The North Carolina Institute of Medicine

Report

of the

Task Force to Reduce Infant Mortality and Infant Morbidity in North Carolina

Phase I = Identification of the Major Factors Associated with Infant Mortality and Morbidity in North Carolina

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NORTH CAROLINA INSTITUTE OF MEDICINE
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INTRODUCTION

The high rate of infant mortality in North Carolina is one of the most significant public health problems this state is facing. To address this concern, the Kate B. Reynolds Health Care Trust sought the assistance of the North Carolina Institute of Medicine (NCIOM) in developing plans and priorities for lowering infant mortality and morbidity in North Carolina. The NCIOM created a task force on infant mortality and morbidity drawing upon experts from across the state. The first phase of the plan was to draw upon currently available data to describe the principal factors associated with infant mortality and morbidity and to identify the gaps in our knowledge and/or data collection systems. The task force created a subcommittee to accomplish this first phase and requested a small grant to write the following report which could serve as a basis for the development of appropriate preventive strategies.

The report will consecutively address the issues of infant mortality and infant morbidity. Currently, reliable mortality data are readily available allowing a very detailed analysis. On the other hand information on infant morbidity is limited; few population based studies have been done, there is no database nationally or at the state level and therefore most of the reported figures are conservative estimates. Recommendations will be made to improve our knowledge through improved data collection systems. Some of these data systems are currently being put in place across the state.

INFANT MORTALITY

I. Definitions

Infant Mortality Rate

Infant mortality is the death of a live born infant before its first birthday. It is expressed as the Infant Mortality Rate (IMR), which is the number of deaths in infants from birth to one year of age per thousand live births. The infant mortality rate can be divided into two components:

- Neonatal mortality rate (NNMR), which is the number of deaths occurring from birth to 28 days of age per thousand live births and

- Postneonatal mortality rate (PNNMR), which is the number of deaths occurring within the 11 remaining months per thousand survivors of the neonatal period. This definition can only be used in the few states such as North Carolina which have a data system matching birth and death certificates. Therefore the US post neonatal mortality rate is expressed per thousand live births and not survivors.

Neonatal mortality results from factors related to maternal health during and before pregnancy, the health of the fetus, including prematurity and the early management of health problems in the newborn.[1] Its major determinants are low birth weight (babies weighing less than

2500 grams) and adequacy of health services. These services include prepregnancy care, sex education, family planning, availability of abortions, prenatal care and perinatal services as well as financial plans such as Medicaid which enhance access to health services.[2,3]

Postneonatal mortality results from the cumulative role of biological factors and sociodemographic and environmental disadvantages.[1,4] The sociodemographic and environmental factors include the following: low socioeconomic status (low income, education and occupation), lack of access to basic medical services (primary care and emergency services) due to location, transportation and/or financing problems, mother's age (<18), non-white race (except Asians), high parity (>3), environmental hazards and housing conditions, alcohol and smoking.[4,5] Most of these factors tend to cluster, defining "high-risk" populations.

II. Descriptive Data

A. Infant Mortality: Comparative Rates, Trends and Risk Factors. In 1985 in North Carolina 1070 deaths in infants were reported, 713 (2/3) in the neonatal period and 357 (1/3) in the post neonatal period.[6] The IMR for 1985 was 12.0 deaths per thousand live births, higher than the US rate estimate for 1985 of 10.6 per thousand.[7]

For 1984, the rates were:[8]

	IMR	NNMR	PNNMR
North Carolina	12.5	8.2	4.3
South East Region	12.6	8.3	4.3
United States	10.8	7.0	3.8

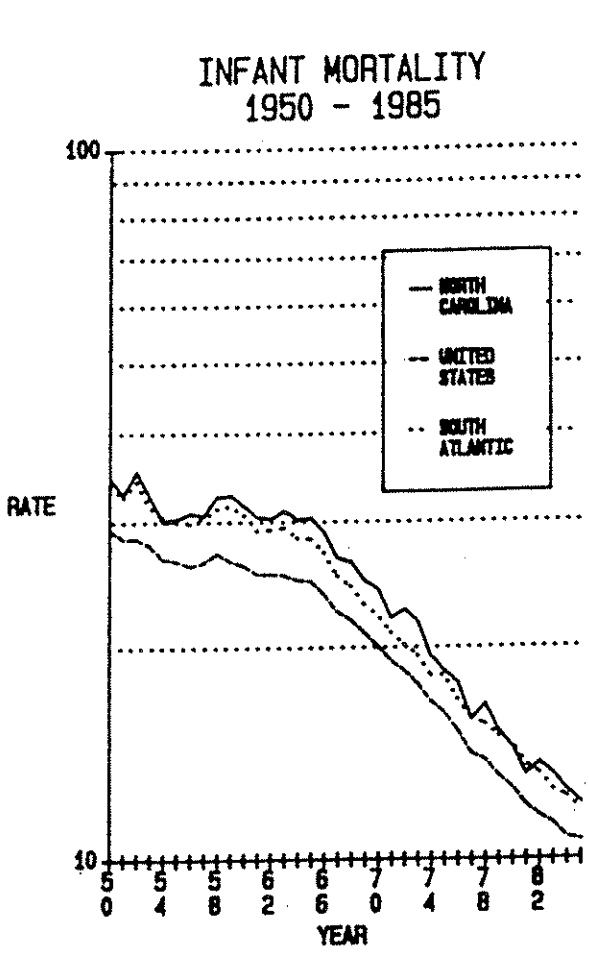
In 1985, only five states had a worse infant mortality than North Carolina. These rates are generally improving in NC and the US, North Carolina persistantly remains among the worst states. (Figure 1).

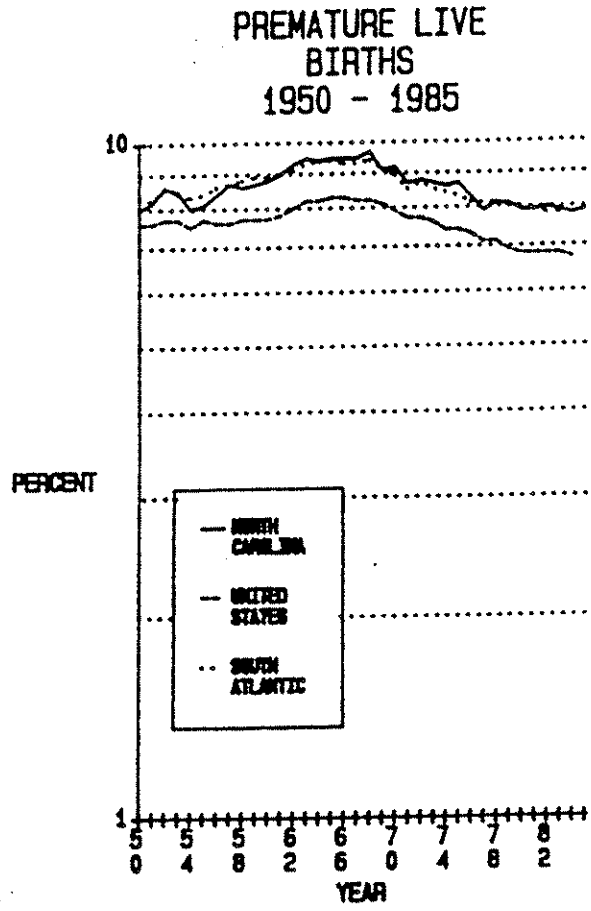
The greatest improvement in the IMR has been seen in the first 27 days of life. This improvement has been greater for whites than for nonwhites, and especially marked in the birthweight group of 1501-2000 grams. Where the white post-neonatal death rate slowly decreased, the nonwhite rate increased in 1983 and 1984, to decrease again in 1985. Post-neonatal mortality has increased among the very low birth weight (VLBW) infants (less than 1500 grams) in the last ten years.[7]

Geographical Pattern of IMR. The infant mortality rates tend to be highest in the southeastern states.[9] Within North Carolina, the highest rates are observed in the coastal plains region, and are more marked in the northeastern counties of the State, particularly the neonatal death rates.[7]

B. Low Birth Weight: Rates, Trends, Risk Factors and Contribution to Infant Mortality

Figure I


INFANT MORTALITY
1950 - 1985
100
10
RATE
NORTH CAROLINA
UNITED STATES
SOUTH ATLANTIC
50 54 58 62 66 70 74 78 82
YEAR


PREMATURE LIVE
BIRTHS
1950 - 1985
10
1
PERCENT
NORTH CAROLINA
UNITED STATES
SOUTH ATLANTIC
50 54 58 62 66 70 74 78 82
YEAR

Rates and Trends:

Low birth weight (LBW) is defined as a birth weight of less than 2500 grams (or 5.5 pounds). It is the result of a shortened gestation (prematurity) or of a poor fetal weight gain (intrauterine growth retardation) or both. A subcategory, the very low birth weight (VLBW) babies, is defined as a birth weight of less than 1500 grams (3.3 pounds).

The rate of LBW among live births has remained fairly stable in the last 30 years (Figure 1)[7]. This rate was 7.9% of live births in North Carolina in 1985 (8% in 1950, 7.94% in 1980), which is comparable to the rate for the Southeastern Region and higher than the US rate of 6.7%. Only five states have a worse LBW rate than North Carolina.

Among the 7.9% LBW babies, 6.4% weighed between 1500 and 2500 grams, 1.5% weighed less than 1500 grams. Although these percentages have remained stable since 1980, there has been a slight shift from the 2000-2500 gram group into the 1500-2000 gram group.[8] In every birthweight category of LBW babies, rates are generally twice as high for nonwhites than for whites. (2.6/1 for infants under 1500 grams, 1.8/1 for infants between 1500 and 2500 grams). Low birthweight rates are especially high in the Northeastern counties of the state (Perinatal Region VI).[7]

Risk Factors for Low Birth Weight (LBW)

Risk factors for LBW have been thoroughly analyzed by the Committee to Study the Prevention of Low Birthweight of the National Institute of Medicine[10] and grouped into 6 categories:

1. Demographic risks:

   age (<17 or >34), race (black), low SES, low education, unmarried status

2. Medical risks preceding pregnancy:

   Parity (<1 or >4), small weight for height, maternal diseases, genital anomalies, poor obstetric history, genetic factors

3. Medical risks during pregnancy:

   multiple pregnancy, short pregnancy intervals, poor weight gain, infections, pregnancy related problems

4. Behavioral and environmental risks:

   smoking, alcohol-drug abuse, toxic and occupational exposure, poor nutritional status

5. Health care risks:

Inadequate prenatal care, iatrogenic prematurity

6. Other risk factors:

Physical and psychosocial stress, working conditions, other medical conditions.

Many of these identified factors are also associated with an increased risk of infant mortality, independent of the effect on LBW. Some factors have been considered specific predictors for VLBW: [11]

-A previous live birth weighing less than 2000 grams

-Major congenital anomalies

-Non-white race

-Vaginal bleeding early in pregnancy

-Infections and premature rupture of membranes

-Cigarette smoking

Contribution of low birth weight to infant mortality

Neonatal Mortality

According to a multicenter US survey done between 1976 and 1979, LBW (under 2500 grams) accounts for over 2/3 of neonatal deaths (72%), VLBW (under 1500 grams) accounts for half of the neonatal deaths.

Expressing it in a different way, we can say that, compared with normal birthweight babies, LBW babies are 40 times more likely to die in the neonatal period, and VLBW are 200 times more likely to die in the neonatal period.[12]

Post Neonatal Mortality

Compared to normal birth weight babies the relative risk of post neonatal deaths is 5 fold for LBW babies and 20 fold for VLBW.[12]

Factors Affecting the Risk of Mortality Associated With Low Birth Weight:

- socioeconomic factors: Poverty, low education and occupation are associated with higher mortality.

- duration of gestation: For a given birthweight, the longer the duration of gestation, the lower the mortality. Within the same gestational age the mortality is higher in lighter babies[12]

- Race: Black LBW infants have a lower risk of dying in the neonatal period but a higher risk of dying in the post neonatal period than their white counterparts. The improved birth weight specific mortality rate among LBW black neonates is not solely due to higher rates of small for gestational age neonates in the black population; survival in preterm black babies at every gestational age is found to be higher than in white babies suggesting an inherent racial difference in maturation.[13,14]

- Sex: Studies have shown a better birth-weight specific survival among female than male neonates, especially for babies weighing between 1000 to 2500 grams.[13,15]

-Perinatal Care: Despite the limited improvement of the rates of LBW in North Carolina, all birthweight specific neonatal mortality rates have improved especially in the groups 750 to 1000 grams (neonatal mortality decreasing from 462 per thousand in 1980 to 306 per thousand in 1984) and in the group 1000 to 1500 grams (decreasing from 146 per thousand in 1980 to 115 per thousand in 1984)[8]. These achievements are in part attributed to the state's Perinatal Care Program, with two major elements: a shift of deliveries from hospitals with small delivery services to larger ones and the doubling of the percentage of VLBW births occurring in tertiary level hospitals.[7,8]

The increased survival observed especially among the VLBW in the last decade raised the concern that in fact the time of death was only shifted toward the early post-neonatal period and that the overall improvement on infant mortality rate was limited. Studies have demonstrated divergent findings either documenting an increase in post neonatal mortality with a shift toward later deaths in all weight groups, and especially in the VLBW[16,17,18] or no major shift, with a decreasing overall postneonatal mortality and a slight increase in the post neonatal mortality in the VLBW group.[19]

C. Trends For Other Risk Factors For Infant Mortality in North Carolina.

Prenatal care: The percentage of women receiving inadequate prenatal care, estimated by Kessner index, has decreased from 6.5% in 1980 to 5.7% in 1984 but rose to 5.9 in 1985 and 6.1% in 1986[8]. This is lower than the average percentage of the Southeastern region (9.1% in 1980, 8.7% in 1984). Those receiving no prenatal care has risen steadily from 1982 (.96%) to 1986 (1.34%). The disparity between whites and non whites is higher in North Carolina (ratio of 3/1 for inadequate prenatal care in nonwhites) than for the United States (ratio of 2/1). The percentage of women receiving no prenatal care has increased especially among teenagers and is higher among nonwhites.

-under 18 year old, the rate was 2.5% in 1980, 2.8% in 1984. (W=2%, NW=3.5%)

-18 years old and over, the rate was 0.8% in 1980, 0.9% in 1984.[3] (W=.4%, NW=1.8%)

Financial Assistance and Programs for Low Income Population: Limited public health funds are available for high risk women only. MCH delivery funds provide limited funding to eligible pregnant women for prenatal care; about 80% of the eligible population is currently being served. Eight counties do not offer routine prenatal care to low income women. Aid For Dependent Children (AFDC) is estimated to cover about 50% of those in need.[20] On the horizon there will soon be an expansion of Medicaid services for maternal and infant care for all who fall below the Federal poverty level.

Accessibility of Services - Transportation: Both remain a problem in North Carolina. The study of social factors related to perinatal mortality in the eastern part of North Carolina found a higher dependance for transportation in the mothers of perinatal deaths than in the control group.[21]

Socioeconomic Status (SES): Low SES, through the interactions of multiple factors has been shown to increase the risk of neonatal mortality by 1.5 and of post neonatal mortality by a factor 2.[22] Poverty is higher in North Carolina (16.7% of the population in 1983) than the US rate (15.2%). It has been increasing over the past years from the 14.7% NC rate noted in 1979.[7]

Age: Live births to teenagers in North Carolina are decreasing. The percentage of live births to teenagers was 19.2% in 1980 and 16% in 1985(US rate 1984 = 13.1%). Births to adolescents under 18 represented 6.3% of all births in 1985 in NC (for whites this rate was 4.4%, for non-whites 10.7%, corresponding US average was 4.8%).[7,8]

Fertility rates for the younger adolescents (10-14 yrs) and older adolescents (18-19 yrs) have remained constant where the middle adolescents (15-17 yrs) are having fewer pregnancies since 1980.

Parity more than three: Women with three or more previous pregnancies represented 11.2% of all women with live births in 1984, a decrease from the 11.9% rate of 1980. This percentage of multiparae is almost twice as high in nonwhites (15.3%) as in whites (8.9%) and higher than the US average of 9.5.[8]

Race: In North Carolina in 1980 the racial composition of the population was 75.2% white, 24.2% non-white (of which 22% were blacks, 1% indians, approximately 1% hispanics). The birth rate in 1985 was 13.2 per thousand in whites, 17.5 per thousand in non-whites.[7] In 1984 non-white live births represented 31% of all live births but 45% of all infant deaths (Infant Death Ratio NW/W = 1.80). Although race appears to be an important factor in mortality rate it is important to note that if one corrects for factors such as height-weight, weight gain, prenatal care, working outside home, income, education, marital status, and smoking, the gap between whites and non-whites almost disappears. The remaining excess IMR in blacks is associated with higher rates of infections.[23]

Education: The percentage of live births to women having less than a 12th grade education was 24.9% in 1984 (21.5% in whites, 32.4% in non-

whites), a decrease from the 1980's rate of 29.4%, although still higher than the US rate of 20.9%.[8]

Out of Wedlock Births: The unmarried birth rate increased by 5% from 1980 to 1985 and currently represents 22% of all live births (equivalent to the US average)[7]. For whites 8.8% of live births are out-of-wedlock compared to 51.8% in the non-white population. The recorded increase is totally accounted for by unmarried nonteenage mothers. The geographical pattern in NC shows a higher proportion of out of wedlock births in the Coastal Plains area and especially the northeastern counties, similar to the pattern of premature births and neonatal deaths.[7]

Occupation: Although the fact of working per se does not adversely affect pregnancy outcome, women working in high stress jobs have an increased risk of having low birth weight babies. Physical exertion is of greatest importance among the high stress factors.[24] A study done by C. Homer on a prospective cohort of 7,000 young women[25] (data from the US National Longitudinal Survey of Labor Market Experience) confirmed these findings: workers had fewer LBW babies than nonworkers, but women working in high stress jobs had two times more LBW babies, and when physical exertion was involved, 7.82 times more LBW babies than women working in lower stress jobs. Among the 50 states, North Carolina has the largest proportion of working mothers, 75% (versus 69% of all US women) work full-time, very often in low paid, low skilled, physically stressful jobs.[7] The role of occupational hazards in North Carolina is not yet documented therefore we cannot assess the impact it might have on infant mortality.

Maternal conditions: Obstetric history/Infections/Smoking: The percentage of women having previous live born babies who died has decreased from 2.6% in 1980 to 2% in 1984[8]. The rate of infections, especially STDs is estimated to be high in NC. Over 80% of pap smears taken in family planning and prenatal clinics show inflammatory changes, which is often associated with infections.[20] Infections could be responsible for as much as 20% of VLBW births.[11]

There has been an overall decline in smoking from 1967 to 1980 except among teenagers[9]. There is a strong relationship between smoking and level of education. The sharpest decline of smoking occurred in the women having more than 12 years of education. Data from 1980 show that the proportion of married mothers 20 years old and over smoking during pregnancy was 16% in the mothers having more than 12 years of education and 40% in the mothers having less than 12 years of education.[9] The relative risk for a smoker having a LBW baby is 1.5.[11]

D. Regional Distribution of Mortality and Risk Factors in Each Perinatal Region of North Carolina for 1980-1984[26] (Table 1) (Figure II)

The highest infant mortality rate is found in residents of region IV (14.5) followed by region V (14.3). In region IV the neonatal death rate is the highest (10.5) as well as the percentage of low birth weight babies (8.5) and very low birth weight babies (1.8). In region IV 65% of live births were whites and 35% were non whites. The relative proportion of non-white births is lower than in region V and VI but the

disparity between whites and nonwhites is greater for virtually all the risk factors. (See Table 1)

Region V has the highest postneonatal mortality rate (5.0) largely due to the high post neonatal mortality rate for non whites (7.1) and the largest proportion of non-white births (44%).

The range of sociodemographic risk factors by perinatal region is summarized below:

- % of birth to teenage mothers: 6.0 (R IV) to 7.6 (R III)

- % of birth to mothers 35 yrs and older: 3.6 (R VI) to 5.0 (R IV)

- % of births to mothers having less than 12 yrs of education: 22.2 (R IV) to 28.7 (R I).

- % of births out of wedlock: 12.5 (R I) to 22.7 (R VI)

- % of non white births: 10 (R I) to 44 (R V)

Interpretation of these data should be done with caution as the rankings for infant mortality rates fluctuate from year to year. If we consider only the rates for 1984, the lowest infant mortality rate is found in Region I (10.3 per thousand), the highest in region V (13.9 per thousand) and region IV ranks fourth (12.1 per thousand).

III. Causes of Deaths

A. US and NC overview:

The annual Summary of Vital Statistics for the US - 1985[27] provides some useful insight in the leading causes of infant death based on the ICD-9 codes (International Classification of Diseases, ninth revision). The results are presented in Table 2 along with comparable figures for North Carolina. To make these figures comparable, the North Carolina figures have been adjusted to reflect a racial distribution equal to the US population; non white babies have higher death rates than white babies for almost every cause except congenital anomalies, and especially high death rates due to prematurity and low birth weight (ratio Black/White - 3.35 in Wegman's report)[27]. The US and NC figures are similar with the exception of a significantly higher mortality in NC from low birth weight and prematurity, although race-specific death rates are comparable in NC - US.

Table 1
Regional Mortality Rates 1980-1984 and Distribution of Selected Variables by Perinatal Region

Perinatal regions	I	II	III	IV	V	VI
#LB 1980-84	32,197	100,783	66,836	63,452	73,478	87,235
%W %NW	90 10	80 20	70 30	65 35	56 44	58 42
# LB 1984	6,400	20,197	13,769	13,341	14,582	17,597
% VLBW	1.3(2.5)	1.4(2.6)	1.4(2.7)	1.8(3.1)	1.6(2.3)	1.5(2.5)
% LBW	6.9(1.9)	7.7(2)	8.0(2.1)	8.5(2.2)	8.1(1.9)	8.1(2)
% Mother <18	6.7(1.95)	6.9(2.2)	7.7(2.7)	6.0(3.8)	7.2(2)	6.9(2.9)
% Mother 35+	4.6(0.8)	4.0(0.9)	4.3(0.8)	5.0(0.7)	3.7(1)	3.6(1)
% Mother ed < 12	28.7(1.3)	28.3(1.2)	28.3(1.5)	22.2(2.1)	27.5(1.5)	27.0(1.8)
% Mother ed 12+	71.3(0.9)	71.7(0.9)	71.6(0.8)	77.6(0.8)	72.4(0.9)	72.9(0.8)
% Mother unmarried	12.5(5.4)	16.9(6.7)	21.5(7.3)	20.9(8.8)	22.6(5.6)	22.7(8.7)
% Mother married	87.5	83.1	78.5	79.1	77.4	77.3
% Primiparae	41.0(0.9)	41.7(0.9)	41.7(0.9)	41.3(0.9)	38.6(0.8)	38.7(0.9)
% 4+	10.9(1.6)	10.1(1.5)	10.5(1.8)	11.2(1.9)	13.2(1.9)	13.4(2)
IMR	11.4(2)	11.8(1.7)	13.5(1.7)	14.5(2)	14.3(1.8)	13.8(1.2)
Neonatal Death Rate	7.5	8.0	9.2	10.5	8.3	9.4
WDR NWDR	6.6 16.3	6.9 12.3	7.4 13.3	7.4 16.1	7.3 11.8	7.1 12.5
Post Neonatal Death	3.9	3.8	4.3	4.0	5.0	4.4
WDR NWDR	3.9 4.3	3.4 5.5	3.8 5.6	3.1 5.7	3.3 7.1	3.1 6.3

( ) = ratio non-white/white for each rate

FIGURE II

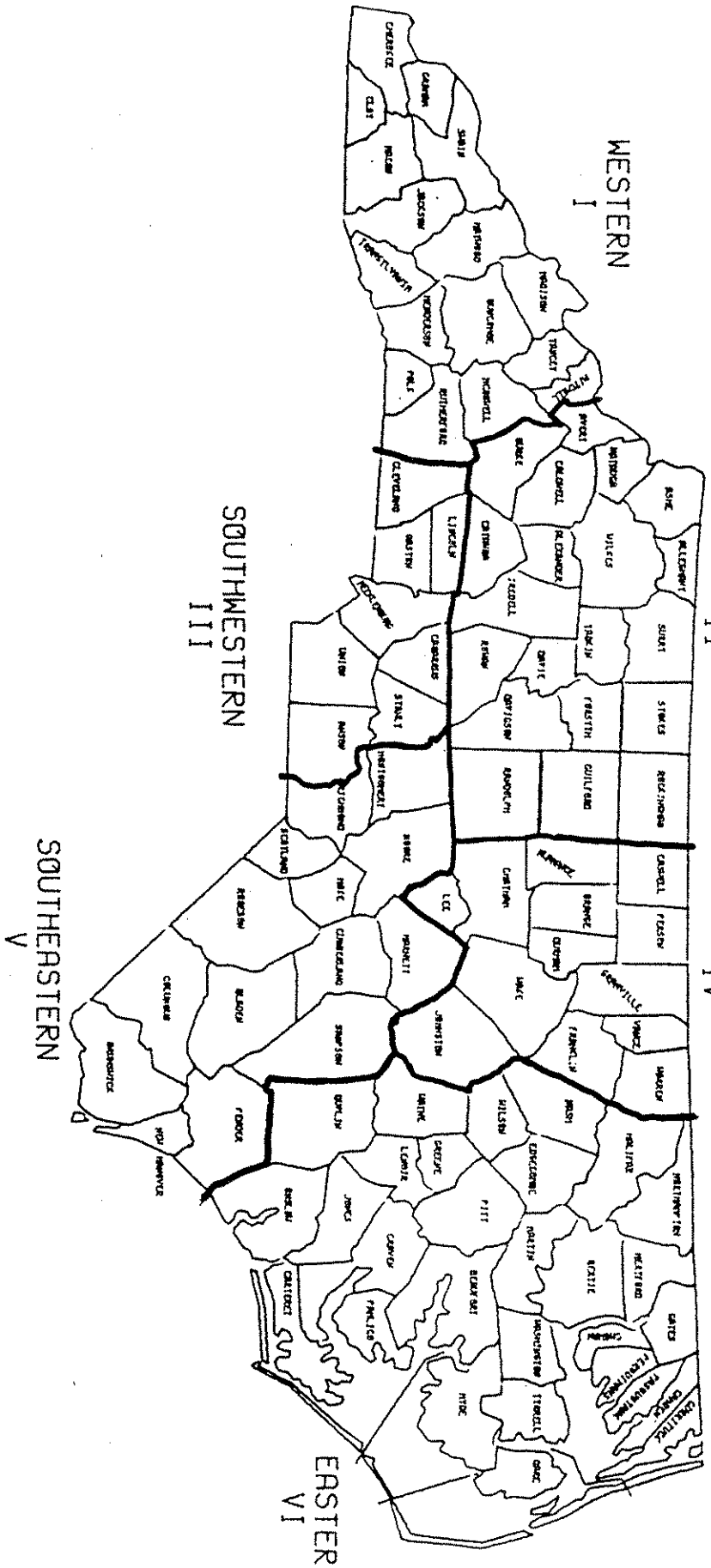

NORTH CAROLINA PERINATAL CARE REGIONS
WESTERN
I
NORTHWESTERN
II
NORTHEASTERN
IV
SOUTHWESTERN
III
SOUTHEASTERN
V
EASTERN
VI

TABLE 2

Comparison of infant mortality rates for leading causes of death
US and NC

Cause	ICD-9 Code	US Death Rates 1984 (Final) Total	by race White	Black	NC Death Rates 1985 Total	by race White	Nonwhite
Other Perinatal Conditions	760-4, 766 770-9	281.2	W 231.7	B 561.3	268.0	W 278.5	NW 568.3
Congenital Anomalies	740-759	233.0	W 235.2	B 234.3	239.4	W 223.4	NW 275.1
SIDS	798.0	142.9	W 142.9	B 242.8	138.7	W 118.2	NW 184.6
Respiratory Distress Syndrome	769.	96.9	W 89.4	B 149.1	86.1	W 79.3	NW 101.3
Preterm LBW	765	88.9	W 65.0	B 217.8	116.3	W 68.0	NW 224.4
IU Hypoxia Birth Asphyxia	768	31.9	W 26.5	B 58.5	27.9	W 27.5*	NW 28.9*
Pneumonia Influenza	480-487	18.7	W 15.1	B 37.1	16.8	W 4.8*	NW 43.4*
Birth Trauma	767	10.2	W 9.2	B 17.0	12.3	W 3.2*	NW 32.6*
Certain Gastrointestinal diseases	008-9 535,555-8	6.7	W 5.2	B 14.5	2.2	W -- *	NW 7.2*

Rates are per 100,000 live births

Notes: US data are for whites and blacks

NC data are for whites and non whites (black represents over 92% of nonwhites, others being mainly Indians and Hispanics)

Number of live births for NC = Total 89,381; W=61,765; NW=27,625

* = Actual numbers < 20

B. Available Mortality Data: Limitations for Prevention

The cause of each infant death recorded by the State Center for Health Statistics is the underlying cause of death, selected among the mentioned causes of death in the Standard Certificate of Death using a computerized system and the four digits of the ICD9 code. The ICD9 classification is based on pathologic diagnoses usually reflecting the organ system of the final disease that lead to death. Contributing factors that began long before death may not be adequately acknowledged. For example, a very premature baby who dies of a brain hemorrhage will be listed separately from a similar baby who dies of respiratory distress, even though prematurity was the true underlying cause of both deaths. The ICD9 codes give excellent information on the immediate diseases that need treatment. However, if one is looking to prevent those diseases one should look beyond the pathologic cause of death to find the preventable cause. There is only a limited amount that can be done to treat the brain hemorrhage or respiratory distress; on the other hand one might prevent the premature birth and thus avoid the pathologic disease and subsequent death. To this end we have regrouped the infant deaths to attempt to reflect groupings of preventable causes such as prematurity.

C. Objectives and Methods of Analysis: Leading Causes of Death.

The three main objectives of our analysis were the following.

- To determine the most frequent specific causes of death and aggregate those causes into groups that reflect different basic etiologies.

- To examine the relation between birthweight and the different aggregated causes of death.

- To analyse the association between certain risk factors and cause of death.

The analysis used aggregated data for the five years 1980 to 1984 in order to have sufficient numbers for meaningful interpretations. This assumes that there have not been major changes in the record system, health care, incidence of fatal diseases, or shifts in population, fertility rates or distribution of birth weights within this 5 year period.

To determine the specific causes of death we obtained a complete listing of all causes of infant deaths in North Carolina for 1980-1984 classified by their complete four digit ICD9 codes and ranked by the number of cases for each code. After reviewing the definition of each of these 4 digit codes, we grouped these causes of death into eight etiologic categories (See Appendix 1 for detailed codes):

They are as follows:

Rank	Causes	#Deaths	%Death
1	Prematurity related deaths (GpA)	2111	37.5
2	Congenital Anomalies (GpB)	981	17.4
3	Sudden Infant Death Syndrome (GpC)	726	12.9
4	Obstetric Conditions (GpD)	284	5.0
5	Other Infections (non perinatal) (GpE)	235	4.2
6	Birth Asphyxia (GpF)	194	3.4
7	Perinatal Infections (GpG)	176	3.1
8	External Causes (GpH)	123	2.2
	Total 1-8	4830	85.9
	Total # deaths 1980-84	5624	

These causes represent ~86% of all causes of infant deaths. Some of these deaths may be significantly reduced using preventive strategies of prenatal and/or perinatal care. They are the deaths related to:

GpA - Prematurity

GpD - Certain obstetric conditions

GpG - Maternal-Perinatal infections

GpF - Birth asphyxia

some GpB - Neural Tube Defects (for which a screening test is available)

These five groups represented 52% of all infant deaths.

This general overview of the causes of infant mortality stresses the importance of the role of prematurity which is the leading cause of death and for which prematurity prevention programs have demonstrated some effectiveness. Not enough information is yet available on the factors causing most of the congenital malformations and the Sudden Infant Death Syndrome, the other major causes of death, to be able to design successful preventive strategies.

More detailed analyses are possible in North Carolina as it is one of the few states matching death certificates with the birth certificate information. It allows us to compare data for three birth weight groups: the "normal" babies (over 2500 grams), and the low birth weight babies divided into two groups, the very low birth weight (VLBW - under 1500 grams) and the moderate low birth weight (MLBW - 1500 grams to 2499 grams). It is also possible to analyze correlations between

sociodemographic and prenatal care information available on the birth certificate and selected causes of death.

D. Findings of the Detailed Analysis

1. Death rates by Birth Weight Groups

The low birth weight babies (under 2500 grams) represented 7.9% of all live births and 63% of all infant deaths during the study period. The infant mortality rate for the LBW group was 106 per 1000. The VLBW represented 1.5% of all live births and 48% of all infant deaths. The infant mortality rate for the VLBW was 433 per 1000. The MLBW represented 6.4% of all live births and 15% of all infant deaths. In this group the infant mortality rate was 31 per 1000. Among the babies weighing 2500 grams and over, who represent 92.1% of all live births, the mortality rate was 5 per 1000.

For every cause, the birth-weight-specific death rate is higher among low birth weight babies and increases sharply as the birthweight decreases (Table 3). The relative risk of infant mortality in infants weighing less than 1500 grams at birth compared to over 2500 grams is 84.9. The relative risk of infant mortality in infants weighing between 1500 and 2499 grams at birth compared to over 2500 grams is 6 (Table 4).

The relative risks of mortality for LBW and VLBW babies are particularly high for prematurity related conditions, obstetric problems and perinatal infections. This can be explained by an increased susceptibility of LBW babies but it can also be argued that obstetric problems and maternal infections are well documented causes of LBW and VLBW.

Table 3

Specific Death Rates per 1000 live births by Birth Weight (BW) Categories for 1980-1984. (The actual numbers of cases are in parentheses).

GP	Cause	BW <1500grms	BW 1500-2499grms	BW >2500grms	Total
GpA	Prematurity related	300.9 (1883)	4.4 (121)	0.2 (82)	5.0 (2111)
GpB	Congenital anomalies	20.3 (127)	10.6 (290)	1.4 (543)	2.3 (981)
GpC	SIDS	3.7 (23)	4.9 (133)	1.5 (570)	1.7 (726)
GpD	Obstetric conditions	41.3 (259)	4.0 (11)	0.04 (14)	0.7 (284)
GpE	Other infections	7.3 (46)	1.4 (37)	0.4 (151)	0.6 (235)
GpF	Birth asphyxia	14.5 (91)	1.0 (28)	0.2 (69)	0.5 (194)
GpG	Perinatal infections	12.8 (80)	1.5 (42)	0.1 (54)	0.4 (176)
GpH	External causes	0.8 (5)	0.7 (19)	0.3 (99)	0.3 (123)
# deaths in BW group		(2708)	(840)	(2003)	(5624)
# of live births		6257	27232	390276	423981
Total BW specific death rate		432.8	30.8	5.1	13.3

Note: in some causes the total number from the 3 BW categories do not correspond to the number recorded in the "total" column, as some BW were unknown.

Table 4

Relative Risks of Infant Mortality by Cause for VLBW and MLBW compared to >2500 grams

		<1500/>2500	1500-2499/>2500
GpA	Prematurity Related	1504.5	22.0
GpB	Congenital anomalies	14.5	7.6
GpC	SIDS	2.5	3.3
GpD	Obstetric conditions	1032.5	100.0
GpE	Other Infections	18.2	3.5
GpF	Birth Asphyxia	72.5	5.0
GpG	Perinatal Infections	128.0	15.0
GpH	External Causes	2.7	2.3
Total		84.9	6.0

2. Causes of death by birth-weight groups

Very Low Birth Weight Group <1500 grams

As expected in the VLBW babies, prematurity related conditions account for the majority of deaths (69.5%) followed by obstetric causes.

Rank	Aggregated Causes	# of Deaths	% of Deaths
1.	GpA Prematurity related	1883	69.5
2.	GpD Obstetric conditions	259	9.6
3.	GpB Congenital anomalies	127 [40 Neural Tube Defects(NTD)]	4.7
4.	GpF Birth asphyxia	91	3.4
5.	GpG Perinatal infections	80	3.0
7.	GpE Other infections	46	1.7
6.	GpC SIDS	23	0.8
8.	GpH External causes	5	0.2
	Total 1-8	2512	92.8
	Total # deaths	2708	

2353 or 87% of all deaths in this group belong to the previously defined preventable deaths [GP's A, D, G, F and some B (NTD)].

Moderate low birth weight group 1500-2499 grams

The patterns presented by this group are quite different from the VLBW group and tend to resemble to the "≥2500 grams group". Although a majority of the babies are premature, a minority being small for gestational age, prematurity accounts only for 15% of all deaths of this group.

Rank	Aggregated Causes	# of Deaths	% of Deaths
1.	GpB Congenital anomalies	290 (~60 NTD)	34.5
2.	GpC SIDS	133	15.8
3.	GpA Prematurity related	121	14.4
4.	GpG Perinatal infections	42	5.0
5.	GpE Other infections	37	4.4
6.	GpF Birth asphyxia	28	3.3

7.	GpH External causes	19	2.3
8.	GpD Obstetric causes	11	1.3
	Total 1-8	681	81.0
	Total # deaths	840	

262 or 31% of all deaths in this group are in the previously defined groups of preventable causes of death. (GPs A, D, G, F and NTD's in B).

"Normal" birth weight group (2500 grams and over)

The single leading cause of death in that group is the SIDS, followed by various congenital anomalies. In this group the congenital anomalies of the heart and the circulation system play a major role, representing more than half of the deaths due to congenital anomalies (as opposed to approximately 1/4 in MLBW group and 1/20 in VLBW group; this discrepancy may be explained at least in part by a discrepancy in survivorship among these 3 groups allowing more time to diagnose the condition).

Rank	Aggregated Causes	# of Deaths	% of Deaths
1.	GpC SIDS	570	28.5
2.	GpB Congenital anomalies	543 (NTD=81)	27.1
3.	GpE Other infections	151	7.5
4.	GpH External causes	99	4.9
5.	GpA Prematurity related	82	4.1
6.	GpF Birth asphyxia	69	3.4
7.	GpG Perinatal infections	54	2.7
8.	GpD Obstetric causes	14	0.7
	Total 1-8	1582	79.0
	Total # of deaths	2003	

300 deaths or 15% belong to the group of preventable causes of deaths.

3. Associated Causes of Death

We reviewed the records of all the infant deaths due to 5 groups of aggregated causes (prematurity, congenital anomalies, SIDS, perinatal infections and birth asphyxia), searching for other causes mentioned in the death certificate which could have contributed to the death.

It is to be noted that this additional information does not modify the rank order of frequency among these groups of causes.

The major finding is that a prematurity related condition (GpA) contributed to half of the deaths primarily due to congenital anomaly (GpB) and to 3/4 of the deaths where the underlying cause was birth asphyxia (GpF) or perinatal infection (GpG). Detailed results are presented below:

Among the 2111 deaths where a Prematurity Related Condition was the underlying cause of death (GpA):

70 had also a congenital anomaly (GpB) 3.3%

3 died of SIDS (GpC)

142 suffered a birth asphyxia (GpF) 6.7%

54 also had a perinatal infection (GpG) 2.6%

Among the 981 deaths were congenital anomaly was the underlying cause of death (GpB)

508 also had a "prematurity related condition" (GpA) 52%
(although only 417 were LBW)

2 died of SIDS (GpC)

99 suffered birth asphyxia (GpF) 10%

22 also had a perinatal infection (GpG) 2%

Among the 726 deaths where SIDS was the underlying cause of death (GpC), in 10 cases prematurity was mentioned as a contributing cause of death (GpA), none of the other groups of causes were mentioned.

Among the 194 deaths where birth asphyxia was the underlying cause of death (GPF)

150 had also a "prematurity-related condition" (GpA) 77%

13 had a congenital anomaly (GpB) 6.7%

4 had a perinatal infection (GpG) 2%

Among the 176 deaths where a perinatal infection was the underlying cause of death (GpG)

135 also had a prematurity related condition (GpA) 77%

13 also had a congenital anomaly (GpB) 7.3%

16 suffered a birth asphyxia (GpF) 9%

4. Association between selected risk factors and 5 of the aggregated groups of causes of deaths (Gps A, B, C, F, and G) - see Table 5)

Multiple births are overrepresented among deaths caused by prematurity and birth asphyxia.

Non-white births are overrepresented in all categories except congenital anomalies.

Low-education in the mothers is exclusively overrepresented in the deaths by SIDS.

Due to its strong association with non-white race, both the out-of-wedlock and maternal age <17 status follow the distribution of non-white mothers showing overrepresentation in all classes but the congenital anomalies.

Inadequate prenatal care was not overrepresented in the deaths due to prematurity but was more frequent in mothers of infant deaths by SIDS, birth asphyxia and infections.

IV. Time of death

Using the Detailed Mortality Statistics for North Carolina 1985[6], we obtained the time of death for the eight leading groups of causes. Results are presented in Table 6.

1. The large majority of deaths due to prematurity as previously defined (GpA) occur in the neonatal period: 72% on the day of birth, 85% in the first 6 days, 93% in the first 27 days of life. The causes of death due to prematurity but occuring in the post neonatal period are bronchopulmonary dysplasia, respiratory distress syndrome and necrotizing enterocolitis.

2. A majority of deaths due to congenital anomalies occur in the neonatal period: 29% in the 1st day, 59% in the first 6 days, 74% in the first 27 days of life. 67% of deaths due to neural tube defects, 60% of deaths by cardiovascular anomaly and 88% of deaths by other congenital anomalies happen in the first 27 days of life.

3. SIDS is almost by definition a postneonatal cause of death, although 5% of deaths attributed to this cause occurred in the neonatal period.

4. The deaths related to an obstetrical cause occur essentially on the day of birth (94% of cases), 98% of them before the end of the first 27 days of life.

5. The nonperinatal infections occur mostly in the post neonatal period, although 9% happened in the neonatal period.

6. Birth asphyxia causes death mainly in the neonatal period, 48% on the first day, 80% in the first 6 days, 84% within the first 27 days of life.

7. More than half of the deaths due to maternal or perinatal infections take place on the first day of life, 82% in the first 6 days. No cases of death attributable to perinatal infections were recorded beyond the neonatal period.

8. As expected, the external causes of death are essentially post neonatal (71% of cases), a few cases, generally homicides, happening within the very first days of life.

The group of "preventable causes of death" follows exactly the pattern of prematurity related causes: 71% in the first day, 85% in the first 6 days, 93% in the first 27 days.

The review of the 1980-1984 infant deaths found very similar data for the 5 selected groups of causes of death.

Table 5

Distribution in percentages of selected sociodemographic risk factors among infant deaths due to selected causes (1980-1984).

	% of State Births	Prematurity GpA	Anomalies GpB	SIDS GpC	Asphyxia GpF	Perinat Inf GpG
Multiple births	2.0	13.6 (287)	4.5 (44)	4.1 (30)	15.5 (30)	5 (9)
Non White Mother	31.8	52.8 (1115)	29 (228)	46 (335)	49 (96)	42.6 (75)
Mother <17	3.5	7.1 (151)	3.5 (35)	6.7 (49)	5 (10)	6.8 (12)
Maternal education <11yrs	27.0	24.8 (525)	22.8 (224)	43.8 (318)	17 (33)	24.4 (43)
Out of wedlock	20.1	34.5 (729)	17.6 (173)	35.6 (359)	38 (74)	31.2 (55)
Inadequate Prenatal Care	6.0	6.9 (307)	7.6 (75)	18.5 (135)	19.6 (38)	13.6 (24)

() = actual numbers

Table 6

Percent of Deaths occurring at different ages for leading groups of causes.

	Age at Death				
	≤1 day	≤1 week	≤1month	PostNeonatal	Total
GpA Prematurity	72%(293)	85%(348)	93%(381)	7%(28)	409
GpB Congenital Anomaly	29%(58)	59%(117)	74%(147)	26%(52)	199
NTD	57%(12)	57%(12)	67%(14)	33%(7)	21
GpC SIDS	0	0	4%(5)	96%(119)	124
GpD Obstetric	94%(48)	96%(49)	98%(50)	2%(1)	51
GpE Other Infections	6%(3)	6%(3)	9%(4)	91%(43)	47
GpF Birth Asphyxia	48%(12)	80%(20)	94%(21)	16%(4)	25
GpG Perinatal Infections	57.5%(23)	82.5%(33)	100%(40)	0	40
GpH External Causes	14%(4)	18%(5)	29%(8)	71%(20)	28
Total 1-8	48%(441)	62%(575)	71%(656)	29%(267)	923
Total of Preventable cases	71%(338)	85%(462)	93%(506)	7%(40)	546
Proportion of prev. deaths among all deaths	(83%)	(74%)	(71%)	(11%)	(51%)
Total # deaths all causes	470	621	713	357	1070

INFANT MORBIDITY

I. Definition/Sources

Infant morbidity refers to the presence of disease(s) in children less than one year old. This represents a wide range of conditions and there are as yet no agreed upon limitations in the definition such as severity or duration of disease. There is likewise no standard outcome measure and no systematic reporting system at the national or state level. Available estimates on infant health status come from various sources, such as hospital discharge data, follow up of high risk neonates, national health surveys, registries of birth defects, specific studies of selected chronic conditions and regionalized perinatal care projects.[22] Information obtained through these sources differ widely in the morbidity considered as significant as well as the subject population. Our discussion will focus on severe conditions leading to hospitalizations, handicaps, developmental delays and chronic disease.

II. Descriptive Data

A. Estimates of Rates of Morbidity and Handicapping Conditions in US and NC - Risk Factors.

A national home-based survey of health status in one year old singletons[18] done in 1978-79 showed that 13% of one-year-olds presented some degree of impairment (congenital anomaly or developmental delay), 2% had a severe impairment, 7% moderate, 4.1% a less significant (mild) impairment. As compared to 1976 data, a decrease was noted in the overall percentage of impairment (from 15.5 to 13.1), mostly among the children presenting a mild impairment. This improvement has been noted for every birth weight category and was the greatest among the VLBW babies. It is comforting to find that increased survival did not lead to an increase in handicaps among survivors.

Birth weight group	% Congenital Anomaly/Dev. Delay	
	1976	1978-9
<1500 gm	49.3	38.7
1500-2000 gm	31.8	28.1
2001-2500 gm	20.1	17.3
≤2500 gm	24.6	21.3
>2500 gm	15.0	12.7

There is a high frequency of major health problems in the first year of life: one in every five children suffers at least

one major health problem, one in ten (9.1%) is hospitalized during the first year of life.[22,28]

In North Carolina in 1976 the proportion of infants with a handicapping condition (defined broadly as a long-lasting physical, mental, social or emotional impairment) was estimated to be 17-18% and 55% of infants had risk factors exposing them to a higher possibility of such health problems.[29]

Risk Factors for Infant Morbidity

Most of the risk factors identified for infant mortality also increase the risk of morbidity. Illnesses tend to cluster in certain children.[28] This may be due to an inherited predisposition, which increases vulnerability to the effects of environmental and social forces[30] or may be a direct result of adverse social and environmental forces. The risk of problems may result from the cumulative effects of a physical condition such as low birth weight, or multiple birth, and environmental conditions such as poverty. Illnesses are more frequent and more severe in children of teenage, non white, single, poor, uneducated mothers. Infants from a low income family are threefold more likely to be hospitalized in the first year of life.[28] A first illness also contributes to lower resistance to subsequent threats leading to more illnesses.[30]

Low birth weight by itself increases the risk of morbidity even when controlling for the adverse sociodemographic correlates of LBW and the increased percentage of congenital anomalies and delays.[28] These LBW neonates are at higher risk for neurodevelopmental handicaps (RR for LBW = 3, for VLBW = 10), congenital anomalies (RR = 2 for LBW, 3 for VLBW), lower respiratory tract conditions, deafness, blindness, and a general increased susceptibility to acute illnesses.[12]

North Carolina has developed a program for High Priority Infants to improve the tracking, identification and follow-up of "High Risk Infants"[31]. These high risk infants are categorized into two groups; A) VLBW or serious neonatal neurologic problem and B) serious environmental, social or medical conditions, or a birth weight between 1501-2000 grams. In 1986, 3417 were enrolled in this program (about 4% of all births); 44% of the Group A infants had one or more abnormal finding (neurosensorimotor, psychological, mental development or home environment), and 17% had an abnormal mental developmental score at the 12 month follow-up assessment.

The risk of being rehospitalized or needing prolonged care increases with decreasing birthweight. Other determinants for hospitalization in infants include the existence of chronic conditions, congenital anomalies and poor development.[12]

(B) Causes of Infant Morbidity in the United States

If we use hospital based data: 1/3 of admissions were for a lower respiratory tract condition, the leading cause being pneumonia which accounts for more hospital care days (540,000 days/year) than any other causes; 1/5 were due to gastrointestinal problems; 1/6 for a congenital anomaly or developmental delay; 1/10 for upper respiratory problems. Among the other causes, injuries played a major role.[32]

According to office-based practice data, infants visit the doctor 5 to 9 times in their first year, with half of the visits for routine care, 13% for upper respiratory infections, 7% for infectious or parasitic disease, 6% for ear problems, and 2% for injuries.[32]

Among 1 year old infants 8.6% had experienced at least one injury requiring a hospitalization or a visit to a health professional. Normal birth weight infants tend to be more at risk for injuries especially in the second six months of life when mobility increases. Injuries are more frequent in infants of young mothers.[33]

The incidence of congenital defects and birth injuries is grossly underestimated by the information obtained from birth certificates. The accuracy of reporting depends on recognizability of the defect at birth, and the perceived severity of it. The completeness of reporting varied in a survey done by Taffel in 1972, anywhere from 22 to 76% in major defects and 8 to 18% for minor defects.[34]

A similar review done in 1982 in North Carolina found that birth certificates reflected only 20% of the congenital anomalies cited on the hospital discharge records of the newborn.[35] Birth certificates identified anomalies in 8 babies per 1000 live births whereas hospital discharge records found 38 per 1000 live births. Congenital anomalies are more frequent among low birth weight babies, especially whites.[36]

Most of the studies show different ethnic patterns for congenital anomalies with a lower overall incidence of anomalies in the black population. In part it is attributed to reporting and associated with the number of visits to health care professionals, and in part to different genetic traits; for example, cleft palate is more frequent in whites, polydactyly more frequent in blacks.[34,36]

The male to female ratio for congenital anomalies is 1.4; this ratio is reduced when the genital anomalies are excluded from the computation.[34] It is estimated that 25-30% of congenital malformations are due to genetic factors, 1.5% to drugs and the rest are probably multifactorial.[22]

The etiology of most of the other causes of handicap or chronic conditions in infants is genetic. For a few of them screening can be carried out during pregnancy or preconceptionally allowing for preventive strategies. Others may be due to perinatal factors, drugs, maternal health problems, antenatal environment or chronic hypoxia.[37,38]

C. Morbidity Estimates for North Carolina

Accurate estimates of infant morbidity in North Carolina are extremely difficult to obtain. An attempt to gather epidemiologic data has been done by the RNDMU.[39] Those estimates will be used in the table below although there are many limitations; 1) they are not adjusted for race or sex distribution, 2) the incidence rates come from studies using birth certificates, therefore grossly underestimating the true incidence; 3) in some cases only prevalence data were available for a population of 0-20 year olds requiring that morbidity be extrapolated from the likely time of onset of symptoms and the survival rate for the selected conditions[40,41]

	incidence/year =new cases/year
Mental Retardation	2500
Congenital Anomalies among which the leading causes are conservatively estimated to be:	1500-2700
- congenital heart/vascular diseases 700	
- Hypospadias 220	
- Clubfoot 200	
- Cleft lip - palate 75	
- Polydactyly 75	
- Spina bifida 40-80	
- Down syndrome 65	
Cerebral Palsy	115
Deafness	90-200
Blindness	60-65
Hereditary conditions	
- Cystic fibrosis	40

- Sickle Cell Anemia	50
- Congenital hypothyroidism	20
- Thalassemia	50
- PKU	10
Congenital infection	
- Toxoplasmosis	60
Asthma	800

Among these handicapping conditions mental retardation and congenital heart disease are more salient, due to their severity, their frequency and the burden they represent in terms of health care needs. For both conditions little is known about their etiology, with little opportunity for preventing their occurrence at this time. Seventy percent of mental retardation is attributed to genetic factors, 8% to prenatal factors, 9% to perinatal events and 12% to infections.[22]

The etiology of congenital heart diseases is unknown in over 90% of cases. Viruses (such as rubella), drugs (amphetamines, lithium) have been proven to play a role in some cases.[42] Genetic factors have some impact, as demonstrated by an increased risk in families who had a previously affected child. It is worth noting that the trend of the last 15 years has been toward an increase, both in North Carolina and nationwide, for certain anomalies of the heart, especially ventricular septal defects.[35] It is possible that this may be due to improvements in technology leading to a better identification of the condition.

CONCLUSIONS

I. Summary

The infant mortality rate (IMR) has been slowly decreasing over the past years. In 1985 IMR in North Carolina was 12.0 per 1000 live births which is higher than the US average of 10.6 and ranks North Carolina 45th in the nation, exceeded by only five states, mostly in the Southeastern Region. Two thirds of these deaths occur in the first month of life.

Low birth weight (under 5.5 pounds) plays an essential role in infant mortality. Although low birth weight babies represent 7.9% of all live births they accounts for 64% of all infant deaths. The risk of dying increases sharply as the birth weight decreases. Improvements in perinatal care contributed to decrease the mortality at every birth weight. However, the proportion of low birth weight babies remained fairly constant over the last 30 years. Non white babies are still twice as likely to be of low birth weight and to die in their first year of life than white babies. In North Carolina the highest rates of

infant mortality and low birth weight are experienced in the Costal Plains Region, which is consistent with the racial distribution in this area.

The leading causes of death in North Carolina between 1980-1984 were: prematurity related conditions (37.5% of all infant deaths), congenital anomalies (17.4%), Sudden Infant Death Syndrome (12.8%) and perinatal conditions including infections, birth asphyxia and obstetrical complications (11.5%). It is important to note that of those whose primary cause of death was a congenital anomaly, a prematurity related problem was a mentioned cause of death in half of the cases; of those who died of birth asphyxia and perinatal infection three-quarters had also a prematurity related condition contributing to their death.

A number of factors are associated with prematurity and low birth weight: they include sociodemographic risks (black race, low socioeconomic status, teenage or single mother), medical risks, behavioral and environmental risks, physical and psychosocial stress such as adverse working conditions, and inadequate prenatal care.

Risk factors are largely unknown for congenital anomalies; non white and younger mothers seem to be less likely to have babies with congenital anomalies. Some risk factors have been suggested for Sudden Infant Death Syndrome but none of them are specific for this syndrome.

The deaths that we identified as potentially preventable represent 52% of all deaths, 93% of these deaths occurring within the first 27 days of life.

Non white and unmarried mothers were over represented in the prematurity related deaths; on the other hand in this group of deaths, the percentage of mothers having had inadequate prenatal care was not much higher than the state average for all births. This raises questions about the qualitative aspects and content of the prenatal care being received.

Infant morbidity is much less documented. Thirteen percent of one year old have some kind of impairment, with a severe handicap or delay in 2% of cases. One in five children suffers at least one major health problem in the first year of life, one in ten even requiring hospitalization. The leading problems are congenital anomalies, developmental delays, injuries and infections.

Here again, LBW babies have a greater risk of morbidity. They are 10 times more likely to suffer neurological or mental handicaps, 3 times more likely to have a congenital anomaly, and consistently more likely to develop lower respiratory infections, deafness and blindness. Even if the proportion of handicap in low birth weight babies surviving the neonatal period has decreased, they still remain at high risk. Among high risk infants followed in the North Carolina High Priority Infant Program, 44% of these VLBW or neurologically suspect infants presented at least one abnormal finding at the twelve month follow-up assessment.

II. Recommendations

The Institute of Medicine Task Force and its subcommittee suggest the following recommendations toward reducing infant morbidty and mortality in North Carolina.

1. A concerted effort should be focused on the complex problem of low birthweight as the major cause of infant mortality and a significant contributor to infant morbidity and health care costs. Unlike other causes of mortality and morbidity, there is reason to believe that a significant portion of low birth weight can be prevented using currently available information.

2. The prevention of low birth weight will require a carefully coordinated effort uniting the energies of the medical profession, public health, social services, employers, public education, a host of community groups and ultimately the resources of the family itself. Low birth weight is not a single medical problem but rather a complex interaction of medical, psychological, environmental and social forces that influence the developing fetus. Success will depend upon considerable cooperation and committment from all these groups.

III. Future Data Needs

Information on infant mortality is quite precise and consistently collected. A new birth certificate will be introduced in 1988 which will further improve our understanding of birth factors related to mortality and the recording of congenital anomalies. In addition, the State Center for Health Statistics has embarked on a program to analyze the currently available data in some new ways that would offer a better understanding of low birthweight and its prevention. These analyses of currently available data will strengthen our understanding of the problem as well as our capacity to evaluate the effect of any interventions.

To address the deficiencies in morbidity information several steps might be taken. With the assistance of the Trust, North Carolina is in the process of implementing a birth defects registry which would provide more extensive information on the incidence of different birth defects. A hospital discharge data system is also currently being put in place across the state. In addition to monitoring birth defects and significant illnesses, it might be feasible to put in place a system for monitoring a few common health problems known to contribute considerably to infant morbidity. A surveillance system to keep track of these sentinal problems might be established in selected communities as a way of assessing changes in these problems as a part of infant morbidity.

Matching infant and maternal prenatal records would also be contributive to the understanding of most infant health problems including prematurity and congenital anomalies. It would provide some insight in the content of prenatal care received for normal and pathologic pregnancies and help to establish correlations with the infant outcomes.

Appendix 1

Etiologic groupings of cause of death

1. GPA Prematurity related causes

*Respiratory causes associated with immaturity of lungs

769; 770.2, .3, .4, .5, .7, .8

*Other ill defined perinatal conditions (highly correlated with deaths in <1500 grams)

779.5

*Necrotizing enterocolitis

777.5

*Extreme immaturity and other preterm

765.0, 765.1

*Intracranial hemorrhage

431; 767.0; 772.1

2. GPB Congenital Anomalies

*neural tube - 740.0; 741.0, .9; 742.0, .2, .3

*heart and vessels - 745.0, .1, .2, .4, .5, .6

- 745.7, .8 .9

- 747.1, .3, .4, .9

*Others: - 748.5, .6

- 751.6

- 753

- 756.6

- 758.1, .2

- 759.7

3. GPC Sudden Infant Death Syndrome

   - 798.0

4. GPD Obstetric conditions (eventually preventable cause of death)

   - 761.0, .1, .5

   - 762.0, .1, .2

5. GPE Infections other than maternal infections and perinatal transmission

   - 0-139

   - 320.0, .1, .8, .9; 322.9

   - 460-466

   - 480-487

   - 490

6. GPF Birth asphyxia

   - 768.4, .5, .9

7. GPG Maternal/Perinatal Infections

   - 320.2

   - 760.1, .2, .8

   - 762.7

   - 771.8

8. GPH External causes (Trauma, injuries, including homicides; exclusion of iatrogenic causes)

   - 812, 815, 816, 818, 819

   - 880-888

   - 890-899

- 904
- 910-915
- 928.9
- 960-969
- 983, 984, 988

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