blue colour (cyanosis), and jaundice. Each was treated as an individual variable categorised as: *yes*, indicating that the symptom was present, and *no*.

2.5 Data Collection

The present study used the data originated from the core Indramayu study and the MotherCare study. Information about pregnancy outcome, pregnancy-related health and health care behaviours of the respondents were obtained from the MotherCare study, while socio-economic backgrounds were extracted from the core Indramayu study. The project interviewers were responsible for collecting most of the data. In the MotherCare study, however, the haemoglobin level data was collected by the project midwives.

The core Indramayu Study used a survey registration system (SRS) as the principal data collection method. The system allowed the prospective monitoring of demographic events and the introduction of new data collection modules over time. The SRS was designed to facilitate the linkage of household and individual characteristics with the events of interest (Utomo et al., 1991:2).

The SRS database contains two main types of data: cross-sectional and longitudinal data. The cross-sectional data were collected once only at the beginning of the study (1989) and were used as baseline data. The cross-sectional data included socio-demographic characteristics and information on domestic sanitation.

The longitudinal data were collected routinely at 90 day intervals. They recorded events such as marriages, births, migration, and deaths which occurred within the preceding cycle. The longitudinal data were gathered using three modules.

Module A was a household member follow-up module for collecting data on demographic events such as pregnancy initiation, pregnancy outcome, migration, death, and marital status changes among household members. This module is also referred to as the Household Record Book (HRB).

Module B was a follow-up module for women aged 12 to 49 years old, regardless of marital status. It gathered information pertaining to the occurrence of menstrual periods, contraceptives used, reasons for not using family planning, tetanus toxoid immunization and iron tablet intake since the last visit. The information obtained related to each month of the three month recall period.

Module C was for children under three years of age. It recorded information regarding immunization, breast-feeding and supplementary food patterns in the last three months. It was also referred to as the Mother and Child Module.

The present study uses information obtained using modules A and B, in combination with data from a MotherCare study which was incorporated in the Indramayu core study. The MotherCare study used a pregnancy module (module D) to collect information related to pregnancies and their outcomes, including pregnancy care behaviour, maternal nutrition, the use of medications, pregnancy complications, birthweight, and pregnancy outcomes. Module D was administered to all pregnant women who were identified through the SRS.

In addition to the use of data derived from the core Indramayu study and the MotherCare study, the present study also uses qualitative data which were gathered by the researcher himself. These data were collected using indepth interviews and focus group discussions.

2.6 Data Processing

The term data processing refers to the transformation of verbal or written information into machine-readable data. It includes data coding, data entry, and data cleaning, as well as creating data files that can be used by a standard statistical package, transforming data into variables useful for analysis, and documentation of these processes (Bourque and Clark, 1992:1). The standard data processing for the Indramayu Study, including coding, data entry, and data cleaning, was carried out in the field using a special data entry package written in Foxpro version 1.02.

An important element of data processing in this study was the creation of a complete pregnancy history file that could be analysed by a standard statistical package, the SPSS package.

The pregnancy history file was derived from the core Indramayu study (SRS) and MotherCare files. Details of the stages and techniques used to create this file are described in Appendix One.

2.7 Methods of Analysis

At the preliminary level of the analysis, univariate analysis was conducted in order to obtain a simple data description of all the variables under study. This was to establish how the cases were distributed across the various categories of each variable, the number of missing values per variable, and the shape of the distributions.

Bivariate analysis using two variables for subgroup comparisons was used for a descriptive presentation of some preliminary findings and for the preliminary analysis of the association between the dependent variable, such as neonatal mortality, and some selected explanatory variables.

The aim of the bivariate analysis was to describe the distribution of variables of interest across various socio-demographic characteristics and the history of previous pregnancy outcomes. This was achieved by the use of a cross-tabulation technique.

The Cramer's V statistic, a chi-square-based correlation analogue, was employed to assess the individual, or gross, effects, of selected explanatory variables on the dependent variables. Crude odds ratios were calculated for variables which showed a significant relationship with the dependent variables. For a two-way contingency table the odds ratio is estimated as the product of the observed diagonal frequencies divided by the product of the non-diagonal frequencies.

A major disadvantage of bivariate analysis, particularly when there are several variables involved in explaining a phenomenon, is that the possible effects of the explanatory variables are estimated separately. The inclusion of other variables in the model may change the original relationship between the dependent variable and an explanatory variable. There is therefore a need for multivariate techniques that allow for the estimation of effects of several variables simultaneously taking into account the effects of other explanatory variables.

The term multivariate analysis is somewhat difficult to define precisely as this term is often not used consistently in the literature (Hair et al., 1992:4). However, for the purpose of this study the term multivariate analysis denotes the use of a statistical method that analyses simultaneous relationships among several variables. Thus, instead of explaining the dependent variable on the basis of a single independent variable, a multivariate analysis is intended to seek an explanation through the use of more than one independent variable.

The multivariate analysis was performed in order to assess not only the determinants of stillbirth and neonatal death but also the determinants of some of the intervening variables. These multivariate analyses were conducted for each period or stage of pregnancy and for the entire course of the pregnancy, in order to examine the joint effects of a set of all the relevant explanatory variables on determining the occurrence of the adverse pregnancy outcomes and the intervening variables.

The type of multivariate techniques employed in the study were factor analysis and a logistic regression model. The factor analytic technique was used to overcome computational and statistical problems of including all the variables in the analysis, as well as any multicollinearity problem. The factor analysis was used as a means of reducing the number of variables entered into the multivariate logistic regression model, in order to build a model that fits a given set of data satisfactorily.

Factor analysis is basically a class of multivariate statistical methods which is focused on data reduction and summarisation. The statistical approach includes finding a way of condensing the information contained in a number of original variables into a smaller set of factors with a minimum loss of information (Hair et al., 1992:225).

There are two basic models that can be used in order to obtain factor solutions: common factor analysis and component analysis. The selection of one model over the other is usually based on the purpose of using the factor analysis and prior knowledge about the variance in the variables (Hair et al., 1992:231). As the objective of conducting the factor analysis is to determine the minimum number of factors needed to account for the maximum portion of the variance represented in the original set of variables, the principal component solution of the factor model was employed.

Factor rotation was used to achieve a simpler and theoretically more meaningful factor pattern, using the varimax procedure which gives an orthogonal solution and therefore eliminates collinearity (Hair et al., 1992:228). This facilitated the selection of surrogate explanatory variables for subsequent statistical analysis. The detailed explanations of the mathematical modeling used in the factor analysis is not presented here but it can be found in related textbooks (for example, in: Johnson and Wichern, 1992).

As the objective of conducting factor analysis is to identify appropriate variables for subsequent analysis, each factor matrix was examined. The explanatory variable with the highest factor loading was selected to represent all the explanatory variables in that factor group. In cases where there was prior knowledge about the reliability of the raw data or of the relative importance of a certain variable over the others in determining the outcome, a variable with a slightly lower loading might be chosen as the surrogate variable to represent a particular factor. This was done to minimise any misleading results due to the omission of an explanatory variable that may have a true relationship with the outcome variable.

Since the dependent variables, stillbirth and neonatal death, were dichotomous variables, a logistic regression model was appropriate to estimate the probability of an adverse pregnancy outcome occurring. Logistic regression is a mathematical modeling approach that can be used to explain the relationship of several independent variables to a dichotomous dependent variable, such as neonatal death. The formula for the general logistic model can be written as follows (Kleinbaum, 1994:18):

$$P(\mathbf{X}) = \frac{1}{1 + e^{-(\alpha + \Sigma\beta_i X_i)}}$$

$$\mathbf{X} = (X_1, X_2, ..., X_k)$$

$$\alpha, \beta_i = \text{unknown parameters}$$

where P(**X**) refers to the probability of the outcome given values of a collection of independent variables X_1, X_2, through to X_k. The terms α and β_i in the model represent unknown parameters that are estimated from the data.

Another way of writing the logistic model is called the logit form of the model:

$$\text{logit } P(\mathbf{X}) = \alpha + \Sigma\beta_1 x_i$$

The odds ratio which describes the effect of the exposure variable X_i is given by the formula $ROR = e^{\beta_i}$

Interaction was also considered, where necessary in the analysis. The logit form of the model which involves two indicator variables *A* and *B* and with an interaction terms can be written as follows:

$$\text{logit } P(\mathbf{X}) = \alpha + \beta_1 A + \beta_2 B + \beta_3 A \text{x} B$$

where P(**X**) refers to the risk of the adverse outcome (event) given values of *A* and *B*.

Stepwise algorithms for the variable selection in the logistic model were adopted, with the likelihood-ratio test employed as a means of testing for variable inclusion or removal, which gives a better result than the Wald statistics for the same algorithms (Norussis, 1990:57).

Model building was initiated with the selection of explanatory variables. Since the explanatory variables had been subjected to factor analysis, selected surrogate explanatory variables were included in the main models.

Following variable selection and the building of main effects models, the existence of interactions and confounding effects was assessed. This examination of interactions was carried out before the assessment of any confounding effects, in order to determine whether or not the measured effect for each explanatory variable was appropriate. For ease of interpreting the results, only two-factor interaction terms were examined. An assessment of confounding effects was not performed if there was strong evidence of interaction involving confounding variables in the model, because the examination of potential confounders with significant interaction terms would have yielded unreliable results (Kleinbaum, 1994:166).

Confounding describes a situation where some risk factor, other than the exposure under study, is distributed differently among exposed and unexposed. The consequence of not controlling for confounding is that disease (event) occurrence would differ among exposed and unexposed cases independently of any possible effects of the studied exposure (Ahlbom, 1993:86). In other words, if the result of analysis indicated that there was a strong exposure-disease relationship, we would not want this finding to be explained away by other variables already known to be predictive of the outcome.

The criterion for identifying potential confounding factors was based on the potential risk associated with the selected confounding factors in terms of the outcome, for instance, neonatal death. The risk factor need not necessarily be a 'direct' cause, but should be known, on the basis of previous research findings, to be an antecedent to the outcome. In addition, a confounding factor should not be an intervening variable in the relationship between the exposure variables and the outcome variable. Control in such cases might spuriously reduce or eliminate a true relationship between the outcome variable and the exposure variable (Kleinbaum et al., 1982:255-257).

The assessment of confounding effects also involves a consideration of *precision*, which refers to the width of the confidence interval around the point estimate. The narrower the confidence interval, the more precise the point estimate (Kleinbaum, 1994:167). The precision consideration is mainly applied when selecting the best model from several models which give similar point estimates. However, validity takes precedence over precision, in the sense that it is more important to obtain the right answer than a precise answer.

Precision was assessed through a comparison of the confidence intervals for the odds ratio of a particular variable under study. The first step is to obtain a 95% confidence interval for β, the logistic coefficient of a variable under study. For a model without interaction terms, this is achieved using the formula β plus or minus 1.96 times the standard error of β ($\beta \pm 1.96 \times$ S.E of β).

2.8 Strengths and Limitations of the Study

Both cross-sectional and longitudinal data are used to address the objectives of this study, so that the limitations of a cross-sectional study, such as lack of information on the processes of change, can be overcome by the use of longitudinal data. The study examines predictors of adverse pregnancy outcomes, stillbirth and neonatal death. For this type of study, it is very important to take account of the effect of gestational age (Adams et al., 1991; Wilcox and Skjaerven, 1992; Gribble, 1993). As will be explained in Chapter Four, the available data on gestational age contains errors. This is particularly the case for the gestational age data derived from women's recollection of the timing of their last normal menstrual periods (LMP).

Because of the important role that gestational age may play in affecting pregnancy outcome, a series of procedures for validating the gestational age data was carried out, using birth weight and prospective data on the timing of menstruation. The results of data validation indicated that, in order to minimise bias due to the use of unreliable gestational age data, a variable describing the quality of gestational age should be included in the multivariate models.

The use of birth weight to validate gestational age meant that the analysis of the determinants of low birth weight could not control for the variables which required a valid gestational age data, especially inter-pregnancy interval.

A systematic data processing procedure was developed to manage the multiple-longitudinal databases. The availability of socio-demographic as well as some reproductive health information which was collected before and during the entire period of pregnancy and also soon after birth, allowed for the examination of factors potentially important as determinants of the adverse pregnancy outcome. Such examinations could be conducted for each period of pregnancy. The analysis conducted in this way provided information that could contribute to the development of an appropriate risk approach strategy for maternal and child health services, taking into account the role of the important predictors in each period of pregnancy.

CHAPTER THREE

DESCRIPTION OF THE STUDY SITE

This study was conducted in Gabus Wetan and Sliyeg sub-districts, two out of nineteen sub-districts, in the Indramayu Regency of West Java Province.

Compared to other areas in Java and Bali, Indramayu has low contraceptive prevalence, high levels of infant and child mortality, low immunization coverage, and a high proportion of deliveries attended by traditional birth attendants (Dasvarma, 1992:13). It was these low levels of health achievements that caused this regency, and particularly Gabus Wetan and Sliyeg sub-districts to be selected as the study sites for the Indramayu study.

In this chapter, the geographic and socio-economic, as well as demographic characteristics of the Indramayu Regency are briefly outlined prior to elaborating on the characteristics of the study population. This is intended to provide a general overview of the Indramayu area where the study was conducted.

3.1 The General Overview of Geography and Socio-Demography of the Indramayu Regency.

Geography.

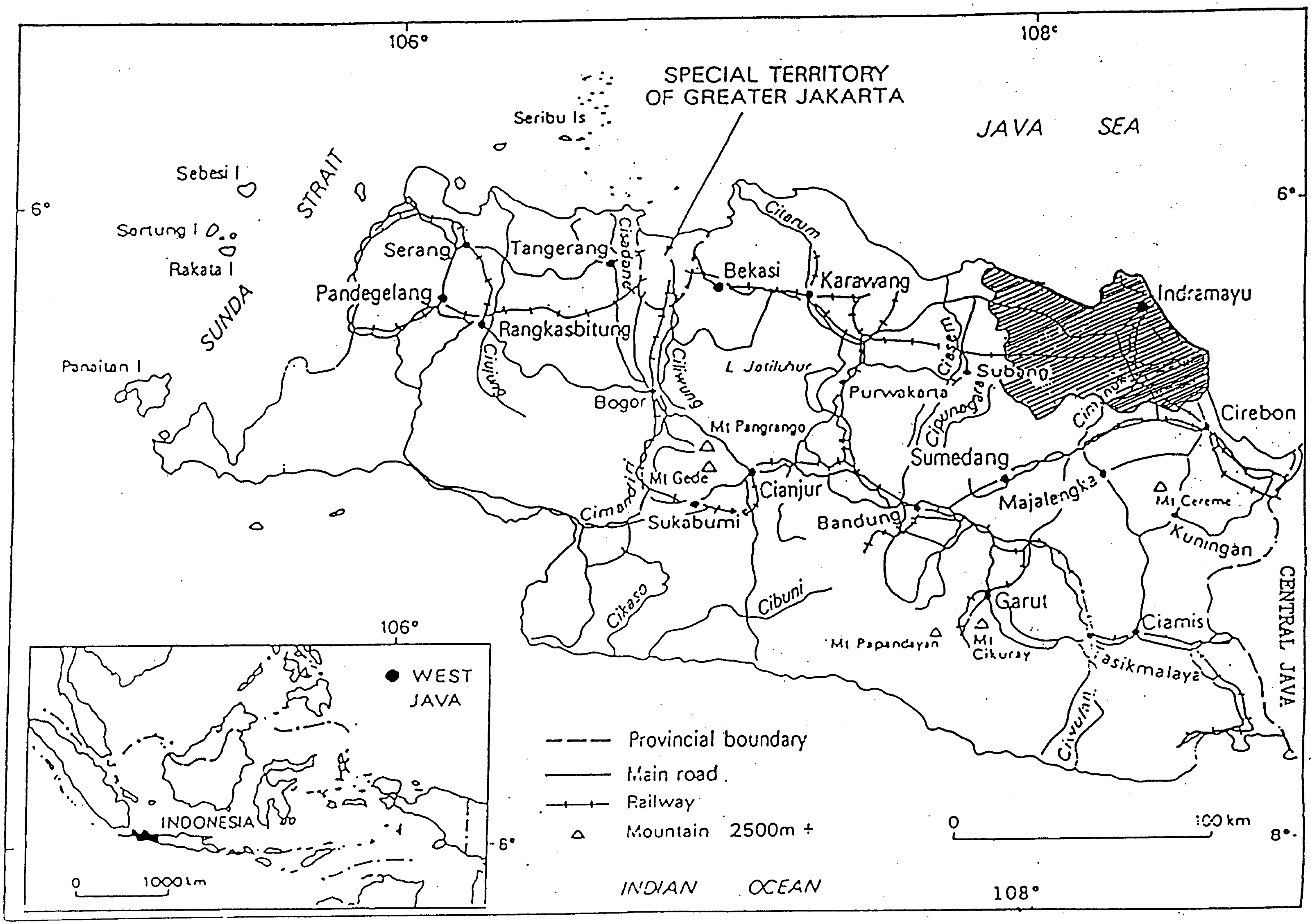
Indramayu regency is located in West Java Province, one of the 27 provinces in Indonesia. It is situated in the north-eastern corner of West Java, close to the border of Central Java. The administrative headquarters of the Indramayu regency is about 207 kilometres away from Jakarta, the capital city of Indonesia.

The Indramayu regency is bounded by the Java sea in the north, and by other regencies of West Java, Cirebon, Majalengka, Sumedang, and Subang (see Map 1 and 2).

The area of Indramayu regency is approximately 1,971 square kilometres. It consist of 19 sub-districts which are further divided into 310 villages. While the

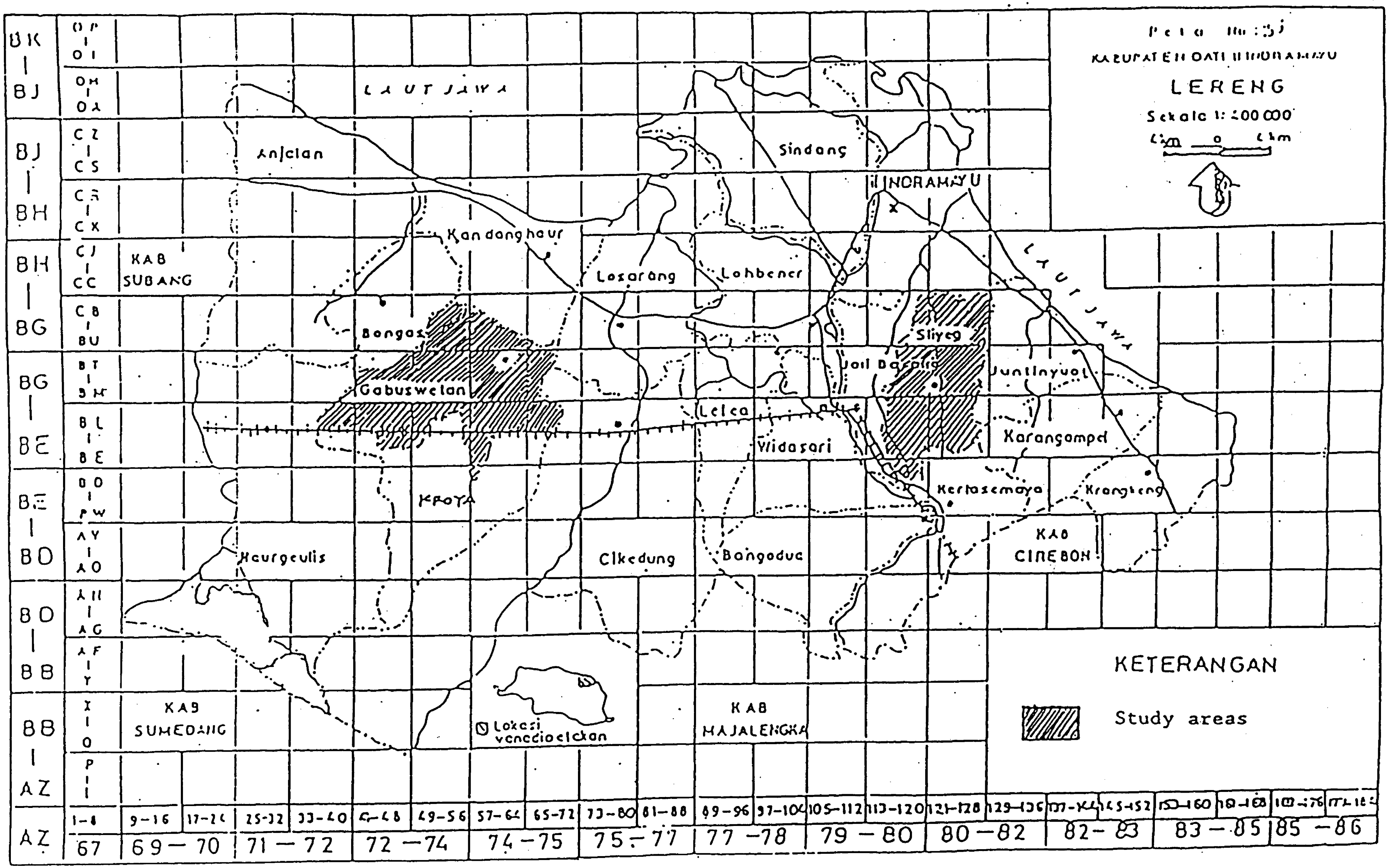
Map 1

Map of West Java



Map 2

Map of the Indramayu Regency



regency is headed by a regent (*Bupati*), the sub-district and village are headed by a sub-district administrator (*Camat*) and a village headman (*Lurah*) respectively.

Socio-Demography.

Based on data compiled in 1991, the total population in the Indramayu regency was 1,438,928 (710,227 males and 728,701 females) with a population density of approximately 719 per square kilometre.

Fourteen per cent of the population are under five years of age; 25 per cent are of elementary school age; adults comprise 56 per cent while another 5 per cent are classed as elderly. The sex ratio at birth was 108 male births per 100 females. The total number of households was 364,990 with, on average, four members per household (*Kantor Statistik Kabupaten Indramayu*, 1992:55-67).

Data from the 1990 population census showed that 64 per cent of the Indramayu population had completed primary schooling. Of the population aged between 7 and 44 years, 21 per cent were illiterate and another 15 per cent did not complete primary schooling. About 99 per cent of the population is Moslem, the remainder being Christian, Hindu and Buddhist (*Kantor Statistik Kabupaten Indramayu*, 1992:85).

Indramayu is a low flat land area with 61 per cent of the land being used for agricultural activities. Most of the heads of households engaged in agricultural activities as farmers (84 per cent); the remainder were engaged in the private sector (7.4 per cent), as government employees (5.7 per cent), and others (*Kantor Statistik Kabupaten Indramayu*, 1992:65-66).

The age of women at marriage was quite low, consistent with women in other areas in West-Java province. Official data on the age of first marriage was not available, but data from the 1980 census showed that the maternal age at marriage in West Java Province was on average 15.6 years in rural areas and 16.7 years in urban areas (Siregar, 1987:138). The low for average ages at marriage is mainly due to cultural reasons. This under-age marriage is known to have deleterious effects for both mother and baby. The study found that teenage pregnancy had the effects of increasing the risk of low birth weight and short pregnancy interval which eventually lead to neonatal death; this is explored in Chapter Seven.

3.2 A General Overview of Health Status and Health Services in the Indramayu Regency.

Health Status.

The level of infant mortality in the Indramayu Regency was quite high compared to the national average. Data from the 1990 census revealed that the level of infant mortality in the Indramayu study was 103.4 per 1000 births. Data from the Indramayu District Hospital revealed that 35 per cent of infant mortality was caused by meningo-enchepalitis, diarrhoea, and broncho-pneumonia. Despite the incidence of tetanus neonatorum being no longer high, some tetanus cases were still found in the hospital and some health centres. In 1992, the case fatality rate for tetanus neonatorum was approximately 33.3 per cent (*Dinas Kesehatan Kabupaten Indramayu*, 1993:12).

Data compiled by the Indramayu Health Services in 1993 indicated that the level of child death under five years of age (*angka kematian balita*) was 51 per 1,000 births (*Dinas Kesehatan Kabupaten Indramayu*, 1993:5). This rate is apparently quite low compared to the national average which was 97 deaths per 1,000 births (Indonesian Central Bureau of Statistics, 1992:100). However, the low rate as estimated by the Indramayu Health Services is unlikely to be a true estimate since the level of infant mortality in the Indramayu district as reported from the 1990 census was very high. With regard to morbidity, the most common causes of under-five child morbidity were upper respiratory tract infections, diarrhoea, skin infections, and pneumonia (*Dinas Kesehatan Kabupaten Indramayu*, 1993:8).

Data compiled in 1993 originating from the district hospital revealed that the maternal death rate associated with pregnancy and child-birth was 2.3 per 1,000 live births. The most common causes were bleeding during pregnancy and at delivery (*Dinas Kesehatan Kabupaten Indramayu*, 1993:6). The level of maternal mortality as reported by the Indramayu Health Services is also low compared to the average rate found in the Household Health Survey conducted in 1985 which was 4.5 per 1,000 live births (Budiarso, 1987:115). A hospital-based study conducted in Indonesia (1978 to 1979) revealed that the maternal mortality rate ranged between 0.85 per 1,000 for the registered mothers, 8.5 per 1,000 for the unregistered mothers, and 48 per 1,000 for the referred mothers (Affandi, 1991:56). Again, the low rate of maternal mortality reported by the Indramayu Health Services may be incorrect.

Health Services.

The government-based health services available in the Indramayu Regency are district hospitals, health centres, and auxiliary health centres. There are two district hospitals, 33 health centres, and 61 auxiliary health centres. The ratio of health centres to the number of population being served is 1 : 46,466 which is below the targeted national standard of 1 : 30,000.

The average number of visits to the health centres was 124 persons (patients) per day/health centre. The contact rate of each health centre to the population was 0.75, which was quite low compared to the national average of 1.5. The coverage for antenatal care was 82 per cent with average frequency of two to three antenatal visits. Despite this being quite high, however, the number the visits was still low compared to the targeted minimum of four visits. The coverage for complete tetanus immunization was 79 per cent (*Dinas Kesehatan Kabupaten Indramayu*, 1993:18).

In addition to government-based health services there are also private and community-based health services. The popular community-based health service is *posyandu*, the village health post. A *posyandu* is actually a collaborative health service between the local community and the health centre. It is available in each village and set up to be operated once a month. The available services include growth monitoring, contraceptive services, immunization, and health education. In 1988, the government of Indonesia launched a village-based midwifery service, *polindes*, which is actually an extension of the *posyandu*. As with the *posyandu*, *polindes* is also a kind of collaborative activity involving the local community and the local health centre. In this case, a village midwife, *bidan desa*, was assigned as the primary care provider with the help of an out-reach health worker, *kader kesehatan*. The *polindes* activities are focused mainly on providing prenatal, delivery, and post-natal care.

At the time of the survey, only one *polindes* had been established in the study area. This was located in Gabus Wetan, and was a pilot project collaboratively established by the local health centre, the local community, and the University of Indonesia.

3.3 The General Characteristics of the Study Population.

The total population of Gabus Wetan is 48,108, inhabiting 10 villages in an area of about 67 square kilometres. The ten villages are comprised of 52 enumerator areas and are further subdivided into 310 segments. In Sliyeg, about 59,510 people reside in 16 villages in an area covering about 63.5 square kilometres. The 16 villages are further subdivided into 55 enumerator areas and 270 segments (Utomo et al., 1992:7).

Most of the population are engaged in agricultural activities and the majority of them regard themselves as Javanese despite their location in West Java, where the predominant ethnic identity is Sundanese. A more detailed description of the study population follows, with particular emphasis on socio-demographic characteristics, reproductive health care behaviours, and the level of adverse pregnancy outcomes such as perinatal and infant mortality.

Socio-demographic characteristics.

As is the case with other women in West Java, young marriage was a characteristic of the respondents. Although the majority of respondents were aged between 20 and 34 years, the distribution of age among the primiparae only, revealed the majority of them were under 20 years (see Table 3.1). In the context of reproductive health, the term 'adolescent' usually refers to the ages from puberty to 19 years of age (Scholl et al., 1987:312; Koetsawang, 1990:491). If this definition is adopted, then a large proportion of pregnancies observed in the study area were initiated at the adolescent age. As will be explained in Chapter Seven, this adolescent pregnancy bears negative consequences for pregnancy outcomes.

Table 3.1 Socio-Demographic Characteristics of the Respondent and Husband in Gabus Wetan and Sliyeg, 1993.

	Gabus Wetan N %	Sliyeg N %	Total N %
Maternal Age: (All respondents)			
< 20	170 (25.9)	208 (25.5)	378 (25.7)
20 - 34	402 (61.3)	474 (58.1)	876 (59.5)
35+	84 (12.8)	134 (16.4)	218 (14.8)
Maternal Age: (Primiparae only)			
< 20	142 (67.0)	176 (75.2)	318 (71.3)
20 - 34	69 (32.5)	57 (24.4)	126 (28.3)
35+	1 (0.5)	1 (0.4)	2 (0.4)
Maternal Education:			
No Schooling	254 (38.8)	336 (41.2)	590 (40.1)
Elementary school	361 (55.1)	429 (52.6)	790 (53.7)
Secondary/tertiary-school	40 (6.1)	50 (6.1)	90 (6.1)
Husband's Education:			
No Schooling	166 (26.7)	247 (31.8)	413 (29.5)
Elementary school	361 (58.1)	438 (56.4)	799 (57.2)
Secondary/tertiary-school	94 (15.1)	92 (11.8)	186 (13.3)
Maternal Working Status:			
Unemployed	331 (53.2)	722 (89.2)	1053 (73.6)
Employed	291 (46.8)	87 (10.8)	378 (26.4)
Husband's Occupation:			
Labourer	197 (32.8)	278 (38.4)	475 (35.9)
Farmer	284 (47.3)	234 (32.3)	518 (39.1)
Others	119 (19.8)	212 (29.3)	331 (25.0)
Respondent Marital Status:			
Never married	3 (0.5)	2 (0.2)	5 (0.3)
First married	404 (61.6)	427 (52.4)	831 (56.5)
Second marriage	220 (33.5)	364 (44.7)	584 (39.7)
Divorced	29 (4.4)	22 (2.7)	51 (3.5)
Household Assets:			
Low	536 (81.7)	737 (90.3)	1273 (86.5)
Medium	58 (8.8)	53 (6.5)	111 (7.5)
High	62 (9.5)	26 (3.2)	88 (6.0)
Parity:			
None	212 (33.4)	234 (29.2)	446 (31.1)
One child	163 (25.7)	136 (17.0)	299 (20.8)
Two children	104 (16.4)	122 (15.2)	226 (15.7)
Three or more children	155 (24.4)	309 (38.6)	464 (32.3)

In both areas, the greater proportion of respondents and husbands had completed elementary schooling, with a small proportion having completed secondary schooling or above. If the 'no schooling' category represents 'illiterate' than the proportion illiterate in the study area was greater than the illiteracy rate in the Indramayu Regency which was 21 per cent.

The greater proportion of the respondents were not engaged in paid employment. However, the proportion of working mothers in Gabus Wetan was approximately the same as those who did not engage in paid employment. Almost all the respondents' husbands were engaged in remunerative employment, the majority of them being farmers and labourers.

As mentioned in Chapter Two, a variable describing household assets was used as a proxy measure of household economic status. A scoring system based on the calculation of cumulative scores of some household goods ownership was used for classifying economic status into low, medium, or high categories. The majority of the respondents' economic status was classified into the low category (86 per cent), with a small proportion in the medium or high categories (see Table 3.1).

With regard to the respondents' marital status, the majority of them were married. Second or higher order marriage is quite common in the study area, but the greater proportion were in their first marriage. Only a few were widowed or had never married.

The majority of the respondents were multigravidae (69 per cent), a large proportion of them having had three or more children.

Reproductive Health Care.

Information about reproductive health care was also collected. This included antenatal and intrapartum maternal health care. The following describes some important features of reproductive health care.

In Indonesia, antenatal care is provided as an integral part of the Maternal and Child Health Program. The services are available to all pregnant women at a reasonable cost. In the study area the majority of respondents attended some antenatal care, but some respondents (16 per cent) did not attend any. Of those who made antenatal visits, the majority of them made only one to three visits during their pregnancy. This frequency is below the recommended number which is at least four visits during the course of pregnancy (*Departemen Kesehatan R.I.*, 1990:8).

Early attendance at the first antenatal care visit is important for a pregnant woman. This early attendance allows for an accurate estimation of gestational age, which would help in making a decision should a complication occur later. In addition, it also allows for the early detection of pregnancy complications, or an assessment of a pregnant woman at risk of developing an adverse pregnancy outcome. In the study area, only 10.3 per cent of the respondents initiated their first antenatal care in the first trimester; the greatest proportion (58.8 per cent) were in the second trimester, and the remainder in the third trimester.

The provider sought for antenatal care ranged from the traditional birth attendant to a health professional such as a midwife or doctor. Of those respondents who initiated antenatal care in the first trimester, the majority (64.2 per cent) went to midwives, with the remainder going to a doctor (3.3 per cent) and traditional birth attendant (32.4 per cent). A focus group discussion conducted by the researcher, which involved some pregnant women, found that although a health professional was sought in the first antenatal care, if the women felt that there was no indication of pregnancy complications, the chosen provider for the next visits was usually a traditional birth attendant. So a combination of health professional and traditional birth attendant was a common source of antenatal care.

Tetanus immunization is one of the important elements of antenatal care. As mentioned in Chapter One, a complete tetanus immunization schedule for a pregnant woman is required in order to prevent neonatal tetanus surely. In Indonesia, a tetanus immunization program in antenatal care is aimed at ensuring that a pregnant woman has received a complete (two-doses) tetanus immunization during pregnancy. In the study area, about 31.9 per cent of the respondents had completed tetanus immunization, 35.9 per cent received incomplete (one-dose) immunization, and the remainder had not received any.

In the study area, most of the deliveries (73.6 per cent) were assisted by traditional birth attendants. However, if complications were encountered during labour then the help of a health professional was sought. The results of analysis (see Chapter Six) showed that a delivery which is attended by a combination of traditional birth attendant and professionals increase the risk of stillbirth. Complications during labour and delayed access to adequate obstetric care are likely to explain the increased risk of stillbirth.

The use of unhygienic methods in dressing the umbilical cord was still observed in this area. This unhygienic practice was usually performed by untrained traditional birth attendant. Although the percentage of those who used an unhygienic instrument, such as bamboo, was only 1.5 per cent, as explained in Chapter Five, the use of bamboo as an instrument for cutting the cord was found to be significantly increasing the risk of neonatal death.

Level of Stillbirth, Neonatal, Perinatal and Infant Mortality.

The study found that the level of infant mortality in the study area was 99.6 per 1,000 live births. This rate was slightly lower than the rate in the Indramayu Regency (based on the 1990 census) which was 103.4 per 1,000 live-births. The high level of infant mortality in the Indramayu Regency was the third highest after Serang and Karawang Regencies which were 123.8 and 109.5 per 1,000 respectively (*Dinas Kesehatan Kabupaten Indramayu*, 1993:5).

In the Indramayu Regency, the incidence of perinatal mortality is also quite high. The present study found that the perinatal mortality rate in the study site was 50.5 per 1,000 total births, which is quite high compared to the national average of 45 per 1,000 (WHO, 1984:66). The rates for perinatal mortality and its components in the Indramayu study are displayed in Table 3.2.

Table 3.2 Stillbirths, Neonatal, and Perinatal Mortality Rates in the Indramayu Study, 1993.

		Neonatal death		Rates			
Live births (N)	Stillbirth (N)	Early (N)	Late (N)	Stillbirth	Early Neonatal Mortality	Late Neonatal Mortality	Perinatal Mortality
1416	30	43	25	20.7 [a]	30.4 [b]	17.6 [c]	50.5 [d]

Note: a. Stillbirth rate per 1,000 total births
b. Early neonatal mortality rate per 1,000 live-births
c. Late neonatal mortality rate per 1,000 live-births
d. Perinatal mortality rate per 1,000 total births

The stillbirth rate in the study area was considerably higher than the figure compiled in 1984 for Indonesia which was 13.7 per 1,000 total births (WHO, 1984:66). The stillbirth rates found in the seven areas analysed by Alisjahbana (1994:22) were between 8.0 and 27.0 per 1,000 total births, on average, below the stillbirth rate in the Indramayu study.

The neonatal mortality rate in the study area was 48 per 1,000 live births. This rate is apparently higher than the national average. The figure of neonatal mortality rate from the 1991 Indonesia Demographic and Health Survey was 31.7 per 1,000 live births (Indonesian Central Bureau of Statistics, 1992:101). The high proportion in the study area underlines the need to improve the existing maternal and child health programmes.

In the study area the early neonatal mortality rate was 30.4 per 1,000 live births. This figure is considerably greater than the average early neonatal death rate found in the seven rural areas analysed by Alisjahbana (1994:22), which was approximately 12.0 per 1,000 live-births. However, compared with other figures compiled in 1984 in Indonesia which were 32.9 per 1,000 live births, the rate in the Indramayu study was slightly lower. A perinatal survey conducted in 51 type C hospitals, at regency level, in 1984 found that the early neonatal mortality was 36.3 per 1,000 live births (Kadri et al., 1991:95). Thus, if we examine the components of perinatal mortality, it may well be that the differences in the perinatal mortality rates between the Indramayu study and the figures compiled in 1984 are mainly attributed to the incidence of stillbirth. These findings suggest that stillbirths should be studied thoroughly.

If the infant and perinatal mortality rates are compared between the two study areas, the level of both infant and perinatal mortality rates are higher in Sliyeg than in Gabus Wetan sub-district (Table 3.3). In the multivariate analysis, a variable describing the study area was included as a control variable.

Table 3.3 The Infant and Perinatal Mortality Rates in Sliyeg and Gabus Wetan Sub-districts, 1993

	Sliyeg	Gabus Wetan
Infant mortality - rate [a]	127	66
Perinatal mortality - rate [b]	60	39

Note: a. per 1,000 live-births
b. per 1,000 total births.

<u>The Proportion of Low Birth Weight and the Short Pregnancy Interval</u>.

As mentioned in Chapter One, low birth weight and short pregnancy interval are known to be important predictors of infant morbidity and mortality. As explained in Chapter Five, these two variables were found to be strongly associated with the increased risk of neonatal death. Therefore, in this present study, these two variables are treated as independent as well as dependent variables (the detailed descriptions are contained in Chapter Five and Seven).

The level of low birth weight cases observed from some studies conducted in Indonesia varies greatly. The variation is not only due to geographical differences but also due to other factors such as the time of weighing. In summary, using 2,500 grams as the cut-off points for low birth weight, most estimates of the prevalence of low birth weight in Java range between nine to fourteen per cent (Alisjahbana, 1994:6).

As can be seen in Table 3.4, on average, the proportion of low birth weight cases was 6.3 per cent. This percentage is quite low compared to the other findings. It does not necessarily mean that the Indramayu babies were healthier and heavier than the others; rather it is due to problems of birth weight measurement particularly related to the timing of weighing which ranged between 0 to 69 days after birth as well as missing data. Therefore as further explained in Chapter Four, due to validity reasons, not all the information on birth weight can be included in the analysis. The results of the analysis of variance suggested that there was little variation in birth weight when the day of weighing was before the seventh day. Thus, the babies whose birth weight was measured after six days were excluded from the analysis. The proportion of low birth weight babies was higher (7.1 per cent) when only those babies whose weight was measured within six days after birth were considered. It is possible that some of the low birth weight babies were in the excluded cases. On the other hand, there is no reason to expect that a sample limited to those infants who were weighed in the first six days would be biased.

Table 3.4 Proportion of Low Birth Weight and Short Pregnancy Interval in Gabus Wetan and Sliyeg, 1993.

	Gabus Wetan N (%)	Sliyeg N (%)	Total N (%)
Low Birth Weight: [a]			
Yes	27 (4.5)	58 (7.8)	85 (6.3)
No	579 (95.5)	684 (92.2)	1263 (93.7)
Low Birth Weight: [b]			
Yes	24 (5.1)	46 (9.0)	70 (7.1)
No	446 (94.9)	464 (91.0)	910 (92.9)
Inter-Pregnancy Interval:			
< 18 months	78 (17.6)	137 (23.5)	215 (21.0)
18 - 29 months	57 (12.9)	119 (20.4)	176 (17.2)
30 - 42 months	57 (12.9)	78 (13.4)	135 (13.2)
> 42 months	250 (56.6)	248 (42.6)	498 (48.6)

Note: a. All of the cases were included
b. Restricted only to those weighed in the first six days.

A study conducted in 1990 in Bogor, West Java, involving 11,274 full-term babies, whose birth weight was measured within five days revealed that the proportion of low birth weight babies was 7.0 per cent (Husaini et al. 1993 cited in Alisjahbana, 1994:6). This prevalence is quite similar to that found in the Indramayu Study.

As mentioned, a short pregnancy interval is known to be associated with poor pregnancy outcomes. In this study, for analytical purposes, the cut-off point for a short-pregnancy interval was 18 months. As explained in Chapter Two, the length of the pregnancy interval was measured from the date of the preceding pregnancy termination to the date of the most recent pregnancy initiation. The study found that the proportion of women with a short pregnancy interval was 21 per cent. The proportion in Sliyeg was higher than in Gabus Wetan. Findings from the Indonesia Demographic and Health Survey (IDHS) conducted in 1991 revealed that women in Indonesia favour relatively long birth intervals, the median length of birth intervals being 38 months. Only one in five (20 per cent) had an interval of less than two years (Indonesian Central Bureau of Statistics, 1992:33). Taking into account the conversion of birth interval (used in the IDHS) into pregnancy interval, the prevalence of short pregnancy interval in the study area is similar to that found in the IDHS.

CHAPTER FOUR

THE ASSESSMENT OF THE QUALITY OF GESTATIONAL AGE AND BIRTH WEIGHT DATA

Gestational age has been found to be important in determining infant survival. A number of studies have indicated that gestational age, together with birth weight, serves as a powerful predictor for perinatal survival (Wilcox and Skjaerven, 1992; Golding and Shenton, 1990; WHO, 1984).

An accurate determination of gestational age is a key process in making decisions about when to conduct certain tests and interventions and allows for the identification and management of pregnancy complications. For clinicians the information may help in making decisions about induction, dysfunctional labor and caesarean section. For epidemiologists, such information will be important in distinguishing between prematurity and retarded foetal growth. For the present longitudinal study, gestational age data are used as a basis for determining the values of variables which use gestational age as one component in their calculations, for example, in calculating inter-pregnancy interval, the timing of antenatal care, maternal age at the beginning of pregnancy and the classification of preterm delivery. Thus, an assessment of the quality of gestational age data will be important in the study of factors bearing on pregnancy outcomes and, in turn, may provide information for the improvement of obstetric practices and indirectly support efforts to lower perinatal mortality.

This chapter raises issues about the need to obtain good quality gestational age data. In doing so, it presents a comparison of the results of univariate and bivariate analysis of the Indramayu gestational age data with the results of other studies. It explains the stages involved in the assessment of gestational age data, including finding a way to select good quality gestational age data. The results of the analysis of the edited and original gestational age data are also compared.

4.1 The Need for Assessing Gestational Data Quality.

The determination of gestational age is essential in pregnancy management. The duration of gestation is measured from the first day of the last normal menstrual period (LMP) and is expressed in completed days or weeks (WHO ICD 9, 1977:764). A number of methods have been used to ascertain the length of gestation. These include the use of ultrasound estimates of foetal size, the use of menstrual histories together with other physical measurements, such as fundal height, and laboratory examination, and a physical and neurological examination of the newborn baby to estimate the length of gestation at delivery (Lubchenco, 1976:10-57). For epidemiologists, a commonly used method for estimating gestational age is the LMP-based estimate of gestational age. This assumes an invariant 28-day menstrual cycle with ovulation occurring at midcycle (Berg, 1991:585).

The use of women's recollection of their last normal menstrual period for ascertaining the length of gestation is fraught with potential error. This is mainly due to uncertainty about the accuracy of the date provided by the pregnant woman. Despite this, menstrual dating is still used as an important tool in determining the duration of gestation (Lubchenco, 1976:10). An accurate date of the last menstrual period provides the most reliable estimate of delivery date. In the pre-ultrasonographic era, which still exists in most developing countries, gestation based on LMP proved to have greater statistical and biological validity than gestation based on physicians' estimates (Kiely and Susser, 1992:343). Some hospital-based studies that have been conducted revealed that, in some circumstances, the estimate of gestational age based on a mother's recall of the LMP is valid (Kramer et al., 1988; Hakim et al., 1992). These studies used ultrasonographic estimates of the foetal biparietal diameter and medical record-based gestational age as the benchmark in validating gestational data based on the last normal menstrual period.

In the Indramayu community-based study, neither ultrasound estimates of foetal growth nor medical records were available. The gestational age data collected were based solely on the women's recall of the date of the last menstrual period prior to pregnancy. Considering the inadequacies that might be found in the use of LMP-based gestational data and the importance of gestational age in the analysis of factors bearing on pregnancy outcomes, an examination of the quality of gestational age data gathered in the Indramayu study is essential. The next two sections are univariate and bivariate analyses of gestational age which provide some evidence about why the validity of such data needs to be assessed.

4.1.1 Results of Univariate Analysis.

As described in Chapter One, the gestational timing of infant birth can be classified into preterm, term, and post-term. The validity of the Indramayu gestational age data is tested indirectly by examining the proportion of preterm deliveries, using gestational age as a means of categorizing preterm cases. The incidence of preterm delivery found in some other studies is used as a relative standard in examining the quality of the Indramayu data.

Table 4.1 shows the incidence of preterm deliveries found in studies conducted in some South-East Asian countries. In these studies, the definition of preterm delivery was in accordance with the WHO standard.

Table 4.1 Incidence of Preterm Deliveries in Various Research Centres

Country	Area	Proportion delivered preterm (%)
Burma	North Okalapa	12.7
	Hlebu	13.2
	Hmawbi	12.9
China	Shanghai	5.1
Thailand	Bang Pa-in	22.4
	Ubon (1)	10
	Ubon (2)	13.6
	Ubon (3)	16
Vietnam	Phu Xuyen	14.7
	Hanoi	8.3

Sources: Golding and Shenton, 1990: 498.

The proportion of preterm deliveries found in the Indramayu study is presented in Table 4.2.

Table 4.2. The proportion of preterm deliveries in the Indramayu study, 1990-1993.

Study Area	Total cases	Total valid cases	Proportion of preterm (%)
Gabus Wetan	656	612	21.7
Sliyeg	816	800	28.3

Source: Data on preterm delivery is extracted from the MotherCare database file.

Compared to the data on preterm deliveries found in South-East Asian countries, it seems that the proportion of LMP-based preterm deliveries in the Indramayu, in general, tends to be higher.

Forty weeks of gestation is the norm and about 80 per cent of deliveries occur within the two weeks on either side of that (Lubchenco, 1976:3). The distribution of live births by gestational age from the Indramayu and other studies is shown in Table 4.3.

Table 4.3 Births by gestation (percentage)

Country	Study site	Gestational age (in weeks)				
		< 37	37 - 38	39 - 40	41 - 42	above 42
Burma:	Rural	12.5	10	76.8	0.4	0.2
	Urban	4	2.5	93.2	--	0.3
	Hospital	8.2	5.1	86.6	--	0.1
India:	Rural	7.7	--	89	--	3.3
Thailand:	Rural	2.5	12	64.7	20.3	0.5
	Hospital	5.7	20.7	57.1	16	0.6
Indramayu	Gabus Wetan	21.7	15.4	39.5	13.4	10
	Sliyeg	28.3	17.5	34.3	12.4	7.6

Data source: a. Data on Burma, India, Thailand was extracted from the WHO (1984:22).
b. Data on the Indramayu study was extracted from the MotherCare database file.

From Table 4.3 it can be seen that, in the Indramayu study, the proportion of deliveries which apparently took place at less than 37 weeks or more than 42 weeks was greater than in any other study sites. Similarly, the proportion of births which occurred at 40 weeks or within two weeks either side was the lowest. These results seem likely to indicate some misreporting in the Indramayu study.

4.1.2 Results of Bivariate Analysis

As previously mentioned, birth weight and gestational age are well-known indicators for predicting mortality and morbidity in the first few months of life. Gestational age itself is highly correlated with birth weight. An infant born prematurely has had inadequate time to develop. Low birth weight infants may result from premature delivery, intrauterine growth-retardation or a combination of the two (Kramer, 1987b:502). Therefore, in addition to the use of gestational age comparisons, birth weight data were employed in assessing gestational data. In this data assessment process, the gestational age-specific birth weight distributions obtained from the Indramayu data were compared with similar distributions of data derived from other studies.

In Indonesia, there was a study concerning the relationship between gestational age and the anthropometric measurements, including birth weight, of live born infants. This study which aims at developing standard intrauterine growth curves was conducted in hospital settings in 14 teaching centres (Alisjahbana et al., 1994). In this study, data on gestational age was obtained through the last menstrual period (LMP) method. The study found that as a result of strict criteria in the selection of respondents, all the respondents in the study were from mid or high socio-economic level (Alisjahbana et al., 1994:87). The results of this hospital study may not be reflects the true situation in community settings due to socio-economic bias. This is particularly the case for the present (Indramayu) study where the majority of the respondents' economic status was classified into the low category (see Chapter Three). In addition, the use of the LMP-based gestational age as the benchmark in validating the Indramayu gestational age may also be debatable due to the quality of the gestational age standard. For these reasons, Lubchenco's gestational age-specific birth weight distributions was used as the standard (Lubchenco, 1976:4).

As with the birth weight data obtained from outside hospital or clinical systems the measurement or weighing of the baby, in the Indramayu study, was not always conducted immediately after delivery. The babies were weighed at some point between

0 and 69 days following birth, which means that not all of the 'birth weight' data can be assumed to reflect actual birth weight. This is so because there can be a physiological weight loss during the first three days of life due to the loss of tissue fluid and meconium as well as a limited food and fluid intake. When the milk supply is adequate, a steady increase in weight is expected from the fourth day of life (Ojo and Briggs, 1982:349).

One-way analysis of variance was performed to determine the extent to which the variability of the day of weight measurement influenced the validity of the data. In this analysis, birth weight was assigned as the dependent variable while gestational age served as an independent variable. The results showed little variation when the day of weighing was less than 7 days. In the Indramayu population, the hypothesis that babies who are weighed within the sixth day of birth have the same mean weight as if they were weighed on the first day could not be rejected (F ratio=0.8842, F probability=0.5062). The cumulative frequency of cases at this six days cut-off point was 68.7 per cent for Sliyeg and 77.6 per cent for Gabus Wetan.

In order to assess whether the early initiation of breastfeeding affects the mean birth weight, especially for those cases weighed within four to six days after birth, an analysis of variance was conducted. This analysis was performed among cases who weighed in that interval since it is assumed that after three or four days following birth there will be an increase of the weight. In this case, due to data limitations, the timing of breastfeeding initiation indicates only whether the breastfeeding was given within 24 hours at birth. The result of analysis indicates that, in this data set, the effect of early breastfeeding on the mean weight was not significant (F ratio=3.24; F probability=0.07).

Table 4.4 presents the 10th and 90th percentile distributions of birth weight by gestation using the Indramayu and Lubchenco data, including all cases in the analysis.

Table 4.4 The 10th and 90th percentiles of birth weight by gestation based on the Indramayu (1990 - 1993) and Lubchenco data.

Study site	Gestation (weeks)	Indramayu data 10th	Indramayu data 90th	Lubchenco data 10th	Lubchenco data 90th
Sliyeg:	28	3150	3500	825	1500
Gabus:	28	2900	3400		
Sliyeg:	30	2100	3200	1000	1750
Gabus:	30	2500	3500		
Sliyeg:	32	1800	3500	1250	2150
Gabus:	32	1800	4000		
Sliyeg:	34	1830	3710	1500	2750
Gabus:	34	2080	4240		
Sliyeg:	36	2410	3745	1900	3275
Gabus:	36	2400	3800		
Sliyeg:	37	2560	3340	2150	3425
Gabus:	37	2800	3780		
Sliyeg:	38	2415	3585	2325	3550
Gabus:	38	2500	3900		
Sliyeg:	39	2700	3525	2500	3650
Gabus:	39	2600	3600		
Sliyeg:	40	2600	3750	2550	3750
Gabus:	40	2600	3670		
Sliyeg:	41	2420	3730	2675	3825
Gabus:	41	2600	3710		
Sliyeg:	42	2675	3847	2700	3850
Gabus:	42	2550	3800		

Source: The Indramayu data is extracted from the MotherCare database file

The percentile distribution of birth weight by gestation suggests that the weight of Indramayu babies was much greater than the birth weight standard. This was particularly the case for those babies born at 36 weeks or earlier. If the distribution of births by gestational age as presented in Table 4.3 are compared, it is highly unlikely that there are really so many overweight babies. Rather, some babies who were in fact born at term (37 to 41 weeks gestation) must have been classified as preterm. This finding provides more evidence that some of the Indramayu gestational age data were inaccurate. Despite overall inconsistencies found in the Indramayu data, some of the anomalous cases may be accurate. Kramer et al. (1988:3308) report that approximately one quarter of infants said to be born premature are in fact born at term and about one-eighth of infants classified as born post-term are actually at term. In order to be able to use the Indramayu data for the analytical program of this thesis, it was therefore useful to devise a classification of data validity.

4.2 Gestational Age Data Validation

In the Indramayu study, the detection of pregnancy began with questioning the woman about her last menstrual period. If the date of the last menstrual period was more than five weeks before and if the delay of the menstrual period was not associated with post-partum amenorrhoea, post abortum amenorrhoea, lactational amenorrhoea, menopausal state, the use of contraception especially norplant, and she felt that she is pregnant, she was then regarded as 'suspected pregnant'. One month later a MotherCare interviewer visited the suspected pregnant woman to ascertain whether or not the respondent was pregnant. If she was pregnant, the interviewer collected some information about the pregnancy, then visited the woman every month for the progressive collection of data about pregnancy-related health and health care behaviour. The beginning of pregnancy was then determined from the reported date of the first day of the last normal menstrual period. In this case, the accuracy of the date of pregnancy initiation is important in determining the quality of gestational age data.

In the present study, the duration of gestation was calculated from the beginning of pregnancy until it terminated. Gestational age was initially obtained by calculating the difference between the date of pregnancy termination and the date of LMP to give the duration in days. This was then converted into completed weeks by dividing by seven and rounding to the nearest integer.

In the Indramayu study, data on women's last menstrual period (menstrual history) was also collected longitudinally once every three months. This was part of the demographic events-related data which were collected longitudinally through the survey registration system (SRS). On these visits, data on a woman's menstrual status were collected retrospectively; menstrual cycles which were experienced between 90 and 60 days, between 60 and 30 days, and up to 30 days before the time of interview.

The data on women's menstrual histories could therefore be used for checking the consistency of the last menstrual period data recorded by the MotherCare interviewers. However, the recorded menstrual history could not be used as a single standard for validating LMP data. Firstly, the accuracy of the recorded date was highly influenced by a woman's recall of her menstrual period. Secondly, in the case that a woman could not clearly provide her date of LMP, the interviewer then asked probing questions and observed the physical pregnancy signs to determine the woman's pregnancy status. Based on these observations and the probing questions, the interviewer then assigned an 'appropriate' date of the LMP. Although the proportion of such cases was small, this procedure might have led to bias and subsequently to misreporting. Thirdly, in some cases, women were reluctant to disclose their pregnancy status in the early stages. The reasons for this were that the young respondents (aged 12 to 14 years) felt that they were still children while others were unmarried; some older respondents, were reluctant because they felt old and already had many children. These situations might have led the women to provide different dates of LMP to the SRS interviewer and the MotherCare interviewer, resulting in some inconsistencies between the date of LMP recorded in the MotherCare file and the menstrual histories recorded in the SRS database. Considering these shortcomings, the recorded birth weight and menstrual histories together with the standard of birth weight by gestation were employed as a way of validating the Indramayu gestational age data.

Figure 3. Gestational Age Data Assessment

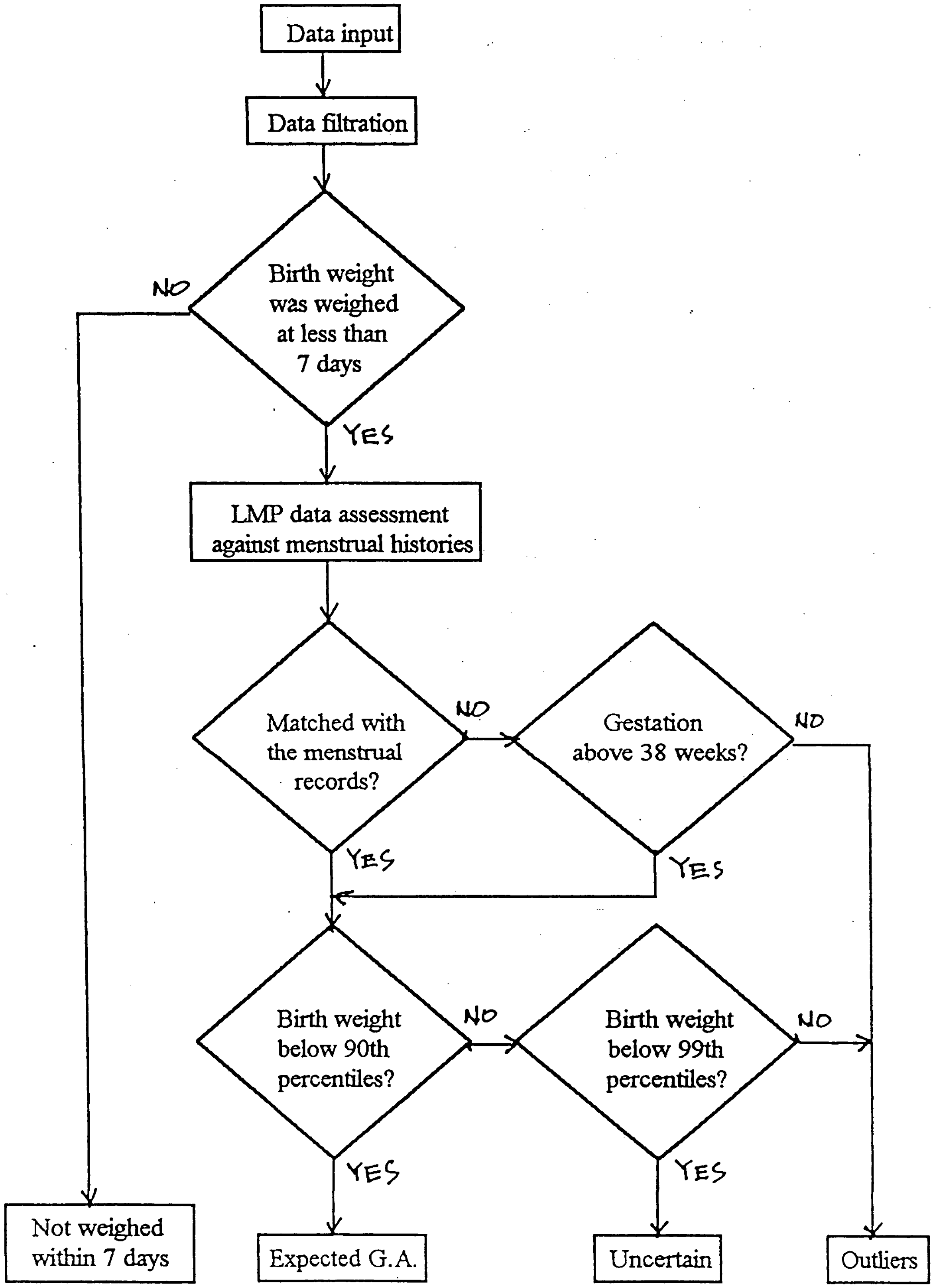


Figure 3 depicts the steps taken in validating the gestational data. As a first step, the cases were divided into two groups, those respondents whose babies were weighed at less than seven days, and those whose babies were weighed at seven or more days after delivery (see Table 4.5 for the number of selected cases). For practical purposes, these two groups of cases were then assigned as validated and not-validated groups. The validated group consists of the cases whose babies were weighed at less than seven days at birth and therefore eligible for further data validation. A missing value was assigned to those cases with missing gestational age data. Following this, the recorded dates of LMP of the validated group were further processed, that is matched with the women's menstrual histories, but the dates of LMP of the other group, whose babies were weighed at seven or more days, were not included in the next data validation process. They were put into a separate, not-validated gestational age category.

Table 4.5 Total and selected cases in the data validation process

Study site	Total cases	Selected cases
SLIYEG	816	549
GABUS WETAN	656	499
Total	1472	1048

Source: These data are extracted from the MotherCare database file.

As explained, data about a woman's menstrual history were collected retrospectively and longitudinally. Each eligible woman (aged 12 to 49 years) in the study sample had a monthly menstrual record. Thus, the timing of a change in menstrual status from a menstruating to a non-menstruating state due to pregnancy (amenorrhoea) could be detected in the menstrual history records. Figure 4 gives a pictorial example of a menstrual record for a woman whose pregnancy had been detected.

Figure 4. A pregnant woman's menstrual records stored in the women longitudinal database file

HAI	HAI	HAI	TAH	TAH	TAH
7 Aug.	6 Sept.	**6 Oct.**	**7 Nov.**	7 Dec.	6 Jan.

Note: HAI refers to menstruation while TAH is not in menstrual period (amenorrhoea).

The date shown in the box is not the exact date of the last menstrual period, but rather the date of the interview visit. From Figure 4 it can be seen that, even though the date of the onset of pregnancy could not be given precisely in the box, it certainly occurred sometime between 6 October and 7 November. This time interval was therefore used as a time reference to validate the correctness of the date of last menstrual period before pregnancy occurred. If the reported date of LMP was far beyond that interval, it may mean that the date of LMP had been incorrectly reported or estimated. However, some allowance was made for those cases where the gestational age was above 38 weeks. Even if the date of LMP was beyond the proposed limit, if the gestation was above 38 weeks, the recorded gestational data was still regarded as valid on the condition that it met another criterion which will be explained below. The decision to include such cases in the analysis was made for three reasons. Firstly, as previously mentioned, women's recall of the date of LMP, in some cases, was inconsistent, because some women gave different dates to the SRS and the MotherCare interviewers. Secondly, the interviewer's own judgement in reporting the date might also have been incorrect. Thirdly, if birth weight was compared with gestational age (see Table 4.4), gestational age at 38 weeks or above generally showed consistency with the standard birth weight.

The time interval between the last menstrual period and conception depends on the variability of fecundability during the cycle, but on average the time interval is 14 days. In some cases however, the 14-day time interval may be confounded by a number of factors such as irregularity of menstrual cycles, postconception bleeding, and prolonged time interval between the last menstrual period and ovulation after withdrawal of a contraceptive drug (Lubchenco, 1976:10). It is therefore possible that the reported LMP in such cases is subject to misreporting. If the researcher used menstrual histories as the only criterion in accepting the validity of LMP data, it is possible that the cases with such conditions were included in the wrong category of validity and this may cause some bias in the analysis. For these reasons, in the present study it was decided to use the recorded birth weight as an additional parameter in judging the quality of the gestational data. As has been mentioned, Lubchenco's data on birth weight by gestation was used as a birth weight standard.

The next stage in the data validation was to ascertain whether or not the birth weight data according to gestation still lay within the range of the birth weight standard. If it exceeded the 90th percentile of the standard birth weight, it was possible that the baby was large for its gestational age. To ensure that the birth weight of such babies was not too far from the valid range of weight for gestational age, another criterion, the 99th percentile of birth weight standard, was applied. If the birth weight exceeded the 99th percentile it is likely that the gestational age was incorrectly reported or misdated. In this case, such gestational age was regarded as an 'outlier'. As a result of this data validation process, the processed gestational age data were categorised into four groups:

a). *Expected gestational age*, if the gestational age matched the two sources of menstrual period data (or did not match the records provided that the gestational age was more than 38 weeks) and the birth weight did not exceed the 90th percentile;

b). *Uncertain*, if the gestational age matched on both menstrual records and the birth weight exceeded the 90th but not the 99th percentile of the standard;

c). *Outlier*, if the gestational age did not match on the menstrual records (and the gestation was below 38 weeks) or the birth weight was above the 99th percentile of the birth weight standard;

d). *Not-validated* with gestational age for those babies weighed at seven or more days after birth.

In addition to these four categories, a missing category was assigned to those cases which either did not have gestational age data or had missing menstrual records, and therefore could not be included in one of the four categories of data. Also, those cases without birth weight data, abortions, stillbirths, and some live born babies, were included in the not-validated category.

A new explanatory variable was created, based on the classification of the gestational age data. The values contained in this new categorical variable thus consisted of four categories that represent the validated and not-validated data (see Table 4.6 below).

4.3 Results of the Data Validation Process.

The main purpose of conducting data validation is to classify data quality, particularly for gestational age data. This enables the researcher to conduct further meaningful data analysis based on the assessment of valid data and thus minimise potential biases due to the use of invalid data.

Table 4.6 presents the distribution of cases according to the categorized gestational age. From this table it can be seen that, of the selected cases for data validation, the largest proportion of gestational age data were in the 'expected gestational age' category. However, this category was less than half of all the cases. The proportion of 'outlier' cases was somewhat higher than the 'uncertain' category cases and much higher than the expected proportion of outliers (one per cent). In both sub-districts, the proportion of missing cases was the lowest. In order to minimize bias, these missing cases will be excluded from the analysis.

Table 4.6 Number of cases based on the categorized gestational age in each of the two sub-districts, 1990-1993.

Study site	Category of gestational age data				
	Expected G.A. N (%)	Uncertain N (%)	Outliers N (%)	Not-validated N (%)	Missing cases N (%)
Sliyeg	352 (43)	44 (5)	98 (12)	306 (37)	16 (2)
Gabus Wetan	303 (46)	54 (8)	69 (10)	186 (28)	44 (6)

For analytical purposes, the four categories were collapsed into three, namely:

a. Category one, for *expected gestational age* cases.

b. Category two, for *uncertain* and *outlier* cases combined.

c. Category three, for *not-validated* cases.

In order to know the extent to which the data validation procedure has affected the quality of data, some descriptive data analysis was conducted. This analysis was conducted for gestational age, birth weight, and some socio-demographic characteristics and pregnancy histories of the cases included in the three categories.

Socio demographic profiles and pregnancy histories.

Tables 4.7 to 4.10 present the socio-demographic profiles and pregnancy histories of the respondents, classified by the categories of quality of gestational age data.

Table 4.7 Socio-demographic characteristics of the respondents classified by the category of gestational age data, Gabus Wetan, 1990 - 1993

Socio-demographic Profiles	Category of gestational age (percentage)		
	Expected G.A. (1)	Uncertain/ outliers (2)	Not-validated (3)
Respondent's age:			
< 20	29.4	21.1	25.3
20 - 34	58.4	65.9	60.8
35+	12.2	13	14
Marital status:			
Never married	0.3	--	1.1
Divorced/seperated	4	2.4	5.9
First marriage	66	59.3	60.2
Second or more - marriage	29.7	38.2	32.8

Table 4.7 (Continued).

Respondent's education:			
No schooling	34	44.7	43.2
Some primary	33.7	34.1	28.6
Completed primary	26.7	17.1	20
Junior or senior-high school	5.6	4.1	8.1
Husband's Education:			
No schooling	26.6	25.4	26.4
Some primary	30.8	39	39.1
Completed primary	22.1	27.1	24.7
Junior or senior-high school	20.4	8.5	9.2
University	--	--	0.6
Respondent's Occupation:			
Unemployed	53.3	51.3	54.8
Laborer	21.8	20.5	16.4
Farmer	22.8	27.4	28.2
Services	0.4	0.9	0.6
Govt. employee	1.1	--	--
Trader	0.7	--	--
Husband's Occupation:			
Unemployed	8.5	7.1	9.5
Laborer	36.3	28.6	29.2
Farmer	43.4	53.6	50.6
Services	3.9	4.5	6
Govt. employee	5.3	1.8	2.4
Trader	0.4	--	--
Driver	2.1	4.5	2.4
Parity:			
0	37.7	21.8	35
1	24.7	27.7	24.4
2	17.1	23.5	10.6
3	9.2	10.1	10.6
more than 3	11.3	16.8	19.4

From Table 4.7 it can be seen that, in general, the socio-demographic profiles of respondents included in the three categories of data follow a similar pattern. However, there are some exceptions. In Category two (uncertain/outlier) the proportions of respondents' husbands who had never attended school and completed primary school were fairly similar while in the other two categories the proportions of husbands who had never attended school were somewhat higher than those who had completed primary school. In Category two data, the largest proportion of respondents had one child while in the other categories the majority had no children.

Table 4.8 Socio-demographic characteristics of the respondents classified by the category of gestational age data, Sliyeg, 1990 - 1993.

Socio-demographic Profiles	Category of gestational age (percentage)		
	Expected G.A. (1)	Uncertain/ outliers (2)	Not-validated (3)
Respondent's Age:			
< 20	26.4	26.1	24.2
20 - 34	24.2	57	57.8
35+	15.6	16.9	18
Marital Status:			
Never married	--	0.7	0.3
Divorced/seperated	2.8	2.8	2.6
First marriage	53.3	55.6	49.3
Second or more - marriage	43.9	40.8	47.7
Respondents's Education:			
No schooling	39.6	37.3	44.1
Some primary	30.5	38	34.3
Completed primary	20.2	21.1	18
Junior or senior - high school	9.7	3.5	3.6
Husband's Education:			
No schooling	32.4	32.1	31.5
Some primary	31.8	46.3	44.4
Completed primary	20.4	14.2	14.2
Junior or senior - high school	15	7.5	9.8
University	0.3	--	--

Table 4.8 (Continued).

Respondent's Occupation:			
Unemployed	90.2	89.4	88.5
Laborer	7.8	6.3	8.2
Farmer	1.2	0.7	1.6
Services	0.6	1.4	1.3
Govt. employee	0.3	1.4	0.3
Trader	--	0.7	--
Husband's Occupation:			
Unemployed	3.9	2.4	5.9
Laborer	34.6	35.7	44.3
Farmer	36.2	31	28.2
Services	10	6.3	8.1
Govt. employee	4.9	3.2	2.2
Trader	0.6	1.6	--
Driver	9.7	19.8	11.4
Parity:			
0	30.4	27	29.4
1	20.9	12.8	13.7
2	14.8	9.9	18.4
3	9.3	14.9	9.7
more than 3	24.6	35.5	28.8

The respondents' socio-demographic characteristics in Sliyeg sub-district also showed a similar pattern to that observed in Gabus Wetan. A few exceptions can be observed in the patterns of educational attainment and parity.

In both sub-districts, the majority of respondents' husbands had some primary schooling. However, the proportion of such education was larger in Sliyeg than in Gabus Wetan. In Sliyeg, the proportion of respondents who were unemployed was larger than in Gabus Wetan. While the majority of husbands in Gabus Wetan were farmers, the majority of husbands in Sliyeg were labourers.

Despite some discrepancy in the proportion of educational attainment and occupation, the patterns of socio-demographic characteristics of the respondents and their husbands in each category of the gestational age data were similar.

As has been explained, a six days cut-off point for the day of birth weight measurement was used as a prerequisite for cases to be included in the gestational age data validation. This cut-off point was employed in order to avoid a potential bias due to the use of invalid birth weight data. According to data collection procedures the birth weight should have been measured as soon as possible after birth, but unfortunately, in the real situation, the day on which the birth weight was measured ranged from 0 to 69 days. The measurement of birth weight was actually dependent on how soon the parent reported the birth to the project interviewer who weighed the baby. In order to discover the joint effects of differing socio-demographic backgrounds on the likelihood of whether or not the baby was weighed at less than seven days, a multivariate logistic regression analysis was conducted. In this case, the outcome variable was set equal to one if the baby was weighed at less than seven days and at zero otherwise.

The resulting coefficients presented in Table 4.9 indicate that almost all of the socio-demographic characteristics of the respondents were not significantly related to the likelihood of whether or not the respondent reported the birth event in less than seven days or more. It is interesting to note that for the respondents whose husband was engaged in trading activities, the likelihood for having the baby weighed at less than seven days was quite remarkably. This may be due to the high interactions with customers that explains the promptness of reporting the delivery to the project interviewer. However, this phenomenon was not significant. The findings suggests that the promptness of reporting a birth event and thus the promptness of weighing the baby was unlikely to be due to respondent factors, but rather to other factors, such as the reporting system of deliveries that was applied in the MotherCare project.

Table 4.9 Logistic regression of the likelihood of measuring the birth-weight at less than seven days, Gabus Wetan and Sliyeg, 1990 - 1993.

Covariates	Gabus Wetan		Sliyeg	
	Odds ratio	p value	Odds ratio	p value
Maternal age:				
(<20)				
20 - 34	1.07	0.82	0.76	0.42
35+	1.68	0.32	0.83	0.68
Marital status:				
(Divorced)				
First marriage	0.75	0.67	0.73	0.62
Second marriage	0.64	0.51	0.81	0.74
Family structure:				
(Nuclear)				
Extended	1.15	0.67	0.85	0.61
Maternal education:				
(No schooling)				
Some primary	1.32	0.3	0.85	0.45
Completed primary	1.34	0.38	1.13	0.67
High school	0.61	0.36	1.99	0.17
Husband's occupation:				
(Unemployed)				
Laborer	1.1	0.84	2.1	0.07
Services	0.73	0.6	3.47	0.01
Govt. employee	2.46	0.24	3.14	0.08
Trader	25.13	0.81	189.14	0.43
Farmer	1.01	0.98	2.7	0.02
Driver	0.96	0.96	2.41	0.06
Parity:				
(o)				
1	1.04	0.91	1.86	0.1
2	2.09	0.1	0.81	0.6
3	0.81	0.65	1.14	0.76
more than 3	0.99	0.99	1.12	0.77
Attendant at birth:				
(Medical personnel)				
TBA & trad. healer	0.68	0.35	0.67	0.18
Others	1.44	0.75	0.54	0.16

Note: the reference category is in the parenthesis.
TBA = traditional birth attendant.

Table 4.10 and Table 4.11 present the respondents' pregnancy histories including pregnancy outcomes. The pregnancy histories also revealed a similar pattern to those observed in the respondents' socio-demographic characteristics. Nevertheless, a very marked difference was observed in the proportion of perinatal deaths. The proportion of perinatal deaths amongst cases included in Category three, not-validated, was by far the highest. This means that, according to the categorisation of cases in the data validation procedure, the rate of perinatal deaths was higher among those respondents whose babies were weighed at more than six days, or whose gestational age was not validated due to inappropriate birth weight measurement. One possible explanation is that the stillbirth cases, a component of perinatal mortality, had no birth weight data and were thus included in the not-validated category. Another explanation is, given that not all the birth weight was measured immediately, it is possible that some of the live born babies have died before their birth weights were taken and thus included in the not-validated group. To find out what factors rendered the rate of perinatal deaths higher among those respondents whose birth weight was measured at more than six days, some covariates of perinatal death need to be examined.

Table 4.10 Pregnancy histories of respondents classified by the category of gestational data, in Gabus Wetan, 1990 - 1993.

Pregnancy histories	Category of gestational age (percentage)		
	Expected G.A. (1)	Uncertain/ outlier (2)	Not-validated (3)
Sex of baby: (current outcome)			
Male	53.1	57.7	49.7
Female	46.9	42.3	50.3
Gravidity:			
Primigravidae	36.3	21.1	33.9
Multigravidae	63.7	78.9	66.1
Preceding pregnancy - interval (in months):			
< 12	12.5	14.6	9.8
12 - 18	3.1	7.3	8.1
19+	84.4	78.1	82.1
Preceding pregnancy - outcome:			
Live birth	85.5	87.6	88.6
Stillbirth	2.1	3.1	--
Abortion	12.4	9.3	11.4
Current pregnancy - outcome:			
Live birth	100	100	96.8
Stillbirth	--	--	1.8
Abortion	--	--	1.4
Perinatal death: (current pregnancy)			
Total births (N)	303	123	177
Perinatal deaths (N)	6	1	17
Perinatal death rate	19.8	8.1	96

Table 4.10 (Continued).

Trimester of prenatal - care initiation:			
First trimester	10.8	13.3	13
Second trimester	62.9	63.7	56.8
Third trimester	26.2	23	28.4
Fourth trimester	--	--	1.9
Provider sought at - first prenatal care:			
T.B.A	27.9	27.4	30.9
Paramedical	12.6	19.5	13
Midwife	54.5	53.1	53.1
Physician	4.5	--	3.1
Other	0.3	--	--
Prenatal visits:			
Never	5.6	8.1	12.9
1 to 5	81.9	86.2	82.3
More than 5	12.5	5.7	4.9
Attendant at delivery:			
T.B.A	87.5	87	87.1
Paramedical	1.3	--	0.5
Midwife	9.9	10.6	7.5
Physician	--	--	3.8
Other	1.3	1.8	1

Note: the TBA are traditional birth attendants, both trained and untrained. The majority have been trained. Total births = stillbirths + live births.

Table 4.11 Pregnancy histories of respondents classified by the category of gestational data, in Sliyeg, 1990 - 1993.

Pregnancy histories	Category of gestational age (percentage)		
	Expected G.A. (1)	Uncertain/ outlier (2)	Not-validated (3)
Sex of baby: (current outcome)			
Male	49.1	57.7	53.6
Female	50.9	42.3	46.4
Gravidity:			
Primigravidae	29.8	26.8	28.8
Multigravidae	70.2	73.2	71.2
Preceding pregnancy - interval (in months):			
< 12	10.2	13.5	12.4
12 - 18	12.6	16.3	14.2
19+	77.3	70.2	73.3
Preceding pregnancy - outcome:			
Live birth	92.7	91.3	92.7
Stillbirth	0.8	2.9	1.4
Abortion	6.5	5.8	6
Current pregnancy - outcome:			
Live birth	100	100	88.6
Stillbirth	--	--	5.9
Abortion	--	--	5.6
Perinatal death: (current pregnancy)			
Total births (N)	352	142	289
Perinatal deaths (N)	6	6	36
Perinatal death rate	17	42.2	124.5
Trimester of prenatal - care initiation:			
First trimester	11.9	16.4	14.2
Second trimester	59.4	67.2	48.4
Third trimester	27.6	16.4	33.3
Fourth trimester	1	--	4.1

Table 4.11 (Continued).

Provider sought at - first prenatal care:			
T.B.A	20.1	24.2	27.9
Paramedical	20.5	25.9	18.7
Midwife	57.3	50	53
Physician	1.7	--	0.5
Other	0.3	--	--
Prenatal visits:			
Never	16.8	18.3	28.4
1 to 5	76.7	78.2	68.3
More than 5	6.6	3.5	3.3
Attendant at delivery:			
T.B.A	76.7	80.3	79.4
Paramedical	6	6.3	2.3
Midwife	10.5	7.7	6.2
Physician	0.3	--	1.6
Other	6.5	5.6	10.5

Note: the TBA are traditional birth attendants, both trained and untrained. The - majority have been trained. Total births = stillbirths + live births.

Table 4.12 presents the socio-demographic characteristics of respondents which were not validated due to missing birth weight data. Only live-born babies with missing birth weight data were included; abortion and stillbirth cases, those with no birth weight data, were excluded. In general, the characteristics of these respondents follow similar patterns to those included in the data validation process. This further analysis continues to indicate homogeneous patterns in the socio-demographic profiles. An exception was respondent's age. The respondents in the excluded cases were older than the others and this also affected parity, in that the number of children ever born was larger. Also, the largest proportion of respondents' husbands, especially for those excluded cases residing in Gabus Wetan, were 'farmers'. The discrepancies present in this category of 'not-validated' cases may have had some influence on the analysis of birth weight, for example, low birth weight; however, the number of such cases was relatively small. Furthermore, the emphasis of data analysis in the present study is not on the determinants of low birth weight *per se*.

Table 4.12 Socio-demographic characteristics of cases with missing data on birth weight, both study sites, 1990 - 1993 (Percentage)

Socio-demographic - characteristics	Study site 1	
	Gabus Wetan	Sliyeg
Respondent's age:		
< 20	24.1	30.8
20 - 34	51.7	46.2
35+	24.1	23.1
Marital status:		
Never married	--	--
Divorced/seperated	13.8	--
First marriage	58.6	28.2
Second or more marriage	27.6	71.8
Respondent's education:		
No schooling	41.4	43.6
Some primary	24.1	23.1
Completed primary	27.6	28.2
Junior or senior - high school	6.9	5.1
Respondent's occupation:		
Unemployed	55.6	84.6
Laborer	11.1	10.3
Services	--	--
Farmer	33.3	5.1
Husband's education:		
No schooling	14.3	26.3
Some primary	46.4	50
Completed primary	25	10.5
Junior or senior - high school	14.3	13.2
Husband's occupation:		
Unemployed	7.7	5.7
Laborer	11.5	60
Services	11.5	17.1
Govt. employee	--	--
Farmer	69.2	11.4
Driver	--	5.7

Table 4.12 (Continued).

Parity:		
0	42.3	32.4
1	7.7	21.6
2	11.5	13.5
3	--	5.4
more than 3	38.5	27

Note: 1. Number of this cases was 29 in Gabus Wetan and 39 in Sliyeg.
All of those cases were live-born.

4.3.1 The Quality of Gestational Age Data

The findings of some studies showed that in the vast majority of cases with gestational ages under 20 or over 45 completed weeks, the recording of gestation is inaccurate. These are referred to as being outside the range of biological plausibility (David, 1980:968). In the Indramayu study, it was found that many cases also fell outside such a range of plausibility (see Table 4.13).

Table 4.13 Proportion of cases beyond the range of biological plausibility, classified according to the category of gestational age data and study site.

Study site	Category of gestational age (Percentage)					
	Expected G.A. (1)		Uncertain/ outlier (2)		Not-validated (3)	
	<20	>45	<20	>45	<20	>45
Sliyeg	-	-	-	2.1	2.3	0.7
Gabus Wetan	-	-	-	2.4	1.6	0.5

The distribution of cases in Table 4.13 shows that, in Category one, Expected G.A., none of them fell outside the biologically plausible range. This suggests that the procedure adopted for validating gestational age worked quite well in selecting good quality data from the cases. In Category three, not-validated, some cases were found to have less than 20 or over 45 weeks gestation. The minimum number of completed weeks of recorded gestation was 12, while the maximum was 47. In order to minimise bias in the next stage of analysis, the cases with gestational age outside the range of biological plausibility are excluded.

Table 4.14 shows the prevalence of preterm deliveries in the cases which have been validated. Of the three categories of gestational age data, the proportion of preterm deliveries in Category one, expected G.A., was the most logical.

Table 4.14 Prevalence of preterm deliveries in each of the two sub-districts, classified according to the category of the validated gestational age data, 1990-1993.

Study site	Category of gestational age (Percentage)		
	Expected G.A (1)	Uncertain/ outlier (2)	Not-validated (3)
Sliyeg	8.5	62.7	32.7
Gabus Wetan	7.7	50.4	23.7

A study conducted in the United States which examined the association between menstrual cycle length and the LMP-based estimate of gestational age (using Ogino-Knaus corrections and other methods) revealed that the proportion of preterm deliveries ranged between 6.2 to 6.4 per cent (Berg, 1991:587). The proportion of preterm deliveries based on the validated gestational age in the Indramayu study compared reasonably well with those in Berg's study as well as in some other countries (see Tables 4.1 and 4.3). On the other hand, the highest prevalence of preterm births was in Category two (uncertain/outlier) data. Such a high prevalence of preterm births is unlikely to be correct, but it was not surprising since cases included in the Category two data were categorised as either *uncertain* or *outlier*.

The majority of births usually occur around two weeks either side of 40 completed weeks' gestation. Results from carefully collected clinical studies have also revealed that about 24 to 28 per cent of births occur at 40 completed weeks (David, 1980:971). The results of the validated gestational age was consistent with these findings (Table 4.15), particularly in Category one, expected G.A., with the proportion of births at 40 weeks ranging from 26.7 to 30.4 per cent for Sliyeg and Gabus Wetan respectively. However, in both sub-districts, the proportion of births which occurred post-term (43 to 45 weeks) was quite high.

Table 4.15 Prevalence of births by gestation classified by the category of the validated gestational age data, Sliyeg and Gabus Wetan, 1990 - 1993.

Category of data	Gestational age (in weeks)					
in each sub-district	< 37	37 - 38	39 - 40	40 only	41 - 42	above 42
Sliyeg:						
Expected G.A	8.5	15.9	46.3	26.7	18.5	10.8
Uncertain/outlier	62.7	19	11.3	7.7	2.8	4.2
Not-validated	32.7	18.6	31	19.9	9.8	4.9
Gabus Wetan:						
Expected G.A	7.7	12.5	50.6	30.4	18.9	10.3
Uncertain/outlier	50.4	23.6	9.8	4.9	4.9	11.3
Not-validated	23.7	14	38.7	26.3	10.8	10.8

The proportion of births at 40 weeks was quite low in the Category 2 (uncertain/outliers) data. As was the case with the data from Table 4.14, it is also unlikely that such a low proportion of births reflects the true situation. It may well be that the gestational age was misdated.

The results of the comparisons of the percentage of preterm and term cases between the validated gestational age and other studies suggest that the validation procedure employed in the present study was quite reliable.

4.3.2 The Quality of Birth weight Data

As previously mentioned the gestational age data were examined, partly, based on the agreement between the recorded birth weight data and the standard of birth weight. While the babies were weighed between 0 and 69 days following delivery, the mode was one and two days for Gabus Wetan and Sliyeg respectively. According to the analysis of variance performed, only those cases whose birth weights were measured at less than seven days reflected the actual birth weight data, and were included in the data validation process. All the tables below present information for those validated cases where birth weight was measured at less than seven days.

Table 4.16 shows the distribution of birth weight in the study area. In both sub-districts, nearly half the birth weights fell in the range 3000 to 3499 grams with more than 60 per cent between 2500 and 3500 grams. This frequency distribution closely approximated those found in other studies conducted in Indonesia and other South East Asian countries (WHO, 1984:13). Using the WHO definition of low birth weight, that is less than 2500 grams, the proportion of low birth weight babies in the study area was 7.1 per cent; 5.1 per cent in Gabus Wetan and 9.0 per cent in Sliyeg.

Table 4.16 Birth weight in the Indramayu study, 1990 - 1993.

Birth weight (in grams)	Study area			
	Gabus Wetan		Sliyeg	
	N	%	N	%
1000 - 1499	no valid cases		no valid cases	
1500 - 1999	3	0.6	8	1.6
2000 - 2499	21	4.5	38	7.5
2500 - 2999	115	24.5	127	24.9
3000 - 3499	206	41.3	236	46.3
3500 - 3999	108	21.6	84	16.5
4000 - 4499	12	2.4	14	2.7
4500 - 4999	5	1	1	0.2
5000+	--	--	2	0.4

The distribution of median birth weight and median gestation periods (Table 4.17) seems to indicate that the median distributions in the Indramayu study were reasonably similar to those in other studies.

Table 4.17 Median birth weights, median gestation periods and the proportion of low birth weight infants in the Indramayu study (1990 - 1993) and other areas (1961).

Study sites	Median birth weight (grams)	Median gestation (weeks)	Percentage of LBW infants
Philippines	2889	39.6	14.2
Malaysia	2986	39.8	16.8
India	2771	40.6	28
Iran	3024	39.4	14.2
Syria	3057	39.8	19.9
Indramayu study:			
- Gabus Wetan	3100	39	5.1
- Sliyeg	3100	38.7	9

Note: Data from other sites are extracted from WHO (1961 cited in Lubchenco 1976:185).

Despite the similarities in median birth weight and median gestation, the proportion of low birth weight in the Indramayu study was much lower than in the other studies. The incidence of low birth weight found in the Indramayu study was also low compared with other studies conducted in Indonesia and other countries (Table 4.18).

Table 4.18 The percentage distribution of low birth weight infants in the Indramayu study (1990 - 1993) and other areas (1984).

Country	Study site	% Low birth weight (< 2500 grams)
Burma:	Rural	14.8
	Urban	25.8
	Hospital	23.5
India:	Rural	19.9
Indonesia:	Rural	14.6
	Hospital	17.5
Thailand:	Rural	8.2
Indramayu study:	Gabus Wetan	5.1
	Sliyeg	9

Note: Data from other studies are extracted from WHO (1984:14).

Given the incidence of low birth weight in these other studies, it is unlikely that the low proportion of low birth weight in the Indramayu study, especially in Gabus Wetan sub-district, reflects the true situation. One possible explanation is that not all the cases were included in the analysis, due to the inappropriate timing of some birth weight measurements. It is possible that some of the low birth weight cases were in the not-validated category. Another explanation is that it is possible that some of the LBW babies have died during the six days period after birth but due to their birth weights have not been taken they are then excluded from the validated groups. This may also render the low incidence of LBW cases. This assumption is supported by the findings in Tables 4.10 and 4.11 which revealed that the majority of perinatal deaths were in the Category three data that comprise the not-validated cases.

Table 4.19 shows the distribution of neonatal deaths in low birth weight and normal birth weight deliveries. Abortion and stillbirth cases were not cross-tabulated with the low birth weight categories because birth weight data were not available for such cases. In this table the distribution of neonatal deaths was classified into two groups, the validated cases and the not-validated cases. For the purpose of classifying low birth weight, cases without birth weight data were excluded from the not-validated category.

Table 4.19 Neonatal deaths in the Indramayu Study (1990 - 1993), classified by whether or not the baby was LBW and the category of data validation.

Study site	Validated cases				Not-validated cases			
	LBW		Normal		LBW		Normal	
	N	%	N	%	N	%	N	%
Gabus Wetan	3	(15)	9	(2.2)	1	(33.3)	2	(1.5)
Sliyeg	8	(17.8)	14	(3.1)	1	(8.3)	8	(3.6)

Note: LBW = low birth weight.

From Table 4.19 it can be seen that, in both sub-districts and categories of data, the percentage of neonatal deaths was higher among babies with low birth weights.

However, it was found that neonatal death also occurred amongst cases with missing birth weight. In Sliyeg, fifteen out of thirty nine cases with missing birth weight were neonatal deaths. In Gabus Wetan, six out of twenty nine cases with missing birth weight were also neonatal deaths. It is possible that some of the missing birth weight cases consisted of low birth weight cases. Given that not all the birth weights were measured as soon as possible after delivery, it is also possible that some low birth weight babies died before their birth weight was measured. In addition, it is also possible that some neonatal deaths attributed to normal babies in the not-validated cases were actually of low birth weight babies which had been misclassified as normal babies due to delays in birth weight measurement. This finding suggests that even though the proportion of neonatal death that occurred in the category of low birth weight cases seems to correspond to other studies, the estimated incidence of neonatal deaths that occurred in the birth weight categories may not be entirely explained or well distributed, due to missing birth weight and the delay of birth weight measurements.

The inclusion of cases without birth weight data and the cases whose birth weight was measured at more than six days in the not-validated group explain as to why the proportion of neonatal death was higher in the not-validated group.

Tables 4.20 and 4.21 show the mean birth weight across various gestational age categories. While Table 4.20 is based on all the cases where birth weights were taken at less than seven days, Table 4.21 was based on Category one (expected G.A) data only. Table 4.20 shows that the mean birth weight of the Sliyeg cases was quite different from the mean of the standard birth weight. A similar pattern was also observed for the Gabus Wetan cases, particularly at a gestational age below 39 completed weeks.

Table 4.20 Mean birth weight by gestational age of the Indramayu study (1990 - 1993) and standard birth weight.

Gestational age (in weeks)	Mean birth weight (in grams)		
	Gabus Wetan	Sliyeg	Standard
28	3150	only one case	1162
29	only one case	3475	1250
30	3000	3287	1375
31	2911	4233	1525
32	2975	3370	1700
33	2833	4056	1900
34	3130	3286	2125
35	3038	3675	2375
36	3042	3497	2587
37	3200	3306	2787
38	3189	3468	2937
39	3118	3546	3075
40	3168	3882	3150
41	3194	3995	3250
42	3275	3788	3275
43	3266	3770	3300

Note: this table is constructed based on all cases where birth weight were taken at less than seven days. Standard birth weight is derived from Lubchenco (1976:4).

However, the validated cases that were included in the Category One (expected G.A) data show a similar pattern to the standard (see Table 4.21). This was not surprising because only cases which matched the criteria were included in the Category

One, whereas the cases with birth weight measured at less than seven days also contain some from 'uncertain' and 'outlier' categories.

Table 4.21 Mean birth weight by gestational age of the Indramayu study (1990 - 1993) and standard birth weight.

Gestational age (in weeks)	Mean birth weight (in grams)		
	Gabus Wetan	Sliyeg	Standard
28	no valid cases	no valid cases	1162
29	no valid cases	no valid cases	1250
30	no valid cases	no valid cases	1375
31	only one case	no valid cases	1525
32	only one case	no valid cases	1700
33	only one case	2166	1900
34	only one case	2100	2125
35	2571	2558	2375
36	2776	2847	2587
37	3000	2884	2787
38	2972	2980	2937
39	3041	3036	3075
40	3098	3111	3150
41	3164	3175	3250
42	3189	3144	3275
43	3200	3223	3300

Note: this table is constructed based on the gestational data in the Category One (expected - gestational age).

Tables 4.22 and 4.23 show the 10th and 90th percentiles of the Indramayu birth weight data and the standard birth weight. As with the mean birth weight, the percentile distribution also shows a similar pattern, with the Category one (expected G.A) data being more consistent with the standard birth weight than the cases where birth weight was measured at less than seven days.

Table 4.22 The 10th and 90th percentile distribution of birth weight by gestational age based on the Indramayu and Lubchenco data.

Study site	Gestation (weeks)	Indramayu data [1] 10th	Indramayu data [1] 90th	Lubchenco data [2] 10th	Lubchenco data [2] 90th
Sliyeg:	28	no valid cases		825	1500
Gabus:	28	no valid cases			
Sliyeg:	30	no valid cases		1000	1750
Gabus:	30	no valid cases			
Sliyeg:	32	no valid cases		1250	2150
Gabus:	32	no valid cases			
Sliyeg:	34	1830	3710	1500	2750
Gabus:	34	2080	4240		
Sliyeg:	36	2410	3745	1900	3275
Gabus:	36	2400	3800		
Sliyeg:	37	2560	3340	2150	3425
Gabus:	37	2800	3780		
Sliyeg:	38	2415	3585	2325	3550
Gabus:	38	2500	3900		
Sliyeg:	39	2700	3525	2500	3650
Gabus:	39	2600	3600		
Sliyeg:	40	2600	3750	2550	3750
Gabus:	40	2600	3670		
Sliyeg:	41	2420	3730	2675	3825
Gabus:	41	2600	3710		
Sliyeg:	42	2675	3847	2700	3850
Gabus:	42	2550	3800		

Note: 1. The Indramayu data includes all cases whose birth weight was collected at less than seven days.

2. The standard birth weight is adopted from Lubchenco (1976: 4).

Table 4.23 The 10th and 90th percentile distribution of birth weight by gestational age based on the Indramayu and Lubchenco data.

Study site	Gestation (weeks)	Indramayu data [1]		Lubchenco data [2]	
		10th	90th	10th	90th
Sliyeg:	28	no valid cases		825	1500
Gabus:	28	no valid cases			
Sliyeg:	30	no valid cases		1000	1750
Gabus:	30	no valid cases			
Sliyeg:	32	no valid cases		1250	2150
Gabus:	32	only one case			
Sliyeg:	34	1750	2600	1500	2750
Gabus:	34	only one case			
Sliyeg:	36	2230	3210	1900	3275
Gabus:	36	2160	3160		
Sliyeg:	37	2515	3300	2150	3425
Gabus:	37	2500	3400		
Sliyeg:	38	2375	3400	2325	3550
Gabus:	38	2420	3440		
Sliyeg:	39	2700	3350	2500	3650
Gabus:	39	2600	3500		
Sliyeg:	40	2550	3550	2550	3750
Gabus:	40	2560	3540		
Sliyeg:	41	2410	3690	2675	3825
Gabus:	41	2600	3620		
Sliyeg:	42	2625	3800	2700	3850
Gabus:	42	2530	3600		

Note: 1. The Indramayu data covers those cases included in the expected G.A. (Category One) data only.

2. The standard birth weight is adopted from Lubchenco (1976: 4).

From the foregoing discussion on the level of low birth weight, the estimated incidence of neonatal deaths across the birth weight categories, and the examination of the gestational age-specific birth weight distributions, it can be concluded that data on birth weight which was collected in the Indramayu study are not entirely valid for the analysis of the correlates and consequences of low birth weight.

As a result of the data validation procedure, a new categorical variable was created. This variable, describing the quality of gestational age data, contains three categories of data, namely 'expected gestational age', 'uncertain and outliers', and 'not-validated'. In the next stage of analysis, this new variable is incorporated as one of the co-variates for the analysis of neonatal deaths. This is particularly so whenever the analysis includes a variable that was created using gestational-age related data such as inter-pregnancy interval, preterm delivery, and maternal age at the beginning of pregnancy.

Following this description of the various characteristics of the Indramayu data, Chapters Five, Six, and Seven present some results of data analysis pertaining to the co-variates of stillbirth and neonatal deaths, and the intervening variables. The analysis takes into account the impact of gestational age data validation procedures in the model buildings processes.

CHAPTER FIVE

DETERMINANTS OF NEONATAL DEATH

As mentioned in Chapter One, studies on the determinants of perinatal death have been conducted elsewhere, including in Indonesia. However, most of these studies were conducted in hospital settings in which the findings may not always be representative of a community in general. The present study emphasizes the importance of the validity issues concerning gestational age and birth weight data which are known to be difficult to measure in community settings.

Validation of gestational age and birth weight data in Chapter Four found that a variable describing the quality of gestational age should be included in any multivariate analysis as a control variable. However, the examination of stillbirth, a component of perinatal death, cannot be controlled in this way because these cases do not have birth weight data and therefore the control variable (type/quality of gestational age data) cannot be included in the model. Consequently, the study of perinatal death is broken down into two components: stillbirth and neonatal death.

The advantage of this type of study is that the researcher can assess the effect of the important risk factors for neonatal death such as inter-pregnancy interval, gestational age, and maternal age. An analysis conducted in this way enables differences to be distinguished between the predictors for stillbirth and neonatal death.

The disadvantage of such analysis would be the relatively small set of the outcome cases that can be analysed. However, in the Indramayu Regency, the incidence of perinatal mortality is quite high. As mentioned in Chapter Three, the study found that stillbirth and neonatal mortality rates are higher than the national average.

For the purposes of identifying the risk factors for adverse pregnancy outcome at each period of pregnancy, the explanatory variables were divided into four groups according to the period or stage of pregnancy; pre-pregnancy, antepartum, intrapartum, and post-partum periods.

The study originally involved a large set of explanatory variables. These were reduced into a smaller set in order to avoid computational and statistical problems likely to result from the inclusion of all the variables in the analysis. Thus, the analysis began with the selection of the explanatory variables to be included in the analysis of the determinants of the adverse pregnancy outcomes. Factor analysis was employed in order to select a smaller set of surrogate variables from the original explanatory variables, as explained in Chapter Two. This factor analysis was performed for each period of pregnancy involving all of the grouped explanatory variables.

Following the selection of variables, the next step was to assess the relationship between the outcome variables and the selected explanatory variables derived from the factor analysis. Bivariate and multivariate analysis was carried out for each of the outcome variables. These analyses were conducted for each period of pregnancy and for the whole period of pregnancy including the post-partum period. As stated in Chapter Two, the bivariate analysis was conducted in order to assess the relationship between some selected explanatory variables and the outcome variables. The Cramer's V statistic, a chi-square-based measure of the strength of a bivariate relationship, was employed in order to assess the individual effect of some selected explanatory variables on the outcome variables.

However, the use of bivariate analysis cannot elucidate whether or not the inclusion of other variables in the model will change the original relationship between the outcome variable and an explanatory variable. To address this problem, a multivariate logistic regression analysis was employed, appropriate for the dichotomous type of outcome variables such as stillbirth and neonatal death. The use of this model allows for the estimation of effects of several variables simultaneously.

The building of the multivariate logistic regression model began with an assessment of a main effects model. Following this, an assessment of the possible existence of interactions and confounding effects was then conducted. As explained in Chapter Two, the examination of interaction was carried out before the assessment of any confounding effect. The latter was not assessed whenever there was a strong evidence of interaction involving confounding variables in the model.

Chapter Three described features of the bivariate relationship between the outcome variables and the characteristics of the study population. In this chapter, therefore, the bivariate analysis is presented only as a preliminary stage in the multivariate analysis of the predictors of neonatal death and stillbirth.

In addition to examining the determinants of stillbirth and neonatal death, this study will also present the results of analysis for the predictors of selected intervening variables (see Chapter Seven).

5.1 Results of Factor Analysis

Factor analyses were carried out for each period of pregnancy. The results are outlined below:

a. Pre-pregnancy period

A factor analysis conducted in this period involved some explanatory variables related to socio-demographic characteristics and history of previous pregnancy. These variables included parity, maternal age, previous child death, family structure, husband's education, household assets, maternal education, preceding pregnancy outcome, inter-pregnancy interval, husband's occupation, maternal working status, planned pregnancy, maternal height and mid-upper arm circumference.

Since the factor analysis requires a metric measurement, the maternal age variable which had been processed as an ordinal variable was split up into two dummy-coded variables representing those respondents aged less than twenty years and those aged more than thirty years. The twenty to thirty years age group was used as a reference category. This categorization will also permits the examination of the effect of teenage pregnancy to the adverse pregnancy outcome.

As explained in Chapter Two, the term *inter-pregnancy interval* refers to the interval between the date of conception of the most recent pregnancy and the date of the preceding pregnancy termination. Therefore, only women who have had at least two pregnancies can be included in the analysis. In other words, the primigravidae, women who were pregnant for the first time, would be excluded when the multivariate model included the pregnancy interval variable or other variables related to previous pregnancy.

In the study area, the number of primigravidae was quite large (N=446), accounting for 30 per cent of all the respondents. The exclusion of primigravidae cases could distort the results since their characteristics may exert an influence on the pregnancy outcome. For this reason, the multivariate analysis conducted in the pre-pregnancy period or for the entire period of pregnancy would take primigravidae women into account using a categorisation of the inter-pregnancy interval variable that represented both primigravidae and multigravidae cases.

The inter-pregnancy interval was initially broken down into four categories: below 18 months, between 18 and 29 months, between 30 and 42 months, and above 42 months. Considering that the distribution of neonatal death cases was concentrated on those with a pregnancy interval of less than 18 months (50 per cent) and those with a pregnancy interval more than 42 months (35 per cent), the four categories of inter-pregnancy interval were collapsed into two, namely less than 18 months and 18 months or more. In order to include the primigravidae cases, three categorisations were then used; an interval of less than 18 months, 18 months or more, and primigravidae. As with maternal age, these were then converted into dummy-coded variables.

The same technique was also applied to the other variables describing the history of previous pregnancy such as previous child death.

The results of the factor analysis conducted in the pre-pregnancy period is presented in Table 5.1.

Table 5.1 Varimax Rotated Component Analysis Factor Matrix (pre-pregnancy period), Indramayu Study, 1993.

Variables	Factor Loadings							Communality
	1	2	3	4	5	6	7	
Parity2	0.88	--	--	--	--	--	--	0.879
Family structure	0.77	--	--	--	--	--	--	0.684
Maternal age1	0.76	--	--	--	--	--	--	0.707
Previous child - death2	-0.76	-0.59	--	--	--	--	--	0.942
Inter-pregnancy - interval2	-0.75	--	--	-0.57	--	--	--	0.931
Previous child - death1	--	0.89	--	--	--	--	--	0.832
Parity1	-0.32	0.76	--	--	--	--	--	0.742
Maternal age2	-0.34	0.64	--	--	--	--	--	0.559
Household assets	--	--	0.71	--	--	--	--	0.568
Husband's education	--	--	0.7	--	--	--	--	0.538
Maternal education	0.36	-0.3	-0.58	--	--	--	--	0.581
Inter-pregnancy - interval1	--	--	--	0.97	--	--	--	0.969
Maternal working - status	--	--	--	--	0.85	--	--	0.755
Husband's - occupation	-0.32	--	--	--	0.49	--	-0.36	0.581
Planned pregnancy	--	--	--	--	--	-0.67	--	0.602
Mid-arm circumfe- rence	--	--	--	--	--	0.64	--	0.505
Maternal height	--	--	--	--	--	--	0.94	0.899
Eigenvalue	4.61	2.07	1.29	1.21	1.1	1.04	0.95	12.27
Percentage of trace *	27.1	12.2	7.6	7.1	6.5	6.1	5.6	72.2

Note: * trace = 17
The minimum value for the factor loadings for sample size of at least 300 subjects with one per cent of significance is 0.15 (Hair et al., 1992:239).

The figures shown in Table 5.1 include all of the loadings greater than 0.15, which are statistically significant. Usually, a name or attribute is assigned to a particular factor according to the significant variables found in that factor. In this case, the assignment of a special name to a particular factor was not conducted since it will only confuse the meaning of the name. The next step is to select which loadings are large enough to be used as surrogate representatives for a particular factor.

From Table 5.1 it can be seen that attitude toward pregnancy (planned pregnancy) and maternal mid-arm circumference are grouped in factor six. Despite the fact that the planned pregnancy loading is higher than that of arm-circumference, the latter was selected as a representative explanatory variable for factor six because it was thought to be more important than planned pregnancy.

In summary, in the pre-pregnancy stage, the explanatory variables selected as the surrogates for the original explanatory variables were parity, previous child death, household assets, inter-pregnancy interval, maternal working status, maternal mid-arm circumference, and maternal height. These seven variables would be incorporated in the multivariate analysis. In addition, bivariate analysis of the relationship between neonatal death and these seven explanatory variables would also be conducted.

b. Antenatal period

The variables included for the factor analysis were tetanus immunization, diseases during pregnancy (such as headache, fever, pain in urination, and antenatal vaginal bleeding), trimester of first antenatal care, type of care provider sought at the first antenatal care, frequency of antenatal care during pregnancy and coffee consumption. The frequency of antenatal care variable was divided into two dummy variables which represented one to three antenatal visits and more than three antenatal visits. The cases without any antenatal visits were used as a reference category.

In this study, information on smoking behaviour and alcohol consumption was also collected. However, due to the small proportion of respondents who were reported as having these behaviours, the variables were excluded from the analysis. In the case of data on haemoglobin measurements, there was a large proportion of missing cases (25 per cent), but due to the important role of this variable that may play in affecting pregnancy outcome, this variable was included in the analysis. This variable was categorised as *not anaemic*, *not measured*, and *anaemic*. As mentioned in Chapter Two, the cut-off point adopted to classify whether or not the women were anaemic was 11 g/dl. In order to fulfil the requirement for inclusion in the factor analysis, this variable was then converted into dummy-coded variables. The results of the factor analysis are presented in Table 5.2.

Table 5.2 Varimax Rotated Component Analysis Factor Matrix (antenatal period), Indramayu Study, 1993.

Variables	Factor Loadings						Communality
	1	2	3	4	5	6	
Frequency of - antenatal care2	0.95	--	--	--	--	--	0.943
Frequency of - antenatal care1	-0.95	--	--	--	--	--	0.943
Timing of first - antenatal care	0.5	--	--	--	--	--	0.369
Haemoglobin2	--	-0.9	--	--	--	--	0.824
Haemoglobin1	--	0.9	--	--	--	--	0.828
Provider sought	--	--	0.83	--	--	--	0.714
Tetanus immunization	--	--	-0.77	--	--	--	0.66
Fever	--	--	--	0.72	--	--	0.607
Headache	--	--	--	0.71	--	--	0.528
Pain in urination	--	--	--	0.53	--	--	0.404
Antenatal bleeding	--	--	--	--	0.72	--	0.542
Coffee consumption	--	--	--	--	-0.7	--	0.5
Antenatal swelling	--	--	--	--	--	0.89	0.801
Eigenvalue	2.45	1.7	1.28	1.22	1.01	1.01	8.67
Percentage of trace *	18.9	13.1	9.9	9.4	7.8	7.7	66.6

Note: * trace = 13.

From Table 5.2 it can be seen that frequency of antenatal care, haemoglobin level, the type of care provider sought at the first antenatal care, antenatal fever, antenatal bleeding, and antenatal swelling were found to have the highest loadings in factor one to six respectively. However, instead of provider sought, tetanus immunization was selected for factor three because of the importance that tetanus immunization may play in affecting neonatal death. In addition, there was a lot of missing data in the variable for the type of care provider (16 per cent). In this case, the frequency of antenatal care was used as a proxy measure for the use of antenatal care services.

c. Intrapartum period

The explanatory variables included in the factor analysis for the intrapartum period were type of cord cutting instrument, the use of special instrument for delivery, foetal presentation, congenital anomalies, sex of baby, preterm delivery, type of birth attendant, and diseases found just before labor, specifically intrapartum bleeding and intrapartum swelling. The type of birth attendant variable was divided into three dummy variables representing those assisted by traditional birth attendant, a combination of traditional birth attendant and medical professional, and medical personnel only. In this case the 'other' category was used as a reference category. The results of the factor analysis are presented in Table 5.3.

Table 5.3 Varimax Rotated Component Analysis Factor Matrix (intrapartum period), Indramayu Study, 1993.

Variables	Factor Loadings						Communality
	1	2	3	4	5	6	
Birth attendant1	-0.92	--	--	--	--	--	0.864
Birth attendant2	0.72	--	0.31	--	--	--	0.721
Birth attendant3	0.49	--	-0.44	-0.37	--	--	0.675
Intrapartum swelling	--	0.7	--	--	--	--	0.554
Intrapartum bleeding	--	0.67	--	--	--	--	0.54
Instrument used for assisting delivery	--	0.5	0.37	--	--	--	0.48
Foetal presentation	--	--	0.66	--	--	--	0.552
Preterm delivery	--	--	0.54	--	--	--	0.421
Congenital anomaly	--	--	--	0.87	--	--	0.772
Cord cutting - instrument	--	--	--	--	0.91	--	0.84
Sex of baby	--	--	--	--	--	0.92	0.856
Eigenvalue	1.75	1.39	1.1	1.05	0.99	0.98	7.26
Percentage of trace *	15.9	12.6	10	9.6	9	8.9	66.1

Note: * trace = 11.

Table 5.3 shows that type of birth attendant, intrapartum swelling, foetal presentation, congenital anomalous, cord cutting instrument, and sex of baby have the highest loadings in factors one to six respectively. These six variables would be incorporated in the next analyses representing the explanatory variables in the intrapartum period.

d. Post-partum period

The explanatory variables included in this period were birth weight, use of colostrum, breast-feeding initiation, giving some liquid before colostrum, and baby's health problem observed in the first few days of life. Baby's health problems included vomiting, difficulty in breast-feeding, shivering, breathing problem, blue colour (cyanosis), and jaundice. As mentioned in Chapter Two, the birth weight variable was categorised into three categories. In order to fulfil the requirements for factor analysis, this nominal variable was then converted into two dummy variables representing those with low birth weight or otherwise, and normal birth weight or otherwise. Results of the factor analysis are presented in the following Table 5.4.

Table 5.4 Varimax Rotated Component Analysis Factor Matrix (post-partum period), Indramayu Study, 1993.

Variables	Factor Loadings					Communality
	1	2	3	4	5	
Giving liquid before colostrum	0.76	--	--	--	--	0.575
Breast-feeding - initiation	0.75	--	--	--	--	0.564
Use of colostrum	0.63	--	--	--	--	0.439
Cyanosis	--	0.81	--	--	--	0.675
Shivering (cold)	--	0.74	--	--	--	0.589
Birth weight2	--	--	0.81	--	--	0.664
Birth weight1	--	--	-0.8	--	--	0.663
Vomiting	--	--	--	0.77	--	0.611
Feeding problem	--	--	--	0.75	--	0.582
Jaundice	--	--	--	--	0.88	0.792
Breathing problem	--	0.47	--	--	0.55	0.53
Eigenvalue	1.74	1.59	1.2	1.15	1	6.68
Percentage of trace	15.8	14.5	10.9	10.5	9.1	60.8

Note: * trace = 11

At this post-partum period, the explanatory variables found to have the highest loadings were giving liquid before colostrum, cyanosis, birth weight, vomiting, and jaundice. Instead of giving liquid before colostrum, breast-feeding initiation was chosen to represent factor one. These five variables would be used as the surrogate variables for the original variables in the post-partum period.

5.2 Results of Bivariate Analysis

Bivariate analyses were conducted for each stage of pregnancy. At the first step, a contingency table analysis employing the Cramer's V chi-square-based statistical test was conducted to examine whether a relationship existed between the explanatory variables and neonatal death. If the relationship was significant, the unadjusted odds ratio values of each category of the significant variables would be calculated. Table 5.5 presents the results, restricted to variables which had a significant bivariate relationship with neonatal death.

Table 5.5 Cramer's V Coefficient and Unadjusted Odds Ratio for the Predictors of Neonatal Death in the Indramayu Study, 1993.

Risk factor at each stage of pregnancy	Odds Ratio	Cramer's V Coefficient
a. <u>Pre-pregnancy Period</u>		
Inter-pregnancy interval:		0.16 ***
- (18 months or more and primigravidae)		
- Less than 18 months	4.24 ***	
Previous child death:		0.13 ***
- (No child death and primigravidae)		
- Yes	3.19 ***	
b. <u>Antenatal Period</u>		
Frequency of antenatal visits:		0.08 **
- (Three or less visits)		
- More than three visits	0.39 **	
Tetanus immunization:		0.13 ***
- (No TT immunization)		
- One or two TT	0.30 ***	
c. <u>Intrapartum period</u>		0.12 ***
Foetal presentation:		
- (Normal)		
- Abnormal	6.33 ***	

Table 5.5 (Continued).

Cord cutting instruments:		0.09 **
- (Scissors/blades)		
- Bamboo	3.40 *	
d. <u>Post-partum Period</u>		
Low birth weight:		0.16 ***
- (No)		
- Yes	6.43 ***	
Jaundice:		0.07 **
- (No)		
- Yes	5.14 *	
Cyanosis (blue colour):		0.13 ***
- (No)		
- Yes	4.45 ***	
Breast-feeding initiation:		0.13 ***
- (Before 24 hours)		
- After 24 hours	3.28 ***	

Note:
* Significant at five per cent level
** Significant at one per cent level
*** Significant at less than one per cent level.

In the pre-pregnancy period, both inter-pregnancy interval and history of previous child death were found to be significantly associated with neonatal death. The odds of neonatal death are considerably greater for those mothers who had a pregnancy interval of less than 18 months than for those mothers with a longer pregnancy interval or primigravidae women. A shorter birth interval had the effect of increasing the odds of neonatal death four-fold. The odds of neonatal death were also increased for those mothers who had experienced child death.

In the antenatal period, the frequency of antenatal visits and tetanus toxoid immunization turned out to be the only variables which showed a significant relationship with neonatal death. More than three antenatal visits during the course of pregnancy decreased the odds of neonatal death. The mothers who received one or two tetanus immunizations had a lower risk of neonatal death than the mothers who had no tetanus immunization.

In the intrapartum period, foetal presentation and cord cutting instruments were significantly associated with the risk of neonatal death. The babies who were delivered abnormally (for example: breech presentation) had an excess risk of neonatal death. The risk of neonatal death was more than six times higher for an abnormal presentation than for the baby who was delivered normally (*cephalic* presentation). The use of bamboo for cutting the cord raised the risk of neonatal death by more than three times over the use of scissors or blades.

In the post-partum period, the variables which were significantly related to neonatal death were low birth weight, jaundice, blue colour, and breast-feeding initiation. Low birth weight had the effect of raising the odds of neonatal death to more than six times that of normal birth weight babies. The babies who had experienced health problems, specifically jaundice or blue colour (cyanosis), during their first few days of life were more likely to die during the neonatal period. Jaundice and blue colour increased the odds of neonatal death by five and four times respectively.

Similarly, the babies which were not breast-fed earlier (within 24 hours) had three times greater odds of neonatal death.

All these significant variables were subjected to multivariate analysis. This was aimed at examining whether or not these significant association persisted after controlling for other variables including some selected confounding factors.

5.3 Results of Multivariate Analysis

A multivariate logistic regression technique was used to examine the joint effects of some selected explanatory variables on the occurrence of neonatal death. All of the surrogate variables which were derived from the factor analysis would be included in the analysis which was conducted in two major stages. The first multivariate analysis was conducted separately for each period of pregnancy involving the surrogate explanatory variables for that period. The second included all of the explanatory variables during the full course of pregnancy including the period following birth (post-partum).

5.3.1 Multivariate Analysis for Each Period of Pregnancy

a. Pre-pregnancy period

In this period, the variables included in the analysis were parity, previous child death, household assets, inter-pregnancy interval, maternal working status, maternal height, and mid-arm circumference. As explained in Chapter Four, due to the inclusion of maternal age and the pregnancy interval variables, a variable describing the quality of gestational age data was also incorporated in the model as a control variable. This was intended to minimize bias due to the introduction of inaccurate gestational age data. The results of analysis are presented in Table 5.6.

Table 5.6 Adjusted Odds Ratio for the Predictors of Neonatal Death (pre-pregnancy period), Indramayu Study, 1993. (N=1286)

Risk Factor	Odds Ratic	Significance
Inter-pregnancy interval:		
- (18 months or more and primigravidae)		
- Less than 18 months	3.91	< 0.0001
Previous child death:		
- (No death and primi-gravidae)		
- Yes	2.4	0.002
Type of gestational age:		
- (Expected G.A.)		
- Uncertain + outliers	1.14	0.73
- Not validated	2.4	0.003

Note: the improvement chi-square value = 9.9; p = 0.007

Table 5.6 shows that three out of the eight variables were significantly associated with neonatal death. The mothers with a pregnancy interval of less than 18 months were at a greater risk of having their babies die in the neonatal period. The effect of a short-pregnancy interval, less than 18 months, was to increase the odds of neonatal death almost four times over those mothers who had at least an 18 months pregnancy interval or primigravidae women.

The presence of previous child death has the effect of raising the odds of neonatal death to more than double that of a case without prior child death.

The gestational age data which were categorised as 'not-validated' were also significantly related to neonatal death; they were classified as 'not-validated' because of missing birth weight data. If the birth weight data were available, this type of gestational age data could be grouped into either expected gestational age or outlier (see Chapter Four). Overall, the type of gestational age data was significantly related to neonatal death. This finding, again, underlines the importance of conducting data validation on the gestational age data. Failure to control for such a variable will lead to bias of the results.

As mentioned in Chapter One, the association between pregnancy interval and neonatal death can be mediated through low birth weight. If this is so, it would be expected that controlling for birth weight would reduce the size and significance of the association. When the low birth weight variable was included in the analysis, it was found that it raised the odds of neonatal death by a large amount (odds ratio for pregnancy interval=7.3; $p<0.0001$). In these data, low birth weight apparently exacerbated the effect of short-pregnancy interval on the risk of neonatal death. This finding indicates the presence of an interactive effect between the pregnancy interval and low birth weight. When the analysis included an interaction term involving pregnancy interval and low birth weight, the results showed that the interaction term was significant ($p=0.01$). Normal babies from mothers with a longer pregnancy interval have a considerably lower risk of neonatal deaths than low birth weight babies with a shorter pregnancy interval (the odds ratio=0.08).

In the presence of the interaction term, an inter-pregnancy interval remains highly significant. This finding suggests that the pregnancy interval has a separate (individual) effect, and thus, the association between short pregnancy interval and increased risk of neonatal death does not entirely operate through low birth weight. Therefore, it suggests that the maternal nutritional depletion theory that leads to low birth weight is unlikely to explain the mechanism through which the short pregnancy interval affects the elevated risk of neonatal death.

b. Antenatal period

The explanatory variables that were included in this period were frequency of antenatal visits, haemoglobin level, tetanus immunization, and diseases experienced during the antenatal period, particularly antenatal bleeding, fever and antenatal swelling. Of these six variables, tetanus toxoid (TT) immunization status was found to be the only variable which showed a significant relationship with neonatal death (Table 5.7).

Table 5.7 Adjusted Odds Ratio for the Predictors of Neonatal Death (antenatal period), Indramayu Study, 1993 (N=1416).

Risk Factor	Odds Ratio	Significance
Tetanus (TT) immunization:		
- (No TT)		
- One or two TT	0.30	< 0.0001

Note: The improvement chi-square value=22.4; $p < 0.0001$

It can be seen that for those women who received one or two tetanus immunizations, the odds of neonatal death decreased by 30 per cent compared to those mothers who did not receive a tetanus immunization. Despite data on the causes of neonatal death being unavailable, this finding indirectly indicated that death attributed to tetanus neonatorum is still prevalent in the study area. The multivariate analysis which included all of the explanatory variables during the course of pregnancy would examine the contribution of this variable in affecting the odds of neonatal death, net of the influence of other potential risk factors in the model.

c. Intrapartum period

In this period, the explanatory variables that were included in the analysis were birth attendant, intrapartum swelling, foetal presentation, congenital anomaly, cord cutting instrument and sex of baby.

Table 5.8 Adjusted Odds Ratio for the Predictors of Neonatal Death (intrapartum period), Indramayu Study, 1993 (N=1387).

Risk Factor	Odds Ratio	Significance
Foetal presentation:		
- (Normal)		
- Abnormal	7.87	< 0.0001
Cord cutting instrument:		
- (Scissors)		
- Bamboo	3.75	0.04

Note: The improvement chi-square value=3.20; p=0.07

Foetal presentation and cord cutting instrument were the only variables which were significantly related to the occurrence of neonatal death. Babies delivered abnormally (for example: breech presentation) were at a greater risk of neonatal death, with the odds increasing to almost eight times compared with the babies delivered normally. The use of bamboo as an instrument for cutting the cord had the effect of raising the odds of neonatal death to almost four times more than the use of scissors.

Based on the significance level of the improvement in chi-square, it is unlikely that the proposed model provided a good model for estimating the relative risk of neonatal death. The lack of significant improvement is due to cases with missing values for the cord cutting instrument variable. When these cases are excluded from the model, the improvement in chi-square value becomes highly significant (p=0.0005).

In order to obtain unbiased estimates of the odds of neonatal death, the reduced model was adopted. Table 5.9 provides the adjusted odds ratio for foetal presentation after the exclusion of the cord cutting instrument variable.

Table 5.9 Adjusted Odds Ratio for the Predictors of Neonatal Death (intrapartum period), Indramayu Study, 1993 (N=1416).

Risk Factor	Odds Ratio	Significance
Foetal presentation:		
- (Normal)		
- Abnormal	6.33	< 0.0001

Note: The improvement chi-square value=12.2; p=0.0005

Despite a slight reduction in the odds ratio, foetal presentation remained highly significant. An abnormal presentation leads to an increased risk of neonatal death more than six times that of a normal delivery. This model gave a valid estimate of the odds of neonatal death since the improvement in chi-square value was highly significant.

d. Post-partum period

The explanatory variables included for this period were low birth weight, breast feeding initiation, and the baby's condition observed in the first few days after birth including vomiting, jaundice, and blue colour (cyanosis). The results of the analysis are presented in Table 5.10.

Table 5.10 Adjusted Odds Ratio for the Predictors of Neonatal Death (post-partum period), Indramayu Study, 1993.
(N=1348)

Risk Factor	Odds Ratio	Significance
Low birth weight:		
- (No)		
- Yes	5.6	< 0.0001
Jaundice:		
- (No)		
- Yes	4.89	0.03
Cyanosis:		
- (No)		
- Yes	3.1	0.01
Breast-feeding initiation:		
- (Before 24 hours)		
- After 24 hours	2.4	0.004

Note: the improvement chi-square value=3.73; p=0.05

The results showed that most of these post-partum variables, except for vomiting, were significantly related with the onset of neonatal death. It was found that the odds of neonatal death were almost six times higher for low birth weight babies than they were for one in the reference group (normal babies and unvalidated cases).

The initiation of breast-feeding more than 24 hours following birth had the effect of raising the odds of neonatal death to more than double those for babies who had been breast-fed within 24 hours. The delayed breast-feeding can be due to baby's factors, mother's factors, or cultural reasons. A qualitative study conducted in the study area found that most of the participants in the focus group discussion tended to initiate breast-feeding in the second or third day after delivery, because of their reluctance to give yellow-coloured breastmilk (colostrum) which is produced in the first day after birth. In their view, colostrum is both dirty and indigestible and therefore should not be given to a baby. Before giving the first breastmilk, a liquid such as honey is given to the baby instead (Utomo et al., 1992:33).

The babies who experienced 'blue colour' were three times more likely to die in the neonatal period than the healthy babies. The blue colour symptom, which is referred to as *cyanosis*, is due to a lack of oxygen and an excess of carbon dioxide in the blood. This symptom is usually associated with mild asphyxia and if not treated promptly, may result in a state of respiratory and circulatory failure (Ojo and Briggs, 1982:378).

For babies who showed 'jaundice' symptoms, the odds of neonatal death were almost five times higher than for other babies. Jaundiced babies are mostly quite normal and the condition bears no relationship to the jaundice which occurs in older children and adults. The jaundice colour is caused by the accumulation of bilirubin in the body and it fades as the liver function begins to eliminate it from the body. In some cases however, the jaundice can be due to other causes such as infection (infective jaundice) and obstructive jaundice (Ojo and Briggs, 1982:390). The causes of this symptom being unavailable and due to its highly significance needs further study.

Having presented the results of multivariate analysis conducted for each period of pregnancy, the following discussion examines the results of analysis involving all of the variables during the full course of pregnancy.

5.3.2 Multivariate Analysis for the Full Course of Pregnancy.

This analysis involved all of the explanatory variables which have been analyzed separately at each period of pregnancy and was conducted in order to assess the joint effects of a set of explanatory variables (during the course of pregnancy) in determining the occurrence of neonatal death. A number of analytical models are introduced, including the main model and interaction model. Where appropriate, a model with the potential confounders will also be tested.

The explanatory variables included in the main effect model are all of the surrogate variables which were derived from the factor analysis conducted for each period of pregnancy.

The variable describing the quality of gestational data was also included in the model as a control variable since this model included inter-pregnancy interval and maternal age. Considering that there was a difference in the level of perinatal death between the study sites, a variable describing the study site, Gabus Wetan or Sliyeg sub-district, was also included in the model as a control variable.

The result of the analysis was that only seven out of the twenty six variables in the model were significantly related to the occurrence of neonatal death. These were inter-pregnancy interval, previous child death, low birth weight, jaundice, blue colour, cord cutting instrument, and the initiation of breast-feeding.

Contrary to the result of analysis conducted in the intrapartum period, the inclusion of cord cutting instruments in this model did not alter the significance of the improvement in the chi-square value (p=0.03). Therefore, the cord cutting instrument variable was retained in the model.

Based on the correlation coefficient, the inter-pregnancy interval turned out to be the most important predictor of neonatal death (r=0.26). The pregnant women with a shorter inter-pregnancy interval had an almost seven times increased risk of delivering a baby who died within the first 28 days of life (neonatal period). Due to the important role of the inter-pregnancy interval in affecting the risk of neonatal death, it is necessary to elucidate the mechanisms through which a short pregnancy interval increased the risk of neonatal death. In addition, it is also important to examine whether or not the relationship between inter-pregnancy interval and neonatal death is confounded by other predictive variables.

A prospective cohort study involving 20,754 pregnancies conducted in the East Bay Area of San Francisco between 1959 and 1966 found that the parents perceiving their pregnancy as unwanted had a greater risk of delivering a baby who died in the neonatal period (Bustan and Coker, 1994:413). In the present study, data on whether or not the pregnancy was wanted (planned) was collected. The planned pregnancy variable was then introduced into the model as a potential confounder for the relationship between inter-pregnancy interval and neonatal death.

The examination of interaction was carried out before the assessment of a confounding effect. In this case a two-factor interaction term involving inter-pregnancy interval and the planned pregnancy was introduced. If the interaction term were significant then the assessment of the confounding effect would not be conducted, since the examination of a potential confounder with significant interaction terms would yield unreliable results (as discussed in Chapter Two). In addition, the interpretation of the confounding effects with significant interaction terms could be complicated. Since the interaction term was not significant, the confounding analysis was conducted. The analysis indicated that the inclusion of the planned pregnancy did not alter the adjusted odds ratio for the inter-pregnancy interval. This suggested that the relationship between inter-pregnancy interval and neonatal death was not confounded by whether or not the pregnancy was planned. Since the confidence interval limits of the two models were similar (see Table 5.11 model 2), the planned pregnancy variable was included in the model. This takes into account the effect of the planned pregnancy.

As mentioned in Chapter One, teenage pregnancy is associated with an excess of perinatal mortality. The excess rates are mediated through low birth weight and preterm delivery. Since there is a possibility of a relationship between maternal age and neonatal death, maternal age at the beginning of pregnancy was included in the model as a potential confounder of the association between the pregnancy interval and neonatal death. Because the result of the interaction effect was not significant, the confounding analysis was carried out. The similarity of the odds ratios between the full and the reduced models suggested that the relationship between pregnancy interval and neonatal death was not confounded by maternal age. Since the confidence interval limits were also similar (see Table 5.11 model 3), the full model was adopted as this model takes into account the effect of maternal age.

Results of the analysis so far indicated that after controlling for some potential confounding factors, the inter-pregnancy interval variable remained the strongest predictor of neonatal death (r=0.26). A short inter-pregnancy interval raised the odds of neonatal death to almost seven times those of the longer inter-pregnancy interval. As mentioned in Chapter One, the theories that link short pregnancy interval and neonatal death would operate if the preceding sibling is surviving. For example, the maternal nutritional depletion effect would be weaker if the preceding child died, because of the physiological demands of lactation being removed after the sibling's death.

The results of analysis with the inclusion of a previous child death variable showed that this significantly affected the risk of neonatal death (p=0.001). At this stage of the analysis, it is not known whether the relationship between inter-pregnancy interval and neonatal death is confounded by the presence of prior child death. In order to assess the possibility of a confounding effect, the previous child death variable was removed from the model. Results showed that the adjusted odds ratio for the inter-pregnancy interval increased after its exclusion. In order to ascertain whether the removal of previous child death resulted in a significant change of the odds ratios, the logistic coefficients and their standard errors of the two models were compared. Results of the comparison are as follows:

(1) Logistic coefficients (β) for inter-pregnancy interval:

- The full model:	1.9353
- The reduced model:	2.3460
	0.4107

(2) Standard errors (S.E):

$$\text{S.E.} = 1.96 \times \sqrt{(0.3696)^2 + (0.3516)^2}$$
$$= 1.0$$

The value of equation (1) being less than equation (2), indicated that the odds ratios differences between the full and the reduced models were not significantly different. This result suggested that the relationship between inter-pregnancy interval and neonatal death was not confounded by previous child death. It further suggested that the effect of short pregnancy interval on the risk of neonatal death was not entirely explained by the maternal depletion theory.

However, there is a slight weakness in drawing such a conclusion as the data on previous child death do not specifically refer to the death of the immediate previous sibling but rather denotes death that occurred to any sibling. In order to support the possibility of a confounding effect by previous child death, the preceding pregnancy outcome variable was then included in the model as a potential confounder of the relationship between inter-pregnancy interval and neonatal death.

As with previous procedures, a two-way interaction term involving preceding pregnancy outcome and inter-pregnancy interval was tested before assessing the confounding effect. Since the interaction term was not significant, the confounding analysis was then proceeded.

Results of the analysis indicated that the inclusion of a preceding pregnancy outcome variable in the model slightly reduced the adjusted odds ratio for the inter-pregnancy interval. This finding suggested that the relationship between inter-pregnancy interval and neonatal death was not confounded by preceding pregnancy outcome. The precision test was carried out in order to examine the feasibility of including the preceding pregnancy outcome variable in the model. Results of the test showed in Table 5.11 indicated that the confidence interval limits of the full model was slightly shorter, therefore the preceding pregnancy outcome was included in the model.

Table 5.11 The Adjusted Odds Ratios and 95% Confidence Intervals Limits for the Inter-pregnancy Interval Before and After the Inclusion of the Potential Confounders, Indramayu Study, 1993.

Multivariate Model	Odds Ratio	95% Confidence Interval Limits
Model 1	6.93	(3.35, 14.3)[a]
Model 2	6.93	(3.35, 14.3)[b]
Model 3	6.93	(3.35, 14.3)[c]
Model 4	6.87	(3.32, 14.15)[d]

Note:

a. Model 1 is a main effect model without confounders

b. Model 2 is model 1 plus planned pregnancy

c. Model 3 is model 2 plus maternal age

d. Model 4 is model 3 plus preceding pregnancy outcome.

These results, together with the finding observed in the pre-pregnancy period which showed that the inclusion of low birth weight as a confounding variable did not reduce the significance and size of the odds ratio for inter-pregnancy interval, lead to the conclusion that the maternal depletion theory is unlikely to explain the mechanism through which short pregnancy interval affects the elevated risk of neonatal death.

As explained in Chapter One, Miller (1994:362) argued that due to the large proportion of preterm delivery in the short pregnancy interval group, it is very likely that the higher mortality rates observed in this group are attributable to prematurity rather than to short interval *per se*. In order to examine this proposition, a bivariate analysis between neonatal death and the pregnancy interval, controlling for preterm delivery was conducted. In this case, only preterm cases which had good quality gestational age data were included in the analysis. The results showed that while no neonatal death occurred in preterm cases in the short pregnancy interval group, about 12 per cent of neonatal deaths occurred in preterm cases in the longer interval group. This finding does not seem to support Miller's proposition about the role that preterm delivery may play in explaining the mechanism through which a short pregnancy interval affects the risk of neonatal death.

Another possible explanation is that previous child death may cause the parents to have another child within a short interval and that these familial mortality effects characterized the short pregnancy interval cases. In order to examine this assumption, a bivariate analysis of the association between neonatal death and inter-pregnancy interval controlling for previous child death was conducted. Result of this analysis showed that the proportion of neonatal deaths with short pregnancy intervals was considerably greater among the cases with a history of prior child death (23.8 per cent) than in the cases without prior child death (2.4 per cent). This finding indicated an interactive effect between inter-pregnancy interval and previous child death. While the confounding effect was not significant, there was a reduction in the odds ratio for the inter-pregnancy interval after the inclusion of the previous child death variable. This suggested that the effect of previous child death on the risk of neonatal death can be both direct and indirect. The indirect effect is mediated through the inter-pregnancy interval variable.

This finding provides evidence that intra-familial mortality effects characterized the short-pregnancy interval and hence increased the risk of neonatal death.

Thus, the final model for the multivariate analysis of the predictors for neonatal death consisted of all the explanatory variables during the course of pregnancy plus planned pregnancy, maternal age, and preceding pregnancy outcome variables. Results of the analysis are presented in Table 5.12.

Table 5.12 Adjusted Odds Ratio for the Predictors of Neonatal Death, Indramayu Study, 1993 (N=1199).

Risk Factor	Odds Ratio	Significance
Inter-pregnancy interval:		
- (18 months or more and primigravidae)		
- Less than 18 months	6.87	< 0.0001
Low birth weight:		
- (No)		
- Yes	9.21	< 0.0001
Jaundice:		
- (No)		
- Yes	6.78	0.03
Previous child death:		
- (No)		
- Yes	3.36	0.001
Cyanosis (blue colour):		
- (No)		
- Yes	3.75	0.007
Cord cutting instrument:		
- (Scissor/blade)		
- Bamboo	6.17	0.03
Breast-feeding initiation:		
- (Before 24 hours)		
- After 24 hours	2.1	0.03

Note: the improvement in chi-square value=4.63; p=0.03

In the final model, the inter-pregnancy interval variable remained the strongest predictor for neonatal death (r = 0.26). A short inter-pregnancy interval raised the odds of neonatal death by almost seven times those of the longer inter-pregnancy interval. As explained in Chapter One, this finding can be partly explained by biological factors. Women with a short pregnancy interval may have insufficient time to recover their nutritional reserves for the demands of pregnancy; this may affect foetal growth and may subsequently increase the risk of death. However, the results of the analysis suggested that neither the maternal nutritional depletion theory, nor the excess of preterm delivery in the short pregnancy interval group could explain the mechanism through which short-pregnancy interval had an effect on the elevated risk of neonatal death. It is likely that an intra-familial mortality effect is the explanatory mechanism.

The presence of prior child death has the effect of raising the odds of neonatal death to more than three times the odds for a case without prior child death. This finding again suggests that intra-familial mortality effects are important in the risk of neonatal death. Exposure of the baby to a similar uterine environment, the receipt of similar care, and the need to replace a dead baby within a short interval may explain the intra-familial mortality mechanism of the short pregnancy interval.

Low birth weight had the effect of increasing the odds of neonatal death to more than nine times the odds of the reference group (normal birth weight and unvalidated cases). This finding corresponds with other findings referred to in Chapter One.

Babies who showed jaundice symptoms during the first few days of life were found to be almost seven times more likely to die in the neonatal period than normal babies. While this finding would indicate that the yellowish tinged skin might not be a normal jaundice, medical information on the causes of jaundice was not available since the information gathered was from the mothers' recognition of this symptom. It is possible that the condition is remembered more vividly by mothers whose children had died.

Babies who showed 'blue colour' (cyanosis) symptoms were also at nearly four times greater risk of dying in the neonatal period than normal babies. This condition might be associated with the lack of oxygen that leads to severe asphyxia (asphyxia pallida). An in-depth interview with the doctor at the local health centre (*puskesmas*) revealed that asphyxia was a common health problem in the area. Thus, the elevated risk of neonatal death due to cyanosis supports the evidence of the interview with the head of the *puskesmas* that asphyxia is one of important causes of neonatal death.

In the study area, most of the deliveries (74 per cent) were assisted by traditional birth attendants. Training was organized by local health centres, but some traditional birth attendants were still practising traditional methods in birthing assistance such as the use of bamboo for cutting the cord. The study found that the use of this instrument increased the odds of neonatal death by more than six times the odds following the use of a more appropriate instrument (for example, the use of sterilized scissors).

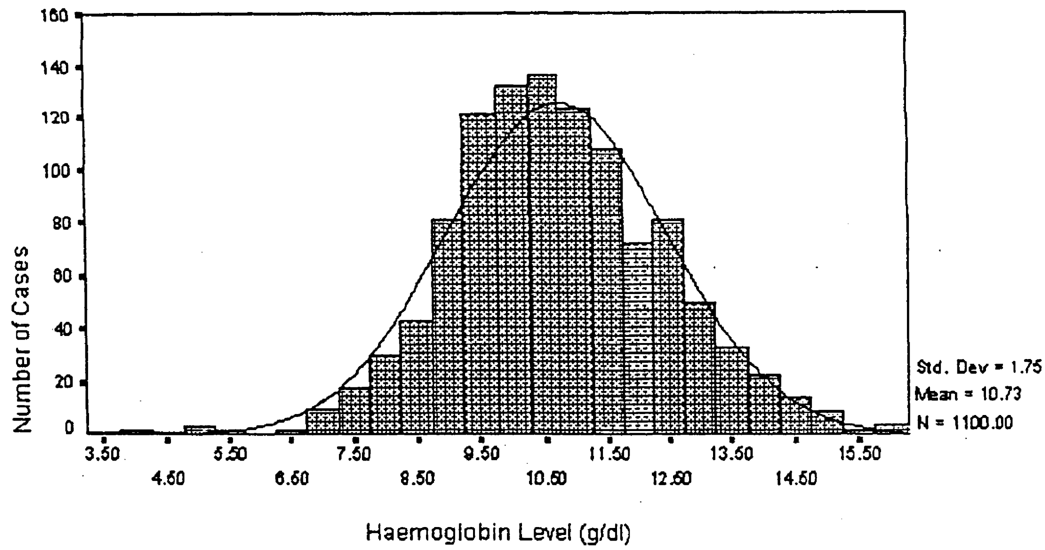
Although the tetanus immunization variable was not significant, a multivariate analysis conducted for the antenatal period found that this variable was the only one which showed a significant relationship with the risk of neonatal death. The presence of other explanatory variables in the model, particularly low birth weight, has rendered tetanus immunization no longer significant. The insignificant of this variable in this stage of analysis does not necessarily means that tetanus immunization is not important. The significance of tetanus immunization in the analysis conducted in the antenatal period and the fact that unhygienic practices in delivery increase the risk of neonatal death underlines the importance of tetanus immunization.

The initiation of breast-feeding after more than twenty four hours had the effect of increasing the odds of neonatal death twofold over the babies that were breast-fed sooner. The delayed breast-feeding can be because the baby encountered health problems at the first few days of life, or for other reasons, including cultural. In the present study, which was based on the MotherCare data, the proportion of mothers who initiated breastfeeding soon after birth was 34.9 per cent; another 30.7 per cent began breastfeeding within 24 hours. In all, the proportion of mothers giving breastmilk within 24 hours after birth was 65.6 per cent.

The significance of a baby's health problems in affecting neonatal death may be associated with delayed breast-feeding. If this is the case, then the baby's health problems may have prevented the baby from early breast-feeding. However, a lack of detailed information concerning factors that related to the initiation of breastfeeding makes it difficult to draw firm conclusions. Whether the breastfeeding practices or other factors are the explanatory mechanisms is worth further study.

The results of analysis indicated that haemoglobin level did not show any significant relationship with the risk of neonatal death. This finding could be true or otherwise be biased by the unreliability of the data. It was observed by other researchers that the haemoglobin data which were measured using the Hemoque were unreliable (Achadi et al., 1993:4). In this study the proportion of anaemic cases was 58 per cent. With such a high proportion, if the distribution of cases is clustered around the suggested cut-off point (11 g/dl) then it would be difficult also to assess the effect of this variable. Figure 5 demonstrates that the mode of the distribution is very close to but just below the cut-off point.

Figure 5 The Distribution of Cases according to the Haemoglobin Level



In summary, there are seven variables which showed consistent significant relationships with the risk of neonatal death. These were inter-pregnancy interval, low birth weight, jaundice, previous child death, cyanosis, cord cutting instrument, and breast-feeding initiation. Of these seven variables, inter-pregnancy interval and low birth weight were found to be the most important predictors for neonatal death. Considering the mutable nature of these two variables, it is very important to further investigate the antecedent factors which are related to these two variables (explored in Chapter Seven).

CHAPTER SIX

DETERMINANTS OF STILLBIRTH

As with the analysis of neonatal death, an analysis of the determinants of stillbirth was also conducted for the entire period of pregnancy and for each period of pregnancy, except of course that analysis at the post-partum period was not conducted because the baby had already died before the delivery.

A factor analysis was also conducted prior to proceeding to the bivariate and multivariate analyses. The main reason for this was that the explanatory variables were somewhat different; for example, inter-pregnancy interval was not considered in the analysis for stillbirths. Results of the analyses are presented in the following sections.

6.1 Results of Factor Analysis

a. Pre-pregnancy period

A factor analysis conducted in this period involved some variables related to socio-demographic profiles, maternal anthropometry, maternal attitude toward pregnancy, and history of previous pregnancy. They included maternal and husband's education, maternal working status, husband's occupation, family structure, parity, household assets, maternal height and mid-arm circumference, previous child death, previous pregnancy loss, and whether the pregnancy was planned.

An inter-pregnancy interval variable was not included in the analysis since its inclusion requires also the inclusion of a variable describing the quality of gestational age data. The gestational age data of all stillbirth cases was included in the 'not-validated' category due to missing birth weight data (see Chapter Four). It is therefore not appropriate to introduce an inter-pregnancy interval variable without one describing the quality of gestational age data as a control variable. However, maternal age at the beginning of pregnancy was still included in the analysis since it was thought that any distortion of the age calculation due to the use of some invalid gestational age was not considerable. In addition, the use of a binomial variable for the age may minimize the distortion effect.

The result of the factor analysis is displayed in Table 6.1.

Table 6.1 Varimax Rotated Component Analysis Factor Matrix (pre-pregnancy period), Indramayu Study, 1993.

Variables	Factor Loadings							Communality
	1	2	3	4	5	6	7	
Parity2	0.9	--	--	--	--	--	--	0.874
Family structure	0.78	--	--	--	--	--	--	0.68
Maternal age1	0.78	--	--	--	--	--	--	0.564
Previous pregnancy loss2	-0.72	--	--	-0.65	--	--	--	0.965
Previous child death2	-0.72	-0.65	--	--	--	--	--	0.952
Previous child death1	--	0.91	--	--	--	--	--	0.85
Parity1	-0.37	0.72	--	--	--	--	--	0.737
Maternal age2	-0.37	0.58	--	--	--	--	--	0.564
Household assets	--	--	0.7	--	--	--	--	0.543
Husband education	--	--	0.7	--	--	--	--	0.536
Maternal education	0.37	--	-0.59	--	--	--	--	0.576
Previous pregnancy loss1	--	--	--	0.93	--	--	--	0.916
Maternal working status	--	--	--	--	0.82	--	--	0.707
Husband's occupation	-0.34	--	--	--	0.43	--	-0.35	0.554
Planned pregnancy	--	--	--	--	0.36	-0.6	--	0.609
Arm-circumference	--	--	--	--	--	0.71	--	0.599
Maternal height	--	--	--	--	--	--	0.95	0.913
Eigenvalue	4.56	2.03	1.37	1.21	1.14	1.02	0.95	12.3
Percentage of trace *	26.8	11.9	8.1	7.1	6.7	6	5.6	72.3

Note: * trace = 17

From this table it can be seen that parity, previous child death, husband's education, previous pregnancy loss, maternal working status, maternal mid-arm circumference, and maternal height have the highest loadings for factor one to seven respectively. Instead of husband's education or household assets, maternal education was selected as a surrogate variable representing factor three. This was so since maternal education was thought to be playing a more important role in affecting stillbirth than the husband's education. Results of bivariate analysis showed that, while husband's education and household assets did not show significant association, maternal education was significantly associated with stillbirth (p=0.009). These seven variables would be incorporated in the bivariate and multivariate analyses.

b. Antenatal period

The explanatory variables included in this period of pregnancy were frequency of antenatal visits during pregnancy, haemoglobin level, coffee consumption, and symptoms of obstetric complications during the antenatal period including headache, fever, pain in urination, antenatal swelling, and antenatal bleeding.

While information on smoking behaviour and alcohol consumption was also collected, the proportion of respondents with such behaviours was small, so these variables were excluded from the analysis.

Similarly, information on the timing of first antenatal care and provider sought at the first antenatal care was also gathered. Due to the large number of missing cases (16 per cent) these variables were also excluded from the analysis, but the frequency of antenatal visits was used as a proxy measure for the use of antenatal care services.

Despite the large proportion of missing cases, the haemoglobin variable was included in the analysis. As with the previous analysis, this variable was categorised as *not anaemic*, *not measured*, and *anaemic*. This variable was then converted into two dummy variables which represented anaemic and not anaemic categories.

Table 6.2 Varimax Rotated Component Analysis Factor Matrix (antenatal period), Indramayu Study, 1993.

Variables	Factor Loadings					Communality
	1	2	3	4	5	
Frequency of antenatal care1	-0.93	--	--	--	--	0.861
Frequency of antenatal care2	0.91	--	--	--	--	0.859
Haemoglobin2	--	-0.89	--	--	--	0.802
Haemoglobin1	--	0.89	--	--	--	0.802
Fever	--	--	0.75	--	--	0.593
Headache	--	--	0.7	--	--	0.511
Pain in urination	--	--	0.51	--	--	0.411
Coffee consumption	--	--	--	-0.72	--	0.522
Antenatal bleeding	--	--	--	0.7	--	0.503
Antenatal swelling	--	--	--	--	0.95	0.92
Eigenvalue	1.96	1.61	1.23	1	0.99	6.79
Percentage of trace	19.5	16.1	12.3	10	9.9	67.9

Note: * trace = 10.

The analysis indicated that frequency of antenatal visits during pregnancy, haemoglobin level, fever, coffee consumption, and antenatal swelling had the highest loadings in factors one to five respectively. Instead of coffee consumption, antenatal bleeding was selected as the surrogate variable for factor four.

6.2 Results of Bivariate Analysis

Bivariate analysis was conducted for each period of pregnancy. The Cramer's V statistical test was employed to assess the relationship between the selected explanatory variables and stillbirth. Unadjusted odds ratios were also computed for the variables which showed a significant relationship with stillbirth. Table 6.3 presents the results, restricted to variables which had a significant bivariate relationship with stillbirth.

Table 6.3 Cramer's V Coefficient and Unadjusted Odds Ratio for the Predictors of Stillbirth, Indramayu Study, 1993.

Risk factor at each stage of pregnancy	Odds Ratio	Cramer's V coefficient
Pre-pregnancy Period:		
Maternal education:		0.07 **
- (No schooling)		
- Attended any school	0.38 *	
Antenatal Period:		
Antenatal bleeding:		0.12 ***
- (No bleeding)		
- Bleeding	8.13 **	

Note:
* Significant at five per cent level
** Significant at one per cent level
*** Significant at less than one per cent level.

Maternal education and antenatal bleeding were the only variables which showed a significant relationship with stillbirth. While school attendance had an effect of lowering the odds of stillbirth by 40 per cent, antenatal bleeding markedly increased the odds of stillbirth, by more than eight times.

6.3 Results of Multivariate Analysis

A multivariate logistic regression technique was employed to assess the joint effects of some selected variables on the occurrence of stillbirth.

As has been done with the analysis of neonatal death, this multivariate analysis was also performed in two stages; firstly, for each period of pregnancy with the relevant explanatory variables for that period, and secondly for the pre-pregnancy and antenatal periods with all of the surrogate explanatory variables.

6.3.1 Results of Multivariate Analysis for Each Period of Pregnancy

a. Pre-pregnancy period.

The explanatory variables included in the analysis for this period were parity, previous child death, maternal education, previous pregnancy loss, maternal working status, maternal mid-upper arm circumference, and maternal height.

Results of the analysis showed that maternal education was the only variable which had a significant relationship with the risk of stillbirth (see Table 6.4).

Table 6.4 Adjusted Odds Ratio for the Predictors of Stillbirth, Indramayu Study, 1993 (N=1319).

Risk Factor	Odds Ratio	Significance
Maternal education:		
- (No schooling)		
- Attended any school	0.42	0.03

Note: The improvement chi-square value=5.0; p=0.02

The analysis found that school attendance had the effect of decreasing the odds of stillbirth by 42 per cent. This finding is consistent with the result of the bivariate analysis.

b. Antenatal period

In this period, the explanatory variables which were included in the model were frequency of antenatal visits, haemoglobin level, fever, antenatal bleeding and antenatal swelling. The results of the analysis are displayed in Table 6.5.

Table 6.5 Adjusted Odds Ratio for the Predictors of Stillbirth, Indramayu Study, 1993 (N=1446).

Risk Factor	Odds Ratio	Significance
Antenatal bleeding:		
- (No bleeding)		
- Bleeding	8.13	0.0001

Note: the improvement chi-square value=10.95; p=0.001

Antenatal vaginal bleeding turned out to be the only explanatory variable that showed a significant relationship with stillbirth. The mothers who had experienced vaginal bleeding during the antenatal period were at greater risk of having an adverse pregnancy outcome (stillbirth). The effect of antenatal vaginal bleeding raised the odds of stillbirth more than eight times.

6.3.2 Results of Multivariate Analysis During the Pre-Pregnancy and Antenatal Periods

This model of analysis involved all of the surrogate explanatory variables that were analysed separately for each period of pregnancy.

As in the analysis of predictors for neonatal death, a variable describing the study site, Gabus Wetan or Sliyeg sub-district, was also included in the model as a control variable.

The analysis showed that two out of the thirteen variables were significantly associated with the risk of stillbirth. These were maternal education and vaginal bleeding.

The mechanism through which educational attainment influences stillbirth is unclear. It may be that better education is associated with higher economic status and therefore with the ability to afford referred treatment. In order to examine the confounding effect of economic status, a variable describing economic status was included in the model as a potential confounder of the relationships between maternal education and the risk of stillbirth. In this case, household assets was used as a proxy measure for economic status.

Consistent with previous procedures, a two-factor interaction term involving household assets and maternal education was assessed before examining the confounding effect. Since the interaction was not significant, a confounding analysis was conducted. Results showed that the odds ratio (for maternal education) of the full and the reduced model were similar. This finding suggested that the relationship between maternal education and stillbirth was not confounded by household assets. In order to examine the appropriateness of including household assets in the model, a precision test was carried out. Because the 95 per cent confidence interval limits of the logistic coefficients of the two models were similar, the full model with the inclusion of household assets was selected, taking into account the effect of household assets on the risk of stillbirth.

In addition to economic status, the effect of maternal education on stillbirth may also be associated with maternal age. As mentioned in Chapter One, both biological and social hypotheses relate pregnancy in young woman to adverse pregnancy outcome. Therefore maternal age at the beginning of pregnancy was also included in the analysis as a potential confounder of the relationship between maternal education and stillbirth.

A two-factor interaction term involving maternal age and maternal education was included in the model. Since the interaction was not significant, a confounding analysis was conducted. The results showed that the odds ratio for maternal education was not changed after the inclusion of the maternal age, which suggests that the relationship between maternal education and stillbirth was not confounded by maternal age. A precision test was carried out in order to determine which model provides greater precision. In so doing, the 95 per cent confidence interval limits of the adjusted odds ratios of the full model with maternal age and the reduced model without maternal age were compared. Since the confidence interval limits of the two models were similar, the full model was chosen as it controls for the effect of maternal age.

With the inclusion of household assets and maternal age in the model, antepartum vaginal bleeding remains the strongest predictor of stillbirth (r=0.14).

In the study area, most pregnancies were assisted by traditional birth attendants. As noted in Chapter Three, the type of birth attendant can be used as a proxy indicator for an obstetric complications variable which has not been included in the analysis. The type of birth attendant was included in the model as a potential confounder of the relationship between antenatal bleeding and stillbirth.

A two-factor interaction term involving the type of birth attendant and antenatal bleeding was examined, and since the interaction was not significant, the confounding effect of the type of birth attendant was then assessed. After the inclusion of the type of birth attendant variable, the adjusted odds ratio for the antenatal bleeding variable was decreased.

In order to ascertain whether the change in odds ratio was significant, logistic coefficients and their standard errors of the two models were compared. Results of the comparison of coefficients are as follows:

(1). Logistic coefficient (β) for antenatal bleeding:

- The full model: 1.5776
- The reduced model: 1.7554

0.1778

(2). Standard errors (S.E.):

$= 1.96 \sqrt{(.6813)^2 + (.6467)^2}$
$= 1.84$

Since the value of equation (1) is much less than equation (2), the logistic coefficients of these two models were not significantly different, so the relationship between antenatal bleeding and stillbirth is not confounded to a significant extent by the type of birth attendant.

To determine which model provides greater precision, the confidence interval limits of the adjusted odds ratios of the full model with the type of birth attendant were compared with the reduced model without the type of birth attendant variable. Results of the comparison are as follows:

(a). The full model:

$= 1.5776 \pm 1.96 \times 0.6813$

$= (0.24, 2.91)$

The C.I. limits for the adjusted odds ratios:

$= (1.27, 18.36)$

(b). The reduced model:

$= 1.7554 \pm 1.96 \times 0.6467$

$= (0.49, 3.02)$

The C.I. limits for the adjusted odds ratios:

= (1.63, 20.50)

As can be seen, the model with the inclusion of the type of birth attendant was the more precise since its confidence interval limit was narrower. For this reason it was selected as the final model for the analysis of the predictors of stillbirth (Table 6.6).

Table 6.6 Adjusted Odds Ratio for the Predictors of Stillbirth, Indramayu Study, 1993 (N=1319).

Risk Factor	Odds Ratio	Significance
Antenatal bleeding:		
- (No bleeding)		
- Bleeding	4.84	0.02
Maternal education:		
- (No schooling)		
- Attended any schoo	0.28	0.002
Birth attendant:		
- (TBA only)		
- Not TBA only	9.2	< 0.0001

Note: the improvement chi-square value = 4.03; p=0.04
TBA=traditional birth attendant.

With the inclusion of the potential confounders, the association between the antepartum vaginal bleeding and stillbirth remains significant. The significance of this variable was also observed in the bivariate as well as the multivariate analysis that was conducted in the antenatal period. These findings suggest that the relationship between antenatal bleeding and stillbirth is not spurious. This is so since the association between antenatal bleeding and stillbirth was not explained away by other potential risk factors in the model. This result is similar to that found in Bandung, Indonesia where along with malpresentation, antepartum vaginal bleeding was observed to be highly associated with perinatal death (Edouard 1990:3).

It is important to note that the incidence of antenatal bleeding might be under-recorded. In the study area, the proportion of respondents with antenatal bleeding was only three per cent. This percentage is quite low compared with the likely incidence rate of gestational bleeding which is 14.6 per cent (Berkowitz et al., 1983:167). A focus group discussion involving the interviewers that was conducted by the researcher found that there was some confusion about the definition used in the recording of antepartum vaginal bleeding. In some cases, the term intrapartum bleeding was also used to record the occurrence of antepartum bleeding. By this definition, only heavy bleeding was recorded; light vaginal bleeding was not reported as part of gestational bleeding.

School attendance had the effect of lowering the odds of stillbirth to 28 per cent of the odds for women who had never attended school. The significance of maternal education is consistent with the results of the bivariate analysis and the multivariate analysis conducted in the pre-pregnancy period. These findings suggested that the association between maternal education and stillbirth is not spurious.

As stated, the results of confounding analyses indicated that the association between maternal education and stillbirth was not confounded by household assets and maternal age. These findings suggested that the biological as well as social hypotheses relating to maternal education were unlikely to be the explanatory mechanisms through which educational attainment influences the risk of stillbirth. Another possible explanation, mentioned in Chapter One, is that maternal education has a positive influence on the use of health-care services. In order to support this proposition, a bivariate analysis was conducted to examine the possibility of a relationship between the use of health services and maternal education. The results showed that maternal education was significantly related to the timing of antenatal care initiation and the frequency of antenatal visits, the two variables that were used as proxy indicators for maternal health services. The proportion of women who made more than three antenatal visits was greater amongst educated mothers than those without any schooling ($p=0.0001$). Similarly, the proportion of educated women who made the first visit at the first trimester was higher than that of mothers without schooling ($p=0.001$). These findings suggested that educated mothers tended to seek antenatal care early and make an adequate number of visits as recommended by the program.

The deliveries which were attended by a person other than a traditional birth attendant were found to have increased odds of stillbirth. The 'other than traditional birth attendant only' category mainly consisted of a combination of a traditional birth attendant and a medical professional. Table 6.6 showed that a delivery which was assisted by a person other than the traditional birth attendant raised the odds of stillbirth by nine times the odds for the case of a delivery assisted by the traditional birth attendant only. This confirms the finding of the in-depth interviews, that if complications were encountered in the delivery then help from a medical professional was sought. As mentioned, a study conducted in Bandung regency found that malpresentation was highly correlated with perinatal death. In the study area, late referrals of complicated cases after prolonged observation at home and unsuccessful attempts by birth attendants to deliver the baby may be responsible for the adverse outcomes.

The role of the traditional birth attendant in assisting the delivery is widely appreciated, but they also have a role in the referral system. If the traditional birth attendants can be trained properly in the early detection of a high risk woman, their role in the referral system can be strengthened.

From the foregoing discussions, it can be concluded that maternal education and antepartum vaginal bleeding showed consistent significant relationships with the risk of stillbirth. While maternal education seems to be changeable, the presence of antepartum bleeding may not be modifiable. This is particularly the case in a situation where adequate health services are not available or are unaffordable. However, the presence of this symptom can be used as a risk marker for a woman developing an adverse pregnancy outcome.

Having now presented the results of analysis of the determinants of both neonatal death and stillbirth, Chapter Seven will outline the results of analysis of the determinants of selected intervening variables.

CHAPTER SEVEN

DETERMINANTS OF THE INTERVENING VARIABLES

As discussed in the previous chapters, there are some socio-demographic and other variables which have an apparent direct relationship with the outcome variables. However, some do not have such a direct relationship. This does not necessarily imply that these variables have no importance at predictors of the outcome variables. It is possible that their relationship is mediated through intervening variables. The term *intervening variable* refers to an intermediate variable through which an independent variable affects a dependent variable.

The mutable nature of some socio-demographic and other characteristics can be manipulated in such a way that may lead to a favourable pregnancy outcome. By analysing the association between some selected background variables and intervening variables, it might be possible to shed more light on the mechanisms through which the background variables affect perinatal death.

The intervening variables that were examined were the inter-pregnancy interval and low birth weight, which are the main predictors for neonatal death. The intervening variables associated with stillbirth, such as antenatal bleeding, were not explored as the proportion of respondents with such disorders was very small.

This chapter presents the results of bivariate and multivariate analyses of the determinants of inter-pregnancy interval and low birth weight.

7.1 Determinants of Inter-Pregnancy Interval

As mentioned in Chapter Two (Research Methods), the term *inter-pregnancy interval* refers to the interval between the date of termination of the preceding pregnancy and the date of the conception of the most recent pregnancy. Therefore, only women who have had at least two pregnancies (multigravidae) can be included in the analysis. By definition, primigravidae cases cannot be included.

The inter-pregnancy interval was classified into less than 18 months, and 18 months or more. As explained previously, a short pregnancy interval increased the odds of neonatal death. It is of particular interest to examine the factors which may be associated with the short pregnancy interval.

Some factors are known to be associated with inter-pregnancy interval. These include socio-demographic profiles, previous pregnancy loss, practice of contraception, and breast-feeding behaviour (Cleland and Rutstein, 1986; Bogue and Bogue, 1980:126). In this study, information on contraceptive history and breast-feeding behaviour prior to the pregnancy was not available, therefore attitude toward pregnancy, expressed as whether or not the current pregnancy was planned, and maternal education were used as proxy measures.

The explanatory variables in the analysis of the determinants of inter-pregnancy interval include maternal age, maternal education, husband's education, maternal working status, husband's occupation, family structure, parity, household assets, previous child death, preceding pregnancy outcome, and planned pregnancy. Unfortunately, some of these explanatory variables were found to correlate with each other, therefore a multivariate analysis which attempted to include all of the explanatory variables was inappropriate. In order to minimize bias due to the multicollinearity problem and to reduce the number of explanatory variables, a factor analytic approach using an orthogonal rotation procedure was also adopted prior to conducting bivariate and multivariate analyses. Table 7.1 presents the results of this factor analysis.

Table 7.1 Varimax Rotated Component Analysis Factor Matrix, Indramayu Study, 1993.

Variables	Factor Loadings						Communality
	1	2	3	4	5	6	
Parity	0.84	--	--	--	--	--	0.786
Maternal age2	0.74	--	--	--	--	--	0.618
Previous child death	0.73	--	--	--	--	--	0.626
Household assets	--	0.73	--	--	--	--	0.723
Husband's education	--	0.7	--	--	--	--	0.552
Maternal education	--	-0.66	0.31	--	--	--	0.595
Maternal age1	--	--	0.81	--	--	--	0.676
Family structure	--	--	0.73	--	--	--	0.641
Preceding pregnancy outcome	--	--	--	0.79	--	--	0.698
Planned pregnancy	-0.4	--	--	0.64	--	--	0.64
Maternal working status	--	--	--	--	0.9	--	0.845
Husband's occupation	--	--	--	--	--	0.9	0.851
Eigenvalue	2.46	1.35	1.32	1.14	1.11	0.87	8.25
Percentage of trace *	20.5	11.3	11	9.5	9.3	7.2	68.8

Note: * trace = 12

The resulting factor analysis revealed that parity, household assets, maternal age, preceding pregnancy outcome, maternal working status, and husband occupation turned out to be the highest loadings for factors one to six respectively. These six surrogate explanatory variables were then subjected to bivariate and multivariate analysis. Note that because these variables are highly correlated, discovery of a relationship between pregnancy interval or birth weight and the surrogate variable for a factor group could be interpreted as a relationship with any variable in that group.

While the bivariate analysis was aimed at exploring the individual effect of the explanatory variables before controlling for other variables, the multivariate analysis was intended to examine the joint effects of a set of explanatory variables on the inter-pregnancy interval.

7.1.1 Results of Bivariate Analysis

The bivariate analysis showed that, amongst the surrogate variables, parity, maternal age, preceding pregnancy outcome and husband's occupation were found to be significantly related to the pregnancy interval (Table 7.2).

Table 7.2 Cramer's V Coefficient and Unadjusted Odds Ratio for the Predictors of Pregnancy Interval, Indramayu Study, 1993.

Risk Factor	Odds Ratio	Cramer's V coefficient
Parity:		0.006 *
- (One to two children)		
- Three or more children	1.38 *	
Maternal age:		0.18 ***
- (Twenty or more years)		
- Less than 20 years	4.36 ***	
Preceding pregnancy - outcome:		0.37 ***
- (Live-birth)		
- Abortion/stillbirth	10.57 ***	
Husband's occupation:		0.09 **
- (Non-farmer)		
- Farmer	0.64 **	

Note:
* Significant at five per cent level
** Significant at one per cent level
*** Significant at less than one per cent level.

As shown in the table, the chance of a shorter pregnancy interval was higher among high parity women than the low parity group. If the higher parity was associated with increasing age, it would be expected that as a woman approached the later stage of her reproductive years, her child bearing rate would start to decline. This decline together with the achievement of the desired family size would have an influence on lengthening the pregnancy interval. The result of bivariate analysis may be contradictory since the higher the parity, the more likely it is that the pregnancy occurred within a short interval. It is possible that the chance of a short pregnancy interval is not directly associated with parity itself, but may be confounded by other correlated variables such as the presence of previous child death leading the parents to a decision to replace the dead child within a short interval. Multivariate analysis was conducted next to examine the effect of parity on the pregnancy interval, controlling for other factors known to be predictive for the inter-pregnancy interval.

The higher chance of a short-pregnancy interval was also observed among young mothers aged less than twenty years. Their chance was four times higher than that of older mothers. This finding seems logical since the desired family size of young women has not been achieved. Younger women might also have higher fecundability.

A preceding adverse pregnancy outcome, especially abortions or stillbirth, had the considerable effect of increasing the odds of a short-pregnancy interval, less than 18 months, to almost eleven times that of the favourable outcome, live-birth. The mechanism through which the preceding pregnancy outcome created a tendency towards a short pregnancy interval may have been through the absence of breast-feeding, which brings about more quickly the resumption of ovulation, and the absence of contraception due to the desire of parents to replace the dead child.

The chance of a short pregnancy interval was lower for the farming families compared to non-farmers. The mechanism remained unclear, but it was possibly related to the intensity and length of breastfeeding or to the economic affordability of another child.

7.1.2 Results of Multivariate Analysis

A multivariate analysis of the determinants of inter-pregnancy interval was only conducted for the pre-pregnancy stage and involved all the surrogate background variables derived from the factor analysis. A logistic regression technique was also employed to assess the predictors of the inter-pregnancy interval. In this analysis, the outcome variable was set equal to one if the pregnancy interval was less than 18 months and zero otherwise.

Results of the multivariate analysis showed that four out of the six explanatory variables were significantly related to the pregnancy interval. These were parity, maternal age, preceding pregnancy outcome, and maternal working status. Based on the coefficient correlation, preceding pregnancy outcome was the strongest predictor of the pregnancy interval (r=0.29).

Since the pregnancy interval was closely related to breast-feeding behaviour, maternal education, the surrogate for the group of variables including breast-feeding, was then used as a potential confounder of the relationship between preceding pregnancy outcome and the pregnancy interval. A two-factor interaction term involving maternal education and previous pregnancy outcome was assessed prior to conducting the confounding analysis. As the interaction was not significant, the confounding assessment was pursued.

Results of the analysis shown in Table 7.3, indicated that the odds ratio for the preceding pregnancy outcome was only slightly altered. This may mean that the relationship between preceding pregnancy outcome and the pregnancy interval was not confounded by maternal education. A precision test between the two models, one which included and one which excluded maternal education, was also carried out. The results showed that the 95 per cent confidence interval limits for the full model which included maternal education were shorter than for the reduced model. For this reason, the full model was selected as it was more precise and was also controlling for the effect of maternal education.

Another confounding factor which was examined was planned pregnancy, the variable used as a proxy measure for the practice of contraception. It was expected that as a woman wanted to have a child she or her husband would abandon the use of any form of contraception. Consistent with previous procedure, an interaction term involving planned pregnancy and previous pregnancy outcome was tested. Since the interaction was not significant, the confounding effect of planned pregnancy was assessed. This showed that there was a slight change in the odds ratio of the preceding pregnancy outcome after the inclusion of a planned pregnancy variable (see Table 7.3). This finding suggests that the relationship between preceding pregnancy outcome and the pregnancy interval was not confounded by planned pregnancy to any extent. A precision test was also conducted in order to determine which model gave greater precision. Since the confidence interval limits for the reduced model, without planned pregnancy, were shorter than for the full model, it was adopted as this model provided greater precision.

Table 7.3 The Adjusted Odds Ratios and 95% Confidence Intervals Limits for Pregnancy Outcome Before and After the Inclusion of Confounding Factors, Indramayu Study, 1993.

Multivariate Model	Odds Ratio	95% Confidence Interval Limits
Model 1	13.94	(7.70, 25.28) [a]
Model 2	12.6	(6.96, 22.65) [b]
Model 3	13.76	(7.54, 25.03) [c]

Note:
a. model 1 is a main effect model (without confounders)
b. model 2 is a main effect model plus maternal education
c. model 3 is model 2 plus planned pregnancy.

The results of analysis for model 2 are presented in Table 7.4.

Table 7.4 Adjusted Odds Ratio for the Predictors of Inter-pregnancy Interval, Indramayu Study, 1993 (N=867).

Risk Factor	Odds Ratio	Significance
Preceding pregnancy outcome:		
- (Live-birth)		
- Abortion/stillbirth	12.6	< 0.0001
Maternal age:		
- (Twenty or more years)		
- Less than 20 years	4.76	< 0.0001
Parity:		
- (One to two children)		
- Three or more children	2.16	0.0001
Maternal education:		
- (No schooling)		
- Attended any school	1.57	0.02
Husband's occupation:		
- (Non-farmer)		
- Farmer	0.66	0.03

Note: the improvement chi-square value = 4.81; p=0.03

Table 7.4 shows that five out of the seven explanatory variables were significantly related to the inter-pregnancy interval. Of these, preceding pregnancy outcome remains the strongest predictor of the inter-pregnancy interval (r=0.28).

As can be seen, young mothers were more likely to become pregnant at a shorter interval than older mothers. The analysis also showed that higher parity women have a greater chance of a short-pregnancy interval than do lower parity women. Despite differences in the estimated odds ratio, the pattern of results of this multivariate analysis was similar to the bivariate analysis. This indicated that the inclusion of preceding pregnancy outcome, the strongest predictor of the pregnancy interval, did not alter the significant relationship between parity and pregnancy interval. If higher parity had been associated with the increase in maternal age, then the result would have been difficult to interpret since it would have contradicted the fact that younger mothers were found to have a greater chance of having a short pregnancy interval.

Another confounding factor not taken into account was the previous child death variable. It is possible that even though the preceding pregnancy outcome was a live-birth, if the child had died soon afterwards it might have had a similar impact, that is, to cause the mother to have another pregnancy immediately in order to replace the dead child. This would shorten the length of the pregnancy interval.

In order to ascertain whether there was a confounding effect of the previous child death on the relationship between parity and pregnancy interval, the confounding assessment was performed. The first step was to identify whether there was a significant interaction between previous child death and parity. The results of the analysis showed that the interaction was not significant. However, the introduction of a previous child death variable caused parity to be no longer significantly associated with the inter-pregnancy interval. On the other hand, the previous child death variable proved to be significantly associated with the pregnancy interval. This indicated that in the presence of a previous child death variable, parity was not an important predictor of inter-pregnancy interval. This finding also led to the conclusion that it was not high parity itself that directly influenced the chance of a short-birth interval, but that other characteristics attached to higher parity women, for example, the presence of previous child death that influenced the women to have another pregnancy within a shorter interval. Since the improvement in likelihood ratio chi-square was significant (p=0.04), the model with the inclusion of a previous child death variable was chosen as the final model for the analysis of the determinants of inter-pregnancy interval. Results of the analysis are presented in Table 7.5.

Table 7.5 Adjusted Odds Ratio for the Predictors of Inter-pregnancy Interval, Indramayu Study, 1993 (N=867).

Risk Factor	Odds Ratio	Significance
Preceding pregnancy outcome:		
- (Live-birth)		
- Abortion/stillbirth	11.73	< 0.0001
Previous child death:		
- (No)		
- Yes	2.27	< 0.0001
Maternal age:		
- (Twenty or more years)		
- Less than 20 years	4.11	< 0.0001
Maternal working status:		
- (Unemployed)		
- Employed	0.58	0.02
Maternal education:		
- (No schooling)		
- Attended any school	1.48	0.04

Note: the improvement chi-square value = 4.23; p=0.04

Results of the analysis showed that the preceding pregnancy outcome was consistently the strongest predictor of inter-pregnancy interval. The odds of a short-pregnancy interval were almost twelve times higher when the preceding pregnancy outcome ended in stillbirth or abortion than they were with a live-birth. The analysis of determinants of neonatal death (Chapter Five), showed that preceding pregnancy outcome was not significantly associated with the risk of neonatal death. The present finding suggests that the association between preceding pregnancy outcome and neonatal death is indirectly mediated through the inter-pregnancy interval.

As expected, the inclusion of a previous child death variable decreased the odds ratio for the preceding pregnancy outcome variable. Despite this the pattern of the results of the multivariate analysis was quite similar to that of the bivariate analysis. This may mean that the relationship between previous pregnancy outcome and pregnancy interval was not spurious, and independent of other variables in the model.

The odds of a short-pregnancy interval were more than double if the mother had experienced a child death. The significant association between this variable and the inter-pregnancy interval supports the previous hypothesis that it was not the parity characteristic that directly influenced the odds of a short-pregnancy interval, but rather the presence of a previous child death that caused the tendency of high parity women to have a child within a short interval. The possible explanation is that, the death of a previous infant interrupts breastfeeding and leads to an early return of ovulation. The desire to replace the dead child may also shorten the pregnancy interval.

As observed in the bivariate analysis, maternal age consistently showed a significant relationship with the pregnancy interval. A younger mother was more than four times more likely to experience a short pregnancy interval than an older mother. This suggested that the association between maternal age and inter-pregnancy interval was not spurious, and it was independent of other variables in the model. In the analysis of the determinants of neonatal death (Chapter Five), maternal age did not confound the relationship between the pregnancy interval and neonatal death. Results of the present analysis suggest that the possible association between maternal age and the risk of neonatal death is mediated through the pregnancy interval.

As can be seen in Table 7.5, the mothers who engaged in paid employment were less likely to have a shorter pregnancy interval. This phenomenon might be due to work-related activities, coupled with the need for a sufficient family income, causing these mothers to postpone their desire to have children in the short term. In the bivariate analysis, this variable was not significant but, due to interactive effects with other variables in the multivariate analysis, it emerged as being significantly related to the pregnancy interval.

School attendance increased the odds of a mother having a short pregnancy interval by fifty per cent over one without formal schooling. If there was a close relationship between maternal education and breast-feeding behaviour, it could be posited that the effect of better education might have shortened the duration of breast-feeding. The cessation of breast-feeding might have brought forward the resumption of ovulation, leading to a shortening of the pregnancy interval. In the bivariate analysis, this variable was not significantly related to the pregnancy interval. However, in the multivariate analysis, it appeared as being significantly associated with the pregnancy variable, due to the joint effects of other variables. Nevertheless, in the absence of breast-feeding behaviour data, this explanation is still inconclusive. Further studies that take into account the effect of breastfeeding behaviour are worth conducting.

Based on the results of analysis, including confounding analyses, it can be summarized that preceding pregnancy outcome, previous child death, maternal age, maternal working status and maternal education were the variables which showed significant relationships with the risk of a short pregnancy interval. In the presence of other variables in the model, the preceding pregnancy outcome was consistently the strongest predictor for the risk of a short pregnancy interval. This leads to the conclusion that the preceding pregnancy outcome exerts an indirect effect on the risk of neonatal death through the pregnancy interval. A similar phenomenon was also observed for the maternal age variable.

7.2 Determinants of Low Birth Weight

As stated in Chapter Four, some of the birth weight data are invalid for the analysis of the determinants of low birth weight. This is due to the delayed birth weight measurements, which resulted in only a fraction of the sample, namely cases where birth weight was taken within the first six days of birth, being eligible for inclusion in the analysis. With such cases, the prevalence of low birth weight was only 7.1 per cent. As also explained in Chapter Four, it is likely that the excluded cases also contained low birth weight babies.

When a comparison of birth weight by gestation was made, only cases grouped in Category 1, *expected G.A.*, were consistent with the standard birth weight (see Table 4.21 in Chapter Four). The pattern of all the included cases differed considerably from the standard since they also contained *outlier* and *uncertain* cases. For the *outlier* cases, the problem was likely due to invalid gestational age, hence it would be problematic if the analysis should include gestational age as one of the covariates. This variable could not be included in the analysis since birth weight was one of the components used in the validation of gestational age data. Thus, for the *outlier* cases the problem of the invalid data can be overcome by excluding the gestational age variable from the analysis.

For the *uncertain* cases, the problem was likely to be related to the accuracy of birth weight data, especially with large-for-gestational age babies. These could be either correct, for example, babies born to diabetic women tend to overweight, or incorrect, through birth weight error. However, the proportion of cases in the *uncertain* category was small (6.7 per cent). Therefore, for the analysis of the determinants of low birth weight, all the cases where birth weight was measured at less than seven days were included in the analysis.

The analysis of the determinants of low birth weight involved both bivariate and multivariate analyses. The multivariate analyses were carried out for each period of pregnancy, involving the relevant variables for that period, and over the entire period of pregnancy involving all of the variables which had been analyzed separately in the pre-pregnancy and antenatal periods.

The explanatory variables included in the analysis of the determinants of low birth weight were socio-demographic backgrounds, maternal anthropometry, frequency of antenatal visits during pregnancy, haemoglobin level, coffee consumption, and symptoms of diseases that were experienced during pregnancy. The frequency of antenatal visits during pregnancy was used as a proxy measure for all antenatal care.

Information on maternal anthropometry was also collected, including maternal height, maternal weight at the time the pregnancy was detected, maternal weight gain during pregnancy, and maternal mid-arm circumference. Unfortunately, since pregnancy was detected, on average, four months after it commenced, maternal weight at the time the pregnancy was detected could not be used as the true measure of pre-pregnancy weight. Consequently, the total pregnancy weight gain also could not be computed. In this case, maternal height and maternal mid-arm circumference measured at the time the pregnancy was detected were used as proxy indicators for maternal anthropometry at the beginning of pregnancy. Maternal haemoglobin level was also included in the analysis as a proxy measure for maternal nutrition, especially at the last trimester.

Information on smoking behaviour was also collected. However, as the number of women with such behaviour was only 0.7 per cent this variable was not included in the analysis.

The variable describing the quality of gestational age data was included in the model as a control variable whenever the model included such variables as inter-pregnancy interval, preterm delivery, and maternal age at the beginning of pregnancy. Because birth weight was used as a factor in the data validation it meant that, in the analysis of the determinants of low birth weight, the particular variables which required a control variable (for example, inter-pregnancy interval) could not be included in the model. In this case, however, maternal age at the beginning of pregnancy was still included in the analysis since it was thought that the distortion of the age calculation due to the use of some invalid gestational age could not be considerable.

A factor analysis using an orthogonal rotation procedure was again employed in order to reduce the number of variables to be included in the multivariate analysis. The following sections present the results.

7.2.1 Results of Factor Analysis

a. Pre-pregnancy period

The factor analysis conducted for this period was particularly aimed at identifying surrogate variables related to socio-demographic characteristics. The result of this analysis is presented in Table 7.6.

Table 7.6 Varimax Rotated Component Analysis Factor Matrix, (pre-pregnancy period), Indramayu Study, 1993.

Variables	Factor Loadings						Communality
	1	2	3	4	5	6	
Maternal age1	0.84	--	--	--	--	--	0.748
Family structure	0.84	--	--	--	--	--	0.747
Parity2	0.83	--	--	--	--	--	0.768
Planned pregnancy	--	-0.77	--	--	--	--	0.617
Parity1	-0.39	0.75	--	--	--	--	0.734
Maternal age2	-0.37	0.68	--	--	--	--	0.632
Husband's education	--	--	0.71	--	--	--	0.553
Household assets	--	--	0.7	--	--	--	0.532
Maternal education	0.41	--	-0.57	--	--	--	0.581
Maternal working - status	--	--	--	0.92	--	--	0.878
Husband's occu- pation	-0.43	--	--	0.43	0.32	--	0.606
Mid-arm circumferenc	--	--	--	--	0.89	--	0.828
Maternal height	--	--	--	--	--	0.97	0.943
Eigenvalue	3.74	1.28	1.19	1.05	0.99	0.92	9.2
Percentage of trace *	28.8	9.8	9.2	8.1	7.6	7.1	70.5

Note: * trace = 13

The resulting loadings presented in Table 7.6 indicate that maternal age, planned pregnancy, husband's education, maternal working status, maternal mid-arm circumference, and maternal height had the highest loadings for factors one to six respectively. These six variables would be used as the surrogate variables for the explanatory variables grouped in the pre-pregnancy period.

b. Antenatal period

The results of the factor analysis for the antenatal period are presented in Table 7.7.

Table 7.7 Varimax Rotated Component Analysis Factor Matrix (antenatal period), Indramayu Study, 1993.

Variables	Factor Loadings					Communality
	1	2	3	4	5	
Frequency of antenatal care1	-0.93	--	--	--	--	0.861
Frequency of antenatal care2	0.91	--	--	--	--	0.859
Haemoglobin1	--	0.89	--	--	--	0.802
Haemoglobin2	--	-0.89	--	--	--	0.802
Fever	--	--	0.75	--	--	0.593
Headache	--	--	0.7	--	--	0.511
Pain in urination	--	--	0.51	--	--	0.411
Coffee consumption	--	--	--	-0.72	--	0.522
Antenatal bleeding	--	--	--	0.7	--	0.503
Antenatal swelling	--	--	--	--	0.95	0.92
Eigenvalue	1.95	1.61	1.23	1	1	6.79
Percentage of trace *	19.5	16.1	12.3	10	9.9	67.9

Note: * trace = 10

The figures in Table 7.7 reveal that the frequency of antenatal visits, haemoglobin level, antenatal fever, coffee consumption, and antenatal swelling had the highest loadings for factors one to four respectively. However, instead of coffee consumption, antenatal bleeding was chosen as the surrogate variable for factor four.

In summary, the surrogate explanatory variables selected following the factor analysis were:

a. Pre-pregnancy period:
- maternal age
- planned pregnancy
- husband education
- maternal working status
- maternal mid-arm circumference
- maternal height

b. Antenatal period:
- frequency of antenatal visits
- haemoglobin level (anaemic status)
- pregnancy disorder, especially antenatal fever, antenatal bleeding and antenatal swelling

These surrogates were then included in the bivariate and multivariate analyses.

7.2.2 Results of Bivariate Analysis

As had been done previously, a contingency table analysis was used to assess the relationship between some selected explanatory variables and low birth weight. An odds ratio was calculated for each explanatory variable that showed a significant relationship with low birth weight. Table 7.8 presents the results, restricted to those variables which had a significant bivariate relationship with low birth weight.

Table 7.8 Cramer's V Coefficient and Unadjusted Odds Ratio for the Predictors of Low Birth Weight, Indramayu Study, 1993.

Risk factor	Odds Ratio	Cramer's V Coefficient
a. <u>Pre-pregnancy period</u>:		
Maternal age:		0.10 ***
- (Twenty or more years)		
- Less than 20 years	2.58 ***	

Note: *** Significant at less than one per cent level

The result of the bivariate analysis was that none of the explanatory variables grouped in the antenatal period were found to be significantly related to low birth weight. At the pre-pregnancy period, maternal age was found to be the only explanatory variables that showed a significant relationship with low birth weight. Young mothers, aged less than twenty years, were more than double more likely to deliver low birth weight babies than those in the reference group. The following multivariate analysis describes the independent effects of this variable.

7.2.3 Results of Multivariate Analysis

A multivariate logistic regression technique was employed to assess the joint effects of some selected explanatory variables on low birth weight. As with the previous procedure, the analysis was conducted in two major stages. Firstly, multivariate analysis was carried out for each period of pregnancy involving the relevant variables for that period. Secondly, it included all of the explanatory variables grouped in the pre-pregnancy and antenatal periods.

a. Multivariate analysis for each period of pregnancy

Results of the analysis which was conducted separately for each period of pregnancy showed that none of the explanatory variables grouped in the antenatal period were significantly associated with the risk of low birth weight. Maternal age which was grouped in the pre-pregnancy period was found to be the only variable which showed a significant relationship with the risk of low birth weight. As seen in Table 7.9, the odds of low birth weight for younger mothers aged less than 20 years was almost three times higher than those for older mothers.

Table 7.9 Adjusted Odds Ratio for the Predictors of Low Birth Weight, Pre-pregnancy Period, Indramayu Study, 1993 (N=1198).

Risk Factor	Odds Ratio	Significance
Maternal age:		
- (Twenty or more years)		
- Less than 20 years	2.63	0.0003

Note: The improvement chi-square value=12.44; p=0.0004

The significant association between maternal age and low birth weight was also observed in the bivariate analysis, which suggests that it is an important independent predictor for low birth weight.

b. Multivariate analysis involving all of the variables grouped in the pre-pregnancy and antenatal periods.

The explanatory variables in this analysis included all the surrogate variables grouped in the pre-pregnancy and antenatal periods. The result of this multivariate analysis was again that maternal age was the only variable which showed a significant relationship with low birth weight. Consistent with the results of analysis conducted in the pre-pregnancy period, young maternal age (teenage pregnancy) increased the odds of low birth weight to three times those of older women. These findings indicate the presence of an independent effect of maternal age on the risk of low birth weight.

As explained in Chapter One, the deleterious effect of teenage pregnancy on low birth weight can be hypothesized through biological and social mechanisms. The biological mechanisms maintain that the nutrition of young women must provide for the demands of both their own growth and that of the foetus. A lack of energy on the part of the mother may adversely affect the growth of the foetus. The social hypothesis proposes that the effect of young maternal age is indirectly mediated through socio-economic disadvantage. This disadvantage may eventually have a negative impact on foetal growth.

If the mechanism is explained through socio-economic disadvantage, then it would be expected that controlling for the effect of other socio-economic variables would reduce the size and significance of maternal age. In this case, household assets and maternal education were used as potential confounders of the relationship between maternal age and low birth weight.

As with previous procedures, an assessment of interaction involving the potential confounder was conducted prior to assessing the confounding effects. Since the interaction terms were not significant, the confounding effects were conducted. Results showed that the odds ratio of maternal age was not changed after the inclusion of household assets and maternal education (see Table 7.10). Precision tests were conducted in order to examine the appropriateness of including household assets and maternal education in the model. Since the 95 per cent confidence interval limits were similar between the full and the reduced models (see Table 7.10), the two variables were included in the model. This model has the advantage of controlling for the effects of household assets and maternal education.

Maternal age is often associated with parity. A community-based study on the determinants of intra-uterine growth retardation conducted in Karachi, Pakistan, found that while no age-parity interaction was observed, primiparity and grand multiparity were important independent determinants of intra-uterine growth retardation (Fikree and Berendes, 1994:585). In order to assess the possibility of a confounding effect of parity, this variable was included in the model. Since the interaction term involving parity and maternal age was not significant, a confounding analysis was conducted. Results showed that the adjusted odds ratio of the full model with parity was slightly reduced. This suggests that the relationship between maternal age and low birth weight was not confounded by parity.

A precision test was carried out in order to determine the appropriateness of including parity in the model. In so doing, the 95 per cent confidence interval of the full and the reduced models were compared. Since the confidence interval limit of the full model was slightly shorter than the reduced model, the former was chosen as the final model for the analysis of the determinants of low birth weight, taking into account the effect of parity on low birth weight.

Due to the important role that the timing of antenatal care initiation may play in affecting the risk of low birth weight (as explained in Chapter One), a variable describing the trimester when antenatal care began was also included in the model as a confounding factor. This variable was categorised into (1) antenatal care initiated in the first trimester, (2) the second trimester, (3) the third trimester, and (4) no antenatal care.

Since the interaction term was not significant, a confounding analysis was carried out. Results showed that the adjusted odds ratios of the two models, with and without the inclusion of trimester of antenatal care intiation were similar (see Table 7.10). Since the results of the precision test indicated that the 95 per cent confidence interval limits of the full model were similar with the reduced model, the full model was selected.

Table 7.10 The Adjusted Odds Ratios and 95% Confidence Intervals Limits fo the Maternal Age Before and After the Inclusion of the Confoundii Factors, Indramayu Study, 1993.

Multivariate Model	Odds Ratio	95% Confidence Interval Limits
Model 1	2.63	(1.55; 4.44) [a]
Model 2	2.63	(1.55; 4.44) [b]
Model 3	2.63	(1.55; 4.44) [c]
Model 4	2.56	(1.51; 4.35) [d]
Model 5	2.56	(1.51; 4.35) [e]

Note:
a. model 1 is a main effect model (without confounder)
b. model 2 is model 1 plus household assets
c. model 3 is model 2 plus maternal education
d. model 4 is model 3 plus parity
e. model 5 is model 4 plus the timing of antenatal care initiation.

Thus, the explanatory variables included in the final model for the analysis of the determinants of the low birth weight consisted of the selected variables which were grouped in the pre-pregnancy and antenatal period, plus household assets, maternal education, parity, and the timing of antenatal care initiation. Results of the multivariate analysis are presented in Table 7.11.

Table 7.11 Adjusted Odds Ratio for the Predictors of Low Birth Weight (Pre-pregnancy and Antenatal Periods), Indramayu Study, 1993 (N=1170).

Risk Factor	Odds Ratio	Significance
Maternal age:		
- (Twenty or more years)		
- Less than 20 years	2.56	0.0005

Note: The improvement chi-square value=11.53; p=0.0007

In the presence of the potential confounders, only the association between maternal age and low birth weight remained significant. Teenage pregnancy still had the effect of increasing the odds of low birth weight more than double those of older women.

The result of the confounding analysis suggested that the social hypothesis was not supported. Therefore it can be inferred that the biological mechanism exerts a strong effect on the risk of low birth weight. As discussed in Chapter One, the biological disadvantage may be explained through the inadequate nutritional support for the growth of the fetus and herself. The avoidance of births among young women would then be necessary to reduce the incidence of low birth weight babies.

Contrary to the findings from studies conducted elsewhere, maternal nutrition which was represented by maternal height, haemoglobin levels and maternal mid-arm circumference did show any significant relationship with the risk of low birth weight. This insignificant relationship was also observed in the analysis of the determinants of stillbirth and neonatal death. With regard to maternal mid-arm circumference, additional multivariate analyses using other than the 23.5 cm cut-off point were also conducted. The other cut-off points used were 23.0 cm and 24.0 cm. The results of analysis using these different cut-off points indicated that the previous results using the 23.5 cut-off point was not altered. Similar results were also observed in the analysis of the determinants of stillbirth and neonatal death. As with the case of haemoglobin levels, because the mode of the distribution is very close to the cut-off points then it would be difficult to assess the effect of mid-arm circumference.

The results of analysis of the intervening variables suggested that maternal age, especially those women aged less than twenty years, indirectly increased the risk of neonatal death through its effect on increasing the risk of low birth weight and short pregnancy interval. If teenage marriage can be avoided then it would be greatly support efforts in lowering the high level of neonatal death.

CHAPTER EIGHT

CONCLUSIONS, POLICY IMPLICATIONS, AND AREAS FOR FURTHER STUDY

This study has addressed the lack of information about the determinants of stillbirth and neonatal death in rural areas of West Java Province, Indonesia. Dividing up perinatal mortality into its components, stillbirth and neonatal death, has facilitated an assessment of the possible differences in the predictors of stillbirth and neonatal death. It has also allowed an assessment of the risk factors for neonatal death, controlling for the effect of inter-pregnancy interval, preterm delivery, and maternal age at the initiation of pregnancy. These three important variables were developed from the validated gestational age data.

In addition to examining the determinants of the main outcome variables, stillbirth and neonatal death, the study has analysed socio-demographic correlates of some important intervening variables. This analysis was aimed at gaining more knowledge of how the background variables influenced the main outcome variables through these intervening variables. The findings of the study will be used to help planners design appropriate strategies for reducing the high level of stillbirths and neonatal deaths in West Java Province and other similar rural areas in developing countries.

As mentioned in Chapter One, the present study has been more concerned with exploration than verification and therefore hypotheses were not established at the beginning of the research program. In this chapter, some findings are identified to address matters not covered by the present study.

The first part of the chapter presents the conclusions drawn from the major findings of this study, and includes a discussion on the important predictors of the main outcome variables, stillbirth and neonatal death, as well as the intervening variables. The second part addresses some policy implications flowing from the findings of the study.

The third section proposes several hypotheses that would be a useful basis for further studies.

8.1 Conclusions

The conclusions concern determinants of neonatal death, determinants of stillbirth, and the determinants of selected intervening variables, inter-pregnancy interval and low birth weight.

Determinants of neonatal death.

The incidence of both neonatal death and stillbirth found in the present study was higher than the national average. The use of longitudinal data and the methods used in the analysis enabled an assessment to be made of the important predictors of neonatal death for each period of pregnancy.

The results of multivariate analysis conducted for each period of pregnancy revealed that, in the pre-pregnancy period, the explanatory variables that showed a significant relationship with the risk of neonatal death were inter-pregnancy interval and previous child death. Tetanus immunization status was the only significant variable in the antenatal period, as was foetal presentation in the intrapartum period, while low birth weight, jaundice, blue colour (cyanosis), and breast-feeding initiation were the significant variables in the post-partum period.

In the multivariate analysis involving all the selected variables over the entire period of pregnancy, the explanatory variables which had previously emerged as being significant in each period of pregnancy, except for foetal presentation and tetanus immunization, were also found to be significantly related to the risk of neonatal death.

Inter-pregnancy interval was found to be significant in both the bivariate and multivariate analyses. Consistent with the findings of studies conducted elsewhere, a short pregnancy interval was found to have the effect of increasing the odds of neonatal death. The results of analysis involving all of the selected explanatory variables over the full course of pregnancy (controlling for the confounding effects of maternal age and other confounding variables) also showed that inter-pregnancy interval was significantly related to the risk of neonatal death. The availability of accurate gestational age data, for calculating the inter-pregnancy interval, has thus proved to be an important consideration in studying the determinants of neonatal death. A method for determining the validity of gestational age data, developed for this study, proved to be a crucially important element of the process of analysis.

Maternal nutritional depletion may be related to the effect of a short pregnancy interval on the risk of a low birth weight baby. If the effect of a short pregnancy interval on neonatal survival was operating through low birth weight, then it would be expected that controlling for birth weight should reduce the size and significance of the association between short birth interval and neonatal death. The results of the multivariate analysis conducted for the pre-pregnancy period showed that the introduction of a low birth weight variable into the model increased the odds of neonatal death by almost twice the odds in the model without a low birth weight variable.

Analysis of potential confounding factors also showed that the association between inter-pregnancy interval and neonatal death was not confounded by previous child death. This finding, together with the results of analysis conducted for the pre-pregnancy period leads to the conclusion that, in the Indramayu data set, the maternal depletion theory was not supported. The bivariate analysis of the relationship between neonatal death and inter-pregnancy interval controlling for preterm delivery, suggested that Miller's proposition (Miller, 1994:362) that an excess of preterm deliveries was associated with a short pregnancy interval did not explain the effect of short pregnancy interval on the increased risk of neonatal death. The mechanism through which a short pregnancy interval increased the risk of neonatal death was likely to be through an intra-familial mortality effect. This effect was characteristic of mothers with a short pregnancy interval.

The significant association between previous child death and neonatal death suggested that this variable operated both directly and indirectly. The direct effect was an increase in the odds of neonatal death by more than three times for a mother who had suffered a previous child death. This effect no doubt reflects biological characteristics of the mothers, including physiological deficiencies which would carry over to subsequent births. The indirect effect was mediated through the inter-pregnancy interval and was explained through the tendency of mothers who had experienced a previous child death to have a short pregnancy interval.

Similarly, in both the bivariate and multivariate analyses, low birth weight was also consistently found to show a significant relationship with the risk of neonatal death. As observed in other studies conducted elsewhere, which were referred to in Chapter One, low birth weight had the effect of increasing the odds of neonatal death. This variable, together with inter-pregnancy interval, was selected as an intervening variable whose determinants were further investigated (see Chapter Seven).

In the multivariate analysis that was conducted for the antenatal period, tetanus immunization status was found to be significantly associated with the risk of neonatal death. However, in the multivariate analysis that included all of the explanatory variables, it was no longer significant. A closer examination of this phenomenon found that the inclusion of a low birth weight variable had explained away the significance of tetanus immunization. This may be due to the strong effect of birth weight variable on neonatal death. However, this does not necessarily mean that tetanus immunization was unimportant since its significance was still observed in the bivariate and multivariate analysis conducted for the antenatal period. In the absence of low birth weight, tetanus immunization would be an important predictor for neonatal death.

Another factor which has a close relationship to the occurrence of tetanus neonatorum is the use of cord cutting instruments. In the study area, 74 per cent of the deliveries were assisted by a traditional birth attendant. The use of unhygienic instruments, such as bamboo for cutting the cord raised the odds of neonatal death. The lack of tetanus immunization coverage together with unhygienic practices employed when dressing the cord undoubtedly exacerbated the risk of neonatal death.

Baby health problems observed soon after birth significantly increased the risk of neonatal death. A baby having a 'blue' appearance, cyanosis, was almost four times more likely to die in the neonatal period than a normal baby. This significant relationship is unlikely to be spurious since both bivariate and multivariate analyses produced consistent findings. Despite detailed information on the consequences of this symptom being unavailable, if this finding is matched with the results of in-depth interviews concerning the major causes of neonatal death in the study area, it is likely that the 'blue baby' symptom associated with asphyxia is the most common cause of neonatal death. This supports the findings of a hospital-based study conducted in 1984 in Indonesia involving several type C hospitals which showed that asphyxia was found to be the dominant cause of neonatal death (Kadri et al., 1990:95).

As with the 'blue baby' symptoms, babies with yellowish tinged skin, jaundice, were also at a greater risk of dying in the neonatal period. Based on the results of bivariate and multivariate analyses it can be concluded that the significant association between jaundice and the risk of neonatal death was not spurious. Detailed information on the causes of jaundice was also unavailable; however, the results of the analysis suggested that this type of symptom was unlikely to be one of normal jaundice but rather one of infections or other disorders. There is also the possibility that the symptom is remembered most readily by women whose children died. Studies conducted in other developing countries have indicated that jaundice is also a prominent cause of neonatal death (Costello, 1993:1).

Delayed breast-feeding, in terms of whether or not breastfeeding was given within 24 hours of birth, was significantly related to the increased risk of neonatal death. A lack of detailed data on the causes of delayed breastfeeding makes it difficult to draw firm conclusions, and this area also merits further study.

Throughout the analysis, haemoglobin level did not show any significant relationship with the risk of neonatal death. A similar insignificant relationship was also observed in the analysis of the determinants of stillbirth and low birth weight. The insignificant relationship may be subject to bias due to a large number of missing cases (25.3 per cent) and the fact that the distribution is clustered around the cut-off point, which consequently fails to provide a meaningful distinction between the ‘normal’ and ‘below normal’ cases in the study population.

Determinants of stillbirth.

Based on the results of bivariate and multivariate analyses, it was found that antenatal vaginal bleeding was the strongest predictor of stillbirth. Even after controlling for the potential confounder, type of birth attendant, the relationship between antenatal vaginal bleeding and stillbirth remained significant. These findings suggested that the association between antenatal vaginal bleeding and stillbirth was not spurious. Despite the fact that the vaginal bleeding during pregnancy might not be modifiable, its presence can be used as a risk marker. Due to the importance of this pregnancy complication in affecting stillbirth, further study is needed to identify the causes of vaginal bleeding.

Another factor which significantly affected the odds of stillbirth was maternal education. School attendance had the effect of lowering the risk of stillbirth. As with antenatal bleeding, the significant relationship between maternal education and stillbirth did not disappear after controlling for the effect of some potential confounders. The results of confounding analysis suggested that neither biological factors, especially maternal age, nor economic disadvantage explained the mechanisms through which maternal education affected the risk of stillbirth. As discussed in Chapter Six, it is likely that maternal education was associated with positive health-seeking behaviour in terms of the tendency of the educated mothers to seek antenatal care early and make an adequate number of antenatal visits. In a hospital-based study conducted in India, previous reproductive loss was found to be associated with an increased risk of stillbirth (Mavalankar et al., 1991:439). In the Indramayu study, this was not found to be the case.

In the multivariate analysis that was conducted in the pre-pregnancy and antenatal periods, the type of birth attendant variable was used as a potential confounder of the relationship between antenatal vaginal bleeding and stillbirth. Despite the association not being confounded by the type of birth attendant, this variable was still found to be significantly associated with the risk of stillbirth. Complications during labour, unsuccessful attempts by birth attendants to overcome the problem, and delayed access to adequate obstetric care may explain the increased risk of stillbirth associated with the type of birth attendant, especially of those mothers who were assisted by a combination of traditional birth attendant and health professional.

Determinants of the inter-pregnancy interval.

Results of bivariate and multivariate analyses suggested that preceding pregnancy outcome was the strongest predictor of the inter-pregnancy interval. An adverse preceding pregnancy outcome, whether the preceding outcome was stillbirth or abortion, was significantly associated with an increased risk of short pregnancy interval. In the analysis of the determinants of neonatal death presented in Chapter Five, preceding pregnancy outcome did not have a significant relationship with the risk of neonatal death. The results of the analysis of the determinants of inter-pregnancy interval suggested that the possible association between preceding pregnancy outcome and neonatal death is indirectly mediated through inter-pregnancy interval.

In the bivariate analysis, higher parity was associated with a higher risk of short-pregnancy interval. The results of the multivariate analysis, with the inclusion of previous child death as a potential confounder, suggested that it was not parity *per se* that directly affected the odds of the short-pregnancy interval, but rather the presence of a prior child death which characterised high parity women and led to the women having another child within a short interval. The effect of prior child death on the increased chance of a short pregnancy interval was also observed in a study conducted in Central Java (Indonesia), which found that, after the death of the child, about 19 to 34 per cent of the women were pregnant again within two to four months of the first menses (Santow and Bracher, 1984:252). A similar finding was also obtained in a study conducted in India, which revealed that the birth interval of women who experienced infant death was nine months shorter than that of women who had not experienced an infant death (Singh et al., 1993:151). The significance of previous child death in affecting the chance of the short pregnancy interval confirms the previous statement that this variable also exerts an indirect effect on the risk of neonatal death.

Young multigravid women were at a greater chance of becoming pregnant at a shorter interval than older multigravidae women. In both the bivariate and multivariate analyses, maternal age was consistently found to have a significant relationship with the risk of a short pregnancy interval. These findings suggested that maternal age was an important independent predictor of the inter-pregnancy interval. In the analysis of the determinants of neonatal death, maternal age was not significantly associated with the risk of neonatal death. The results of the present analysis suggested that, as with the preceding pregnancy outcome, the association between maternal age and neonatal death was mediated through inter-pregnancy interval.

In the present analysis, maternal education was used as a proxy measure for breast-feeding behaviour. Despite maternal education not confounding the relationship between previous pregnancy outcome and inter-pregnancy interval, it emerged as being significantly associated with the chance of a short pregnancy interval. If school attendance was associated with shorter breast-feeding (due to the increased use of bottle feeding), it may be inferred that the effect of maternal education on the chance of a short pregnancy interval operated through the cessation of breast-feeding which eventually stimulated the resumption of ovulation. In the absence of contraception, the next pregnancy will occur much earlier.

Results of the multivariate analysis indicated that maternal working status was associated with the chance of a short pregnancy interval. Paid working mothers were less likely to have a baby within a short interval. The corollary was that mothers who engaged in household chores only were at a greater risk of having a baby within a short interval.

Determinants of low birth weight.

Based on the results of bivariate and multivariate analyses, it can be inferred that, of the socio-demographic variables, maternal age was the most important predictor of low birth weight. Other variables included in the analysis, such as the use of maternal health services, maternal nutrition at the beginning of pregnancy, and diseases during pregnancy, were not statistically associated with the risk of low birth weight.

Contrary to the findings from studies conducted elsewhere, the present study found that the strong association between maternal age and low birth weight remained after controlling for the effects of other known direct predictive variables such as the use of antenatal care and maternal nutrition at the beginning of pregnancy (Kramer, 1987a:681; Lee et al., 1988:86). This suggests that the relationship between young maternal age and low birth weight may vary between populations.

The emergence of maternal age as a significant independent predictor of low birth weight and the fact that the relationship between maternal age and low birth weight was not confounded by household assets, maternal education, and other potential confounders leads to the conclusion that biological disadvantages, such as their adolescent developmental status, rather than socio-economic disadvantages, constitute the mechanism through which young maternal age affects the risk of low birth weight. This finding provides further evidence that supports other studies in which a higher incidence of low birth weight was observed among younger women (Kline et al., 1989:277; Miller, 1989:240; Gribble, 1993:142; Defo and Partin, 1993:97).

The significance of maternal age as an independent predictor for low birth weight and inter-pregnancy interval suggests that the effect of young maternal age on the elevated risk of neonatal death operated indirectly through the tendency of having a low birth weight baby and a short pregnancy interval. In the study area, and in the Indramayu Regency in general, the tradition of young marriage remains widespread. This tradition together with low maternal educational attainment, has proved to have a negative impact on pregnancy outcomes. If these mutable conditions can be improved, then it will make a substantial contribution in supporting efforts to reduce the high level of adverse pregnancy outcomes.

8.2 Policy Implications

This study found that socio-demographic as well as medical factors have a significant effect on the risk of neonatal death and stillbirth. Some of the socio-demographic factors have direct, and others indirect, effects on the risk of adverse pregnancy outcomes. This means that efforts aimed at reducing the risk of adverse pregnancy outcomes should not be concentrated on medical aspects only, but also include a socio-demographic dimension. This also implies that public health initiatives based on a multi-sectoral approach should be adopted in order to enhance efforts aimed at reducing the high level of neonatal death and stillbirth in the study area or in other areas where similar conditions apply.

The methods used in the data analysis, particularly the multivariate analysis that was conducted for each period of pregnancy, have identified some important predictors of the adverse pregnancy outcome. The findings can contribute to the development of an appropriate risk approach strategy for maternal and child health services taking into account the role of the important predictors in each period of pregnancy.

The significance of the inter-pregnancy interval variable as a strong predictor of neonatal death bears some methodological and programming implications. From the methodological point of view, the significance of inter-pregnancy interval, as a strong predictor of neonatal death and also as a significant variable describing the quality of gestational age data, underlies the importance of conducting the gestational age data validation especially for the data originating from the community-based study. This is because the accurate determination of the length of pregnancy interval is greatly influenced by the accuracy of gestational age data. As noted by Miller (1994:361), the use of inaccurate gestational age data can produce an inverse relationship between inter-pregnancy interval and length of gestation, in the sense that a short inter-pregnancy interval will be linked to longer gestation, and vice versa. The inclusion of a variable describing the quality of gestational age data as a covariate in the multivariate model is therefore useful in obtaining unbiased estimates of the relative risk due to the possible introduction of incorrect gestational age data.

This study has developed a special method of validating the quality of gestational age data, the first of its kind in a community-based study. Despite the algorithms used in the process of gestational age data validation not being tested by other reliable methods, such as the use of an ultrasound estimate of foetal size as the benchmark, the results of bivariate presentations of gestational age data against birth weight showed an improvement after the use of the gestational age data validation. Similarly, the proportion of preterm deliveries became more reliable when a comparison was made with other findings (see Chapter Four). Hence, the methods used in the validation of the quality of gestational age data can be applied in areas with similar conditions. However, it would be useful for other studies to be initiated to assess the sensitivity of the algorithms used in the present study.

From a programming point of view, the significant relationships between inter-pregnancy interval and neonatal death consistently observed in the analysis imply that any attempt to reduce the occurrence of a short pregnancy interval, for instance through family planning, would be important in lowering the incidence of neonatal death. The results of the analysis showed that it was intra-familial mortality effects rather than maternal nutritional depletion that explained the means through which a short pregnancy interval increased the risk of neonatal death. The significance of previous child death in both directly and indirectly influencing the risk of neonatal death shows that it can also be used as one of the risk markers in assessing the likely risk of a pregnant woman's baby dying in the neonatal period.

Despite lack of a direct influence of preceding pregnancy outcome on the risk of neonatal death, it was found that this variable was the strongest predictor of the inter-pregnancy interval. This means that it also indirectly influenced the risk of neonatal death through the inter-pregnancy interval. Therefore, in order to minimise the risk of neonatal death, the mother who has had a preceding adverse pregnancy outcome, such as a stillbirth or abortion, should also be given particular attention.

Maternal age was found to indirectly influence the risk of neonatal death through its effect on the pregnancy interval and low birth weight. The avoidance of young marriage would eventually have a greater impact on lowering the risk of neonatal death. Although a low birth weight baby may not die in the neonatal period, it is possible that the adverse effects of low birth weight may cause death in the post-neonatal period.

The problem of adolescent marriage may not only be related to bio-medical risks but may also be related to socio-economic welfare as well. The adverse consequences include psychological stress, poor parental jobs, unstable marriage and unwanted children (Koetsawang, 1990:496). Children born to teenage mothers may be disadvantaged as a result of maternal socio-psychological immaturity.

In Indonesia, the law that regulates the age of marriage is the Law of Marriage No.1, 1974. It proclaims that the legal minimum ages of marriage are 16 and 19 years for a woman and a man respectively (*Undang-Undang Perkawinan No.1/1974 bab II pasal 7 ayat 1*). The law of marriage has been criticised on the grounds that the legal minimum age prerequisite would lead to high-risk pregnancy and lengthen a woman's reproductive years (Yafizham 1987:379). Since most laws were designed to protect children and adolescents from marrying too early, it is possible that the actual minimum age of marriage is lower than the legal one. Thus, from a reproductive health point of view the ages specified by the law are not appropriate. The findings of the study based on the Indramayu data provided further evidence that teenage pregnancy had deleterious effects on reproductive health, especially in raising the risk of low birth weight and short pregnancy interval, which may eventually lead to neonatal death. In the short run, it is important to increase efforts to promote later marriage, but if a norm of late marriage cannot be attained, for example, due to cultural tradition, then family planning aimed at delaying pregnancy should be advocated to this group. The provision of adequate education for women not only lengthens the period of schooling but may also increase the awareness of the importance of avoiding young marriage.

Ever having attended school increased the risk of a short pregnancy interval. If there is a close relationship between educational attainment and a greater exposure to mass media campaigns, such as to encourage the practice of bottle feeding, it may be that better education will shorten the duration of breast-feeding. If the cessation of breast-feeding can bring about an early resumption of ovulation, then more health education should be provided about the importance of breast-feeding.

The results of bivariate and multivariate analyses conducted in the antenatal period found that a lack of tetanus immunization significantly increased the risk of neonatal death. In Indonesia, the target for tetanus immunization programs is not only pregnant women but also all prospective brides. This effort is undertaken jointly by the Ministry of Health and the Ministry of Religious Affairs (Kandun, 1991:11). Official Indramayu District Health Services data showed that the coverage for pregnant women in the Indramayu Regency was 81.9 per cent. Of those women, 79 per cent had completed tetanus immunization (*Dinas Kesehatan Kabupaten Indramayu*, 1993:18). This relatively high level of tetanus immunization should have prevented the occurrence of neonatal tetanus.

Data from the Indramayu Study showed that the proportion of women who had completed tetanus immunization, that is received two tetanus immunizations during pregnancy, was only 31.9 per cent. Considering the importance of tetanus immunization in preventing neonatal death and that a considerable proportion (16 per cent) of pregnant women in the study area did not attend antenatal care at all, it is important, in the short run, to strengthen existing efforts to immunize all pregnant women as well as prospective brides. It is especially important to reach those women who do not attend any antenatal care services.

Another factor that is closely related to the risk of tetanus neonatorum is the practice of dressing the umbilical cord. The study found that the use of bamboo for cutting the cord significantly increased the risk of neonatal death. In the study area, training designed for the traditional birth attendants has long been initiated, which implies that the training has reached most of the traditional birth attendants. The existence of unhygienic practices in birthing assistance indicates that the aims of the training have not been fully achieved. This may mean that training more relevant to the local conditions should be adopted. The provision of necessary equipment after training and adequate supervision of traditional birth attendants are required in order to reduce the high level of neonatal deaths.

In the present study, low birth weight was found to be a strong predictor of neonatal death. Efforts to minimise the occurrence of low birth weight would undoubtedly have a considerable impact on lowering the incidence of neonatal death. From the results of analysis of the determinants of low birth weight, it appears that maternal age was the only variable which showed a significant relationship to low birth weight. Other variables, such as the frequency of antenatal visits, the timing of antenatal care initiation, and maternal nutrition at the beginning of pregnancy, were not statistically directly related to the risk of low birth weight. These findings bear some implications; for example, efforts to reduce the incidence of low birth weight should not only concentrate on medical initiatives but also on social initiatives as well. The avoidance of young marriage can be advocated as a part of a social program.

Infant health problems which were encountered during the first few days of life, such as jaundice and asphyxia, were found to greatly increase the risk of neonatal death.

These problems, along with low birth weight and bacterial infections, were found to be the leading causes of neonatal deaths in other developing countries (Costello, 1993:1). The improvement of post-natal health care services and efforts to increase the awareness of mothers regarding the importance of using post-natal care are necessary. The awareness of post-natal services is very important since there is a local belief that a newborn baby should not be exposed outside the home until 30 to 40 days following birth. The existence of this belief, together with the limited resources available, could be exacerbating the problems.

Delayed breastfeeding had a deleterious effect on neonatal survival. As discussed in Chapter One, from a medical point of view the first breastfeeding can be initiated within thirty minutes of birth. This early breastfeeding has the advantage of stimulating the suckling reflex. In most societies in developing countries, feeding in the neonatal period is usually no problem since most mothers are willing to breastfeed. However, some mothers in the Indramayu area are not willing to give colostrum which is produced soon after delivery. Instead of colostrum, another fluid such as honey or sweetened tea is given to the baby while waiting for the 'white' breastmilk. This practice may have a negative effect on the health of the baby as the withdrawal of colostrum will deny the adequate antibodies required for disease prevention. In addition, the use of other liquids may also facilitate the introduction of harmful organisms. A study which further investigates the causes and consequences of delayed breastfeeding would be useful.

Another socio-demographic factor found to be significantly associated with the risk of an adverse pregnancy outcome, especially stillbirth, was maternal education. School attendance significantly reduced the risk of stillbirth. This underlines the importance of providing adequate education for women, which will also reduce the high percentage of young marriages. The improvement of maternal education is not only beneficial in lowering the risk of stillbirth, but is also important in increasing the overall well-being of a woman and ultimately her family.

Along with maternal education and type of birth attendant, antenatal vaginal bleeding was an important predictor of stillbirth. Although vaginal bleeding may not be modifiable, its presence can be used as a risk marker for a stillbirth. As explained previously in the analysis, due to data limitations, the timing of antenatal bleeding was ignored in the sense that it was not specified whether the bleeding occurred in early or late pregnancy. An analysis that takes into account the timing of the event would be important as it will provide information on the necessity for prompt action. Another important feature in need of study is the use of a correct definition of vaginal bleeding. The incidence of antenatal bleeding found in this study may be underestimated since only heavy bleeding was recorded. Therefore, a more detailed study on the timing of events and the use of a broader definition of vaginal bleeding are important.

The results of analysis showed that maternal nutrition was not significantly associated with adverse pregnancy outcomes. As explained in Chapter Two, due to limitations of the data, only maternal height, maternal mid-arm circumference and haemoglobin levels were used as proxy indicators for maternal nutrition. In this study, the cut-off point used for mid-arm circumference was 23.5 cm which corresponds with that used in the government campaign to prevent adverse pregnancy outcomes. Despite the fact that the use of the different cut-off points did not show any significant relationships with the risk of adverse pregnancy outcomes, it may not be necessarily means that this variable is not an important predictor for adverse pregnancy outcome. Rather, a more sensitive cut-off point for the mid-arm circumference should be investigated.

In the study area, most of the deliveries were assisted by traditional birth attendants. The combination of a traditional birth attendant and a professional was a strong predictor of stillbirth. This type of birth assistance is actually not a direct cause but rather an indication of obstetrical complications during labor. As traditional birth attendants are still prominent in birthing assistant and their undesirable practices are associated with the increased risk of poor pregnancy outcomes, their role in delivery practices should also be taken into account. They should be incorporated into the health delivery system as this would make it easier to monitor their harmful practices, and at the same time increase their participation in the timely referral of emergency cases and in promoting public health activities such as family planning, breastfeeding promotion and immunization for the newborn babies.

Throughout the analyses, especially the analysis employing the multivariate logistic regression model, the use of antenatal care was not significantly associated with the risk of adverse pregnancy outcome. However, this does not necessarily mean that antenatal visits are not important. The lack of appropriate services may be responsible for the non-significance of their role in reducing the risk of adverse pregnancy outcome. The fact that some socio-demographic and pregnancy history variables have a significant relationship with the risk of adverse pregnancy outcome underlines the importance of antenatal care, at least for early detection of a woman who may be at greater risk of developing an adverse pregnancy outcome. The improvement of maternal health care services, together with efforts to increase the awareness of the importance of using antenatal care at an early stage of pregnancy would be useful in alleviating the occurrence of adverse pregnancy outcomes.

In Indonesia, efforts have been made to overcome the barriers to access to maternal and child health services, including the provision of mobile health services and the monthly opening of a *posyandu* organised by the local community with the assistance of the local health centre. Recently, a village-based midwifery service, *polindes*, was launched. This *polindes*, which is primarily staffed by a *bidan desa*, a village-based midwife, was initiated by the Government of Indonesia in June 1988 as part of the effort to increase maternal welfare (*Upaya Peningkatan Kesejahteraan Ibu*). It was planned that by the end of the Fifth Five-year Development Plan (*Repelita V*), the number of *bidan desa* would be 18,000 (Alisjahbana 1993:1).

The *polindes* is an extension of *posyandu* activities and is also a kind of collaboratory activity between the local community and local health centre. While the health sector provides appliances and the *bidan desa*, the community provides the building and shares some of the running expenses. The midwifery services available at *polindes* include prenatal, delivery, and postnatal care.

The introduction of *polindes* is a crucial important step in providing services close to the people in need. This is particularly the case for pregnant women who cannot afford to use private or government-based maternal health services, such as *puskesmas*, due to geographical and financial constraints. A cost-benefit analysis conducted in a rural area of West Java Province in 1992 revealed that the social benefits of the *polindes* included less travel time and lower travel costs compared with the use of government-based maternity services, and that total charges were also less. It also found that the presence of *polindes* reduced the incidence of perinatal mortality (Yusril, 1993:9).

The development of currently promoted village-based maternity services (*Polindes*) should therefore be encouraged as this will bridge the gap between the formal health care delivery system and informal health delivery practices such as traditional birth attendants. However, as is the case in other developing countries, the health care system including *polindes* may not be able to reach all of the population. The risk approach should be used to allocate existing resources to reflect need rather than according to demand. The findings of the study can be used as an input for the development of an appropriate risk approach strategy at *polindes*, taking into account the role of the important predictors in each period of pregnancy.

Polindes can be used as a means of integrating traditional birth attendants into formal health care delivery system. For example, as a *bidan desa* is expected to be capable of recognising the warning signs of an abnormal or potentially abnormal pregnancy, the *polindes* may be used as a maternity waiting home, serving as a first point in developing a referral system and for the regular supervision and training of the traditional birth attendants.

In the absence of medical help, the *bidan desa* is expected to be capable of carrying out emergency measures. In order to ensure the effectiveness of their role in providing services, *polindes* should be backed up with adequate resources, especially the provision of essential obstetric care. The provision of adequate services around the timing of labour and delivery would be very useful in reducing the chances of poor pregnancy outcome to either the mother or the baby. The provision of obstetric care should also be followed up with a regular in-service training to the midwives. This training is very important to improve the skills to deal effectively with the cases in need of emergency obstetric care.

Bidan desa should also be involved in health education activities. For example, education in the importance of tetanus immunization, proper referral of obstetric complications, family planning and the avoidance of young marriage could be initiated at *polindes*. In order to support these activities, the provision of informative and attractive materials for public health education are necessary. Considering the limitation of resources and the need of gaining community participation, intersectoral collaboration (for example with local village administrators and non-governmental organizations) are extremely needed to achieve the desired goals.

8.3 Proposed Areas for Further Study

The following are several inconclusive results from the analysis and evaluation of the theoretical framework.

a. The reason that an infant's poor health condition at birth increases the risk of neonatal death.

Consistent with findings reached by others, a baby's poor condition at birth was found to increase the risk of neonatal death. In this study, information on the causes of this condition such as jaundice was unavailable and therefore it is difficult to draw firm conclusions as to how the condition affected the risk of neonatal death.

b. The reason that delayed breastfeeding increases the risk of neonatal death.

Delayed breastfeeding, in terms of whether or not the breastfeeding is initiated within 24 hours of birth, affects the risk of neonatal death. Due to data limitations, the present study did not reach firm conclusions about the mechanisms through which the delayed breastfeeding affects the risk of neonatal death.

c. The reason that mothers who experience complications during pregnancy, especially antepartum vaginal bleeding, are more likely to have the pregnancy end with a stillbirth than mothers with no vaginal bleeding.

The results of the analysis showed that antepartum vaginal bleeding significantly increased the odds of stillbirth. In this study, due to data limitations, the timing of the occurrence of this symptom was not taken into account and therefore merits further study.

d. There was no significant relationship between maternal nutrition and the risk of adverse pregnancy outcome.

The results of analyses indicated that the risk of adverse pregnancy outcomes was not significantly influenced by maternal nutrition. Further study that elaborates the role of nutritional anaemia and maternal mid-arm circumference in affecting the risk of adverse pregnancy outcomes, using valid haemoglobin data and a more sensitive cut-off point for mid-arm circumference, is required to enhance efforts in lowering the high level of adverse pregnancy outcomes.

These hypotheses developed from the empirical findings can be useful as a basis for developing further study aimed at addressing the lack of information about how socio-demographic and bio-medical factors affect the risk of stillbirth and neonatal death.

Lack of resources on the part of both community and government in providing maternal health care underlines the need to make efficient the allocation of scarce resources. It is the role of the present study to provide more relevant information in the context of the community being studied about some of the antecedent factors associated with the occurrence of adverse pregnancy outcome. The application of these findings, including the proposed areas for further study, may contribute to the development of health care policies in rural areas, especially in efforts to alleviate the high level of adverse pregnancy outcomes which are experienced by mothers in the Indramayu area and other rural areas of developing countries.

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APPENDICES.

Appendix 1 describes the step taken in the data processing. The computer programming used in the validation of the Indramayu gestational age data is outlined in Appendix 2. The programming is written in the Microsoft Foxpro language, and is used to explain the algorithm of the data validation procedure (see Figure 1 in Chapter Four). This covers only a subset of the programmings employed in processing the Indramayu data.

Appendix 1.

A description of the data processing employed in the study.

1. Database files used

The database files used in the present study derived from the Baseline database, the SRS, and the MotherCare database files. Selection of the data to be processed and analyzed depended primarily on the aims of the study and the quality of particular items of data.

The Baseline database (HSH_DATA.DBF).

This database contains cross-sectional household-level baseline data collected at the beginning of the Indramayu study. The information recorded in this file includes a household identification number, socio-demographic characteristics of the respondent, contraception used, infant feeding, household assets, house construction, curative and preventive medical care, water supply and sanitation. The information extracted from this database file is mainly related to household assets and domestic hygiene.

Household member database (from the SRS database).

This cyclical household member database (MBR_DATA.DBF) was collected through the SRS which was updated every three months during the course of the Indramayu Study. It contains the member's individual identification number, socio-demographic characteristics, relationship to the head of the household, matching number of spouse, and type of household entry and exit. Most of the data contained in this database file were used.

Demographic events database (from the SRS database).

This cyclical household events database (EVT_DATA.DBF) contains data on all the demographic events reported. As with the household member data file, the information contained in this database file was updated every three months. Information extracted from this file included events related to the initiation of pregnancy, type of pregnancy termination, mother and child identification number, deaths, spouse and parental matching number, and marital status changes.

The MotherCare database files.

These files were derived from the MotherCare study, which was incorporated in the Indramayu Prospective Study. They contain cross-sectional and longitudinal data on maternal reproductive health and health care behaviour which were collected during the antenatal, intrapartum, and post-partum periods. The information collected included the date of the last menstruation period, maternal demographic characteristics, reproductive history, whether the pregnancy was wanted, maternal health and anthropometric indicators, prenatal care during pregnancy, gestational complications and how these were treated, type of pregnancy termination, birth attendant and place of delivery, the baby's anthropometric measurements and perinatal survival.

The present study used the MotherCare files as the main database, together with other databases to examine some major determinants of adverse pregnancy outcomes.

2. Procedure for data merging

A systematic procedure was used to create some new files in a form suitable for a standard statistical analysis package. Because the data entry and editing program used allowed for the inclusion of some invalid data, additional procedures for the detection of inconsistent data were implemented.

The procedures adopted for the creation of the new, merged database files were as follows:

(1). Creation of the mother file

A file for mothers was created to contain information pertaining to maternal socio-demographic background and reproductive health and health care behaviour. Each record in the file contains longitudinal maternal pregnancy histories, including information on pregnancy outcomes. Unlike the original MotherCare files from which the file was created, the database fields were designed in such a way that they facilitated analysis using a standard statistical package such as SPSS. The steps taken in creating the mother file were as follows:

(a). Assignment of a unique permanent identification (ID) number

In the Indramayu study two identification numbers were employed, namely the permanent ID number (PERMID) and the present ID number (PRESID). The PERMID was not changed once it had been assigned to the respondent. However, the PRESID was updated according to the current domicile of the respondent. For the purpose of record matching, the PERMID was used as a unique identifier.

Unfortunately, except for the PRG_FRST.DBF file, the MotherCare files did not include the PERMID field. Therefore, the first step was assignment of PERMID to the MotherCare files, using a program called Moth_id1.prg.

(b). The exclusion of multiple pregnancies and twin births

During the period covered by the MotherCare study, a respondent might have experienced more than one pregnancy. In such cases, in order to avoid complications in data matching, only the first pregnancy was included. The number of such multiple pregnancies was very small (one per cent). Twin births were also excluded.

(c). Only respondents with complete observations were analyzed.

A complete observation was defined as one where data were available for all stages in the MotherCare study, that is, during the antenatal, intrapartum, and post-partum periods.

(d). Identification of incorrect visit dates

A small proportion of records contained incorrect dates of visits. When examination revealed that incorrect dating was due to a typing error during data entry, the visit date was corrected.

(e). Data matching between database files

Because the mother file information was originally stored in different database files and because the nature of the data collected in each file was sometimes quite different, files had to be carefully matched.

(f). The creation of a subset of the mother file

The mother file was divided into several subsets to facilitate data analysis. The first subset created was MOTH_ID2.DBF, containing data on maternal pre-pregnancy anthropometry, maternal socio-demographic characteristics, history of previous pregnancy outcomes, term at which the pregnancy termination occurred, type of pregnancy outcomes, maternal survival, anthropometric measures of the baby, attendant and place of birth, delivery kits used and referral (if any). Detailed programming for the creation of this subset file is explained in Moth_id2.prg.

(g). Adding father's socio-economic background

The father's socio-economic data were added to the mother file subset. The new subset file which contains information on both the mother and her spouse is MOTH_ID6.DBF. The programming is explained in Moth_id6.prg.

(h). Creating a subset file containing monthly or trimester data

The MotherCare files included baseline (cross-sectional), monthly, and trimester data. While baseline data was gathered only once during the course of pregnancy, the monthly and trimester data were collected prospectively on monthly and trimester visit cycles. A subset of the file containing monthly data, and also trimester data, was created based on the topic of each variable under study. Therefore, the monthly file may consist of several topic files. As with the previous mother file, these monthly files were also horizontally constructed so that each record in the file contained complete information on each topic for each respondent. The information held in each record was captured from the MotherCare file (PRG_MNTH.DBF) in which the data were collected monthly during the course of pregnancy. During the compilation of monthly data on prenatal care, the data were not directly captured based upon monthly interval but on the visitation sequential number. This was necessary because the monthly data collection for some respondents was conducted at more than one-month intervals. If the program algorithm had used a monthly interval, some data might have overwritten other data. Therefore, the programming of the monthly data was arranged in such a way that it prevented any loss of data due to overwriting.

(2). Creation of the child file

The child file contained information on child survival and the parents' socio-economic background. The first step taken in its creation was the assignment of both child and parent ID numbers from the event file. The parents' socio-economic background was then added. In order to know whether the baby could be followed up until the neonatal or post-neonatal period for those babies who were still alive, the membership status of the baby was needed. In determining this, the type of household entry and exit together with the date of entry and exit was also allocated to the file. The perinatal and post-neonatal survival of the child was identified by classifying the deaths into stillbirths, early neonatal, late neonatal, and post-neonatal deaths.

(3). Combination of child and mother files

In order to facilitate the analysis of the determinants of stillbirth and neonatal death, the mother and child files were combined using a program called Mch1.prg.

3. Checking for data consistency and compatibility

Consistency checks of the mother and child files were aimed at ensuring that the procedures used to create the files resulted in data that were both internally consistent and consistent with the original files. They also provided a broader understanding of the nature of the data. The checking procedures used descriptive univariate and bivariate statistics, while a five per cent of cases were checked against paper records for every newly created data set.

4. Difficulties in records matching

A number of difficulties were found during data processing. It is hoped that the identification of these problems may contribute to improving methods of managing longitudinal data.

(1). Not all the database files had the permanent (PERMID) and current (PRESID) identification (ID) numbers. Some records contained a different ID number stored as PERMID and PRESID, for example, due to a split household. It was therefore necessary to add the PERMID variable to each of the MotherCare files because, in data matching and analysis, the unique ID number used to match the records was PERMID.

(2). Not all the MotherCare files had the date of data collection, i.e. the date of interview. For example PRG_QRTR.DBF did not include visit dates. This made it difficult to match some records, particularly for cases with multiple pregnancies and thus multiple records with the same permanent identification number.

(3). Examination of the database files showed that, in some cases, two or more visits in the regular visit cycle, for example, a monthly visitation cycle, had been conducted in the same month. In a number of cases, the date of visit was recorded incorrectly, for example, the date of the last visit was shown as being earlier than the date of first visit.

(4). A discrepancy was also found in some cases between the number of events (pregnancy outcome either single stillborn (LMT) or single live born (LHT)) stored in the SRS database file (EVT_DATA.DBF) and the MotherCare database file (PRG_INTR.DBF). This discrepancy might have occurred because the updating of database records between the database files was not done simultaneously.

(5). Household member data stored in member files (MBR_DATA.DBF) were not accompanied by the date of the last update. This created problems when the member data and MotherCare data were merged. A number of marital status changes were recorded for some respondents, whose spouse number then also changed. It was difficult to determine which spouse related to a particular time.

(6). When a respondent had more than one pregnancy, one identification number appeared for several records in the same file. However, no system had been developed to identify the number or order of these pregnancies. This situation made it difficult to create a pregnancy history record for each respondent, especially if the date of interview was incorrectly recorded or missing.

(7). There was no subset of the SRS database files, either in MBR_DATA.DBF or EVT_DATA.DBF, which was separately extracted at one time to serve as baseline data for nested studies, such as the MotherCare study. This posed problems when it was necessary to relate the databases in the nested study to the SRS databases.

(8). The data entry package used was not equipped with specific skip, not applicable, or 'no answer' values. For example, whenever a skip question or 'no answer' to a certain question was encountered, the values of these variables were set to zero for numeric variables or blank spaces for character variables. During interruptions such as power supply failure during data entry, it was difficult to differentiate between the genuine missing values and unintentional missing values created by the technical problem. Specific values for skip or 'no answer' questions during data entry also facilitate the assignment of missing values during data analysis.

Appendix 2.

A computer programming designed for the validation of gestational age data.

```
** Program Name: LMP_SUB.PRG
** Function: this subset of LMP.PRG is designed to examine
**         the accuracy of LMP-based gestational age data.
**         The Lubchenco birtweight by gestational age is
**         used as the standard for the Indramayu
**         gestational age data validation
*******************************************
** Source files: BIA_WMN.DBF and MCH1.DBF
** Target file:  LMP.DBF
** Fields to be added in the created database are
** RE_GESTA,REV_LMP,TY_GESTA
** The sequential programming taken to arrive at LMP_SUB.prg
** are as follows: Run moth_id1.prg --> check for double
** cases using mothdbl.dbf and pr4_mnth.prg --> moth_id2
** --> moth_id5 --> moth_id6 --> chil_sv1 --> mch1 -->
** mch2 --> mch3 --> LMP_SUB
** A more detailed programming is outlined in LMP.PRG


stop=0
SET DATE BRITISH
SET STATUS ON
SET SAFETY OFF

** Creating a new target file
Create LMP from DB_LMP

** Appending data from MCH1
USE LMP
Append from mch1

Use BIA_WMN
Index on PERMID To Biadex

SELECT A
USE BIA_WMN INDEX BIADEX

SELECT B
USE LMP

**SELECT C
**USE REJECT

**Set the initial value to rev_lmp as EQUAL to m_lmp
**Set the default value re_gesta EQUAL to m_gesta
```

```
**Mark=0 (The 'confusing' Gestation will be assigned 1)
**The final values will be dependent on some consistency
**checks performed.
** A 0 value will be assigned to ty_gesta, for the
** birthweight with missing data (0 & 9999).
** This means that those cases with missing birthweight will
** be included in the 'not-validated' cases.


 SELECT B
 DO WHILE .NOT. EOF()
  Replace RE_GESTA with M_GESTA
  Replace rev_lmp with m_lmp
  Replace TY_GESTA with 0
  Replace MARK with 0
  SKIP
 ENDDO
 Go top

**Step 1  ---> selecting cases; DAYOW less than 7 days
**           Day of weighing baby > 6 days is invalid.
Select B
SET FILTER TO (DAYOW<7 .AND. BWEIGHT<>0)
GO TOP

Terus=.T.
DO WHILE Terus
**Consistency check stage 1

SELECT B
TANGGAL=M_LMP+8
PERMANEN=PERMID

**Start checking for respondent's menstrual status
SELECT A
SEEK PERMANEN

IF FOUND()
 DO WHILE PERMID=PERMANEN
  IF TGREF>TANGGAL
   ** if Tgref>Tanggal, means that, at the specified date or
   ** later the respondent's menstrual status will be in the
  ** state of not-in menstrual period (TAH), the woman being
  ** pregnant.

   ** Alternative 1
    IF HAMMAID='TAH'
     ** Check whether in the last month the woman
     ** had already got menstruation.  If yes -->
     ** something wrong with the original LMP data.
```

```
 ** Move back the pointer to the previous record
    SKIP -1
   IF HAMMAID='TAH'
    ** Don't discard the data at this stage,instead,
    ** continue with the next procedure (CHECK2)
    ** then make a final decision
       SELECT B
       SET PROCEDURE TO CHECK
       DO CHECK2
       CLOSE PROCEDURE
       Exit
    ELSE
    **Accept the original LMP (Re_gesta=M_gesta).
    **then check whether the bweight below 90th
    **percentile.
       SELECT B
       SET PROCEDURE TO CHECK
       DO CHECK1
       CLOSE PROCEDURE
        Exit
   ENDIF
 ENDIF (Hammaid)

** Alternative 2
** It is possible that at the calculated date, the
** respondent is still in menstrual state (HAI).
** This may be due to prolonged menstruation or
** slightly miscalculation.  Therefore it is a need to
** ascertain whether or not at the next month (visit)
** the woman already in menstruation state.  If yes,
** the LMP data is O.K. If, not, continue with the next
** LMP validation stages.

 SELECT A
 IF HAMMAID='HAI'
  ** Move the record pointer to the next record
  SKIP

   IF HAMMAID='HAI'
    ** Still in menstrual period --> something
    ** wrong with the data.  But, continue with
    ** the next validation procedure

      SELECT B
      SET PROCEDURE TO CHECK
      DO CHECK2
      CLOSE PROCEDURE
      Exit
    ELSE
    ** The data is O.K. --> accepted
    ** Checks for the birthweight against the standard
```

```
        SELECT B
        SET PROCEDURE TO CHECK
        DO CHECK1
        CLOSE PROCEDURE
         Exit
      ENDIF
    ENDIF (HAI)

   ** Alternatif 3
     SELECT A
     ** HAMMAID='TAJ' --> NO ANSWER

     IF HAMMAID='TAJ' .OR. HAMMAID='TTH'
      SELECT B
      REPLACE RE_GESTA WITH 99
      REPLACE REV_LMP WITH CTOD('  /  /  ')
      ** TY_GESTA=9 --> Indicates invalid data
      REPLACE TY_GESTA WITH 9
      EXIT
     ENDIF

  ELSE
    ** Tgref is still below the date --> move forward
    ** the pointer

   SKIP
    If eof()
    ** The date of not in menstrual period was not found,
    ** assign a missing value to that record.
    ** Re_gesta=99 --> missing value

      SELECT B
      REPLACE RE_GESTA WITH 99
       REPLACE REV_LMP WITH CTOD('  /  /  ')
       ** TY_GESTA=9 --> Indicates invalid data
       REPLACE TY_GESTA WITH 9
       Exit
    Endif
  ENDIF (TGREF)
 ENDDO (PERMID)

ELSE    && PERMID is not found in the record

   SELECT B
 ** Re_gesta=99 --> missing value
   REPLACE RE_GESTA WITH 99
   REPLACE REV_LMP WITH CTOD('  /  /  ')
   ** TY_GESTA=9 --> Indicates invalid data
   REPLACE TY_GESTA WITH 9
ENDIF (found)
```

```
 Select B
 Skip
  If EOF()
   Terus=.F.
  Endif
ENDDO
**
CLOSE DATABASES
** Calculate the revised/validated gestation
** based on the new LMP (rev_lmp)
** This is a modified program, the value of rev_lmp is
** basically the same as in m_lmp!!
** The content of RE_GESTA is not similar to the original
** M_GESTA, because some of the undetected gestation age
** were assigned a missing value.  In addition there is also
** an effect of rounding values of the gestational data (see
** procedure below).
** However, for the purpose of obtaining greater precision,
** RE_GESTA is used instead of M_GESTA.


USE LMP
GO TOP

DO WHILE .NOT. EOF()
 IF (.NOT. EMPTY(DATE_PTM)) .AND. (.NOT. EMPTY(REV_LMP)) .AND.
RE_GESTA<>99 .AND. RE_GESTA<>98
  ** GESTA=CEILING((DATE_PTM - REV_LMP)/7)
   ** Round can be rounded up or down
   ** Round(5.4,0) --> 5; Round(5.6,0) -->6
   ** GESTA=ROUND((DATE_PTM - REV_LMP)/7,0)

   GESTA1=ROUND((DATE_PTM - REV_LMP)/7,1)
   REPLACE M1_GESTA WITH GESTA1
   IF M1_GESTA<40.0
    GESTA=CEILING(M1_GESTA)
    ELSE
    GESTA=INT(M1_GESTA)
   ENDIF
    REPLACE RE_GESTA WITH GESTA

  ELSE
   IF RE_GESTA<>98
    REPLACE RE_GESTA WITH 99
    REPLACE TY_GESTA WITH 9
   ENDIF
   REPLACE M1_GESTA WITH 99
 ENDIF

  SKIP
```

```
ENDDO
***
SET SAFETY ON
SET FILTER TO
CLEAR ALL
CLOSE DATABASES
**? CHR(7)
** End of Prg.

**================================================================

** Program Name: CHECK.PRG
** Purpose: a checking procedure for the LMP data
**        validation, which is part of the LMP_SUB.PRG.


PROCEDURE CHECK1
**Checking for birthweight below the 90th percentile

SELECT B
   If m_gesta=24
    If bweight<1250
      REPLACE RE_GESTA WITH M_GESTA
      REPLACE REV_LMP WITH M_LMP
     ** TY_GESTA=1 --> BIRTHWEIGHT BELOW 90TH %tile
     ** Indicates a good quality data
      REPLACE TY_GESTA WITH 1
     Else
      SET PROCEDURE TO CHECK
      DO CHECK3
      CLOSE PROCEDURE
    Endif
   Endif (24)
   **
   If m_gesta=25
    If bweight<1300
      REPLACE RE_GESTA WITH M_GESTA
      REPLACE REV_LMP WITH M_LMP
      REPLACE TY_GESTA WITH 1
     Else
      SET PROCEDURE TO CHECK
      DO CHECK3
      CLOSE PROCEDURE
    Endif
   Endif (25)
   **
   If m_gesta=26
    If bweight<1350
      REPLACE RE_GESTA WITH M_GESTA
      REPLACE REV_LMP WITH M_LMP
      REPLACE TY_GESTA WITH 1
```

```
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
   CLOSE PROCEDURE
 Endif
Endif (26)
**
If m_gesta=27
 If bweight<1400
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 1
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
   CLOSE PROCEDURE
 Endif
Endif (27)
**
If m_gesta=28
 If bweight<1500
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 1
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
   CLOSE PROCEDURE
 Endif
Endif (28)
**
If m_gesta=29
 If bweight<1600
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 1
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
   CLOSE PROCEDURE
 Endif
Endif (29)
**
If m_gesta=30
 If bweight<1750
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 1
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
```

```
    CLOSE PROCEDURE
  Endif
 Endif (30)
**
If m_gesta=31
  If bweight<1950
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 1
   Else
    SET PROCEDURE TO CHECK
    DO CHECK3
    CLOSE PROCEDURE
  Endif
 Endif (31)
**
If m_gesta=32
  If bweight<2150
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 1
   Else
    SET PROCEDURE TO CHECK
    DO CHECK3
    CLOSE PROCEDURE
  Endif
 Endif (32)
**
If m_gesta=33
  If bweight<2450
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 1
   Else
    SET PROCEDURE TO CHECK
    DO CHECK3
    CLOSE PROCEDURE
  Endif
 Endif (33)
**
If m_gesta=34
  If bweight<2750
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 1
   Else
    SET PROCEDURE TO CHECK
    DO CHECK3
    CLOSE PROCEDURE
  Endif
 Endif (34)
```

```
**
If m_gesta=35
 If bweight<3000
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 1
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
   CLOSE PROCEDURE
 Endif
Endif (35)
**
If m_gesta=36
 If bweight<3275
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 1
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
   CLOSE PROCEDURE
 Endif
Endif (36)
**
If m_gesta=37
 If bweight<3425
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 1
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
   CLOSE PROCEDURE
 Endif
Endif (37)
**
If m_gesta=38
 If bweight<3550
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 1
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
   CLOSE PROCEDURE
 Endif
Endif (38)
**
```

```
If m_gesta=39
 If bweight<3650
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 1
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
   CLOSE PROCEDURE
 Endif
Endif (39)
**
If m_gesta=40
 If bweight<3750
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 1
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
   CLOSE PROCEDURE
 Endif
Endif (40)
**
If m_gesta=41
 If bweight<3825
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 1
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
   CLOSE PROCEDURE
 Endif
Endif (41)
**
If m_gesta=42
 If bweight<3850
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 1
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
   CLOSE PROCEDURE
 Endif
Endif (42)
**
```

```
If m_gesta=43
 If bweight<3875
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 1
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
   CLOSE PROCEDURE
 Endif
Endif (43)
**
If m_gesta=44
 If bweight<3900
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 1
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
   CLOSE PROCEDURE
 Endif
Endif (44)
**
If m_gesta=45
 If bweight<3925
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 1
  Else
   SET PROCEDURE TO CHECK
   DO CHECK3
   CLOSE PROCEDURE
 Endif
Endif (45)
**
** 98=missing values
    If m_gesta>45
     Replace Re_gesta with 98
     Replace Rev_lmp with CTOD('  /  /  ')
     REPLACE TY_GESTA WITH 9
    Endif
SELECT B
RETURN
***** End of prg.
**==============


PROCEDURE CHECK2
** PROGRAM: CHECK2.prg
** Purpose: The last step in consistency checks performed
```

```
**      The original LMP data, for some reasons, is
**      just accepted if the gestational age above 38
**      weeks.  Replace the validated gestation with
**      the original gestation.

SELECT B
** In this procedure, the original gestation is used
** as a filter condition rather than the validated
** gestation, because some of the validated gestation is
** not consistent with the woman's menstrual records.

IF M_GESTA>38 .AND. M_GESTA<46 .AND. M_GESTA<>99
  ** Mark=1 --> indicating 'not-matched' menstrual hist.
  REPLACE MARK WITH 1
  DO CHECK1
 ELSE
  REPLACE RE_GESTA WITH M_GESTA
  REPLACE REV_LMP WITH M_LMP
 ** TY_GESTA=3 --> indicates the worst gestation
  REPLACE TY_GESTA WITH 3
ENDIF
SELECT B
RETURN
**End of prg
**==========


PROCEDURE CHECK3
**Program: CHECK3.PRG
**Purpose: designed for consistency checks towards cases
**      which have birthweight beyond the 90th & 99th
**      percentile of birthweight standard.
** Checks whether the woman's birthweight is less than
** 98th percentile of the standard birthweight.
** The calculation of 99th percentile birthweight is done
** indirectly using a standard deviation approach.  It is
** assumed that,IN A NORMAL DISTRIBUTION,  mean=median
** --> 50th percentile.  The birthweight distribution by
** gestation in the standard population is assumed
** normal.  Therefore, mean (P50)= (P90+P10)/2.
** The distance of 90th percentile from the mean is about
** 1.28 SD --> P90-P50=1.28 SD ; P98-P50=2.05 SD;
** P99-P50=2.33 SD.  Based on this assumption, the
** calculation of 98th & 99th percentiles of standard
** birthweight by gestation are as follows:
**
** The standard birthweight of:
** 98th percentile=P50+((2.05/1.28)*(P90-P50)).
** 99th percentile=P50+((2.33/1.28)*(P90-P50)).
```

```
SELECT B

P10=0
P50=0
P90=0
P99=0

   If m_gesta=24
    P10=500
    P90=1250
    P50=(P10+P90)/2
    P99=P50+((2.33/1.28)*(P90-P50))
    If bweight<P99
      **Accept the data
      SELECT B
      REPLACE RE_GESTA WITH M_GESTA
      REPLACE REV_LMP WITH M_LMP
    ** TY_GESTA=2 --> indicates 'uncertain' quality
      REPLACE TY_GESTA WITH 2
     Else
      **Reject the data
      REPLACE RE_GESTA WITH M_GESTA
      REPLACE REV_LMP WITH M_LMP
    ** TY_GESTA=3 --> indicates the 'worst' quality
      REPLACE TY_GESTA WITH 3
    Endif
   Endif (24)
   **
   If m_gesta=25
    P10=580
    P90=1300
    P50=(P10+P90)/2
    P99=P50+((2.33/1.28)*(P90-P50))
    If bweight<P99
      **Accept the data
      SELECT B
      REPLACE RE_GESTA WITH M_GESTA
      REPLACE REV_LMP WITH M_LMP
      REPLACE TY_GESTA WITH 2
     Else
      **Reject the data
      REPLACE RE_GESTA WITH M_GESTA
      REPLACE REV_LMP WITH M_LMP
      REPLACE TY_GESTA WITH 3
    Endif
   Endif (25)
   **
   If m_gesta=26
    P10=625
    P90=1350
    P50=(P10+P90)/2
```

```
 P99=P50+((2.33/1.28)*(P90-P50))
 If bweight<P99
   **Accept the data
   SELECT B
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 2
  Else
   **Reject the data
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 3
 Endif
Endif (26)
**
If m_gesta=27
 P10=750
 P90=1400
 P50=(P10+P90)/2
 P99=P50+((2.33/1.28)*(P90-P50))
 If bweight<P99
   **Accept the data
   SELECT B
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 2
  Else
   **Reject the data
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 3
 Endif
Endif (27)
**
If m_gesta=28
 P10=825
 P90=1500
 P50=(P10+P90)/2
 P99=P50+((2.33/1.28)*(P90-P50))
 If bweight<P99
   **Accept the data
   SELECT B
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 2
  Else
   **Reject the data
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 3
 Endif
```

```
Endif (28)
**
If m_gesta=29
  P10=900
  P90=1600
  P50=(P10+P90)/2
  P99=P50+((2.33/1.28)*(P90-P50))
  If bweight<P99
    **Accept the data
    SELECT B
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 2
   Else
    **Reject the data
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 3
  Endif
Endif (29)
**
If m_gesta=30
  P10=1000
  P90=1750
  P50=(P10+P90)/2
  P99=P50+((2.33/1.28)*(P90-P50))
  If bweight<P99
    **Accept the data
    SELECT B
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 2
   Else
    **Reject the data
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 3
  Endif
Endif (30)
**
If m_gesta=31
  P10=1100
  P90=1950
  P50=(P10+P90)/2
  P99=P50+((2.33/1.28)*(P90-P50))
  If bweight<P99
    **Accept the data
    SELECT B
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 2
```

```
  Else
   **Reject the data
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 3
 Endif
Endif (31)
**
If m_gesta=32
 P10=1250
 P90=2150
 P50=(P10+P90)/2
 P99=P50+((2.33/1.28)*(P90-P50))
 If bweight<P99
   **Accept the data
   SELECT B
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 2
  Else
   **Reject the data
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 3
 Endif
Endif (32)
**
If m_gesta=33
 P10=1350
 P90=2450
 P50=(P10+P90)/2
 P99=P50+((2.33/1.28)*(P90-P50))
 If bweight<P99
   **Accept the data
   SELECT B
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 2
  Else
   **Reject the data
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 3
 Endif
Endif (33)
**
If m_gesta=34
 P10=1500
 P90=2750
 P50=(P10+P90)/2
 P99=P50+((2.33/1.28)*(P90-P50))
```

```
 If bweight<P99
   **Accept the data
   SELECT B
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 2
  Else
   **Reject the data
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 3
 Endif
Endif (34)
**
If m_gesta=35
 P10=1750
 P90=3000
 P50=(P10+P90)/2
 P99=P50+((2.33/1.28)*(P90-P50))
 If bweight<P99
   **Accept the data
   SELECT B
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 2
  Else
   **Reject the data
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 3
 Endif
Endif (35)
**
If m_gesta=36
 P10=1900
 P90=3275
 P50=(P10+P90)/2
 P99=P50+((2.33/1.28)*(P90-P50))
 If bweight<P99
   **Accept the data
   SELECT B
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 2
  Else
   **Reject the data
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 3
 Endif
Endif (36)
```

```
**
If m_gesta=37
  P10=2150
  P90=3425
  P50=(P10+P90)/2
  P99=P50+((2.33/1.28)*(P90-P50))
  If bweight<P99
    **Accept the data
    SELECT B
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 2
   Else
    **Reject the data
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 3
  Endif
Endif (37)
**
If m_gesta=38
  P10=2325
  P90=3550
  P50=(P10+P90)/2
  P99=P50+((2.33/1.28)*(P90-P50))
  If bweight<P99
    **Accept the data
    SELECT B
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 2
   Else
    **Reject the data
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 3
  Endif
Endif (38)
**
If m_gesta=39
  P10=2500
  P90=3650
  P50=(P10+P90)/2
  P99=P50+((2.33/1.28)*(P90-P50))
  If bweight<P99
    **Accept the data
    SELECT B
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 2
   Else
```

```
    **Reject the data
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 3
  Endif
Endif (39)
**
If m_gesta=40
  P10=2550
  P90=3750
  P50=(P10+P90)/2
  P99=P50+((2.33/1.28)*(P90-P50))
  If bweight<P99
    **Accept the data
    SELECT B
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 2
   Else
    **Reject the data
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 3
  Endif
Endif (40)
**
If m_gesta=41
  P10=2675
  P90=3825
  P50=(P10+P90)/2
  P99=P50+((2.33/1.28)*(P90-P50))
  If bweight<P99
    **Accept the data
    SELECT B
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 2
   Else
    **Reject the data
    REPLACE RE_GESTA WITH M_GESTA
    REPLACE REV_LMP WITH M_LMP
    REPLACE TY_GESTA WITH 3
  Endif
Endif (41)
**
If m_gesta=42
  P10=2700
  P90=3850
  P50=(P10+P90)/2
  P99=P50+((2.33/1.28)*(P90-P50))
```

```
 If bweight<P99
   **Accept the data
   SELECT B
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 2
  Else
   **Reject the data
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 3
 Endif
Endif (42)
**
If m_gesta=43
 P10=2725
 P90=3875
 P50=(P10+P90)/2
 P99=P50+((2.33/1.28)*(P90-P50))
 If bweight<P99
   **Accept the data
   SELECT B
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 2
  Else
   **Reject the data
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 3
 Endif
Endif (43)
**
If m_gesta=44
 P10=2740
 P90=3900
 P50=(P10+P90)/2
 P99=P50+((2.33/1.28)*(P90-P50))
 If bweight<P99
   **Accept the data
   SELECT B
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 2
  Else
   **Reject the data
   REPLACE RE_GESTA WITH M_GESTA
   REPLACE REV_LMP WITH M_LMP
   REPLACE TY_GESTA WITH 3
 Endif
Endif (44)
```

```
  **
  If m_gesta=45
   P10=2745
   P90=3925
   P50=(P10+P90)/2
   P99=P50+((2.33/1.28)*(P90-P50))
   If bweight<P99
     **Accept the data
     SELECT B
     REPLACE RE_GESTA WITH M_GESTA
     REPLACE REV_LMP WITH M_LMP
     REPLACE TY_GESTA WITH 2
    Else
     **Reject the data
     REPLACE RE_GESTA WITH M_GESTA
     REPLACE REV_LMP WITH M_LMP
     REPLACE TY_GESTA WITH 3
   Endif
  Endif (45)
  **
  ** 98=missing values
      If m_gesta>45
       Replace Re_gesta with 98
       Replace Rev_lmp with CTOD('  /  /  ')
       REPLACE TY_GESTA WITH 9
      Endif
SELECT B
RETURN
**end of prg.
**==========
```