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9. ABSTRACT The California Project of the Inter-American Investigation of Mortality in Childhood was carried out in San Francisco and three surrounding counties. The study found infant death rates of 18.5 per 1,000 live births in San Francisco and 17.2 per 1,000 live births in the three counties. Mortality in the neonatal period account for two-thirds of these deaths. Low birthweight played a key role in neonatal mortality particularly during the first day of life. The study found that 77.7% of the neonatal fatalities and 85.6% of those dying in the first day of life weighed 2,500 grams or less at birth. Mortality was also very high among infants of mothers under 20 and over 34 years of age. The vast majority of babies born to young mothers who die the first day had very low birth weights. This demonstrates a clear need for special measures capable of reducing the health risks faced by both young mothers and their children. The authors recommend various specific measures that should be taken and present data obtained by the California Project on other aspects of mortality among infants and preschool children 1-4 years of age.

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PATTERNS OF INFANT AND EARLY CHILDHOOD MORTALITY IN THE CALIFORNIA PROJECT OF A COLLABORATIVE INTER-AMERICAN STUDY^{1,2}

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Data from the California Project of the Inter-American Investigation of Mortality in Childhood⁴ show that, in the area studied, infants of teenage mothers and babies with low birth-weights experienced relatively high rates of death. This article presents an analysis relating to these points. It also summarizes significant Project findings on other aspects of infant and young child mortality in the San Francisco Bay area.

Introduction

The Inter-American Investigation of Mortality in Childhood⁴ was a collaborative research effort involving 15 projects in 10 nations of the Americas. One of these projects was carried out within the United States, in the Bay Area of northern California. This region encompasses the City of San Francisco and its three surrounding counties. At the time of the study the urban area was estimated to have a population of 716,500, while the population of the suburban counties was estimated at 2,027,900. The area as a whole was characterized by a heterogeneous population, with considerable

economic diversity and good representation of all socioeconomic groups.

Methodology

The death certificate was employed as the starting point for the Project because registration of deaths is considered complete in the State of California. Upon receipt of each death certificate, a statistical clerk would visit the hospital where the death occurred and abstract the data, placing the abstracted data on the previously prepared PAHO study form. If an autopsy was performed, a complete report was obtained.

A total of 898 deaths occurred among persons under five years of age during the twelve-month period covered (1 June 1969-31 May 1970). Of this number, 784 deaths occurred during infancy (the first year of life), 570 being neonatal⁵ and 214 postneonatal; the remaining 114 occurred among children 1-4 years of age. Autopsies were performed and autopsy reports obtained for 735 of these cases, representing 82.1 per cent of the total.

¹Also appearing in Spanish in the *Boletín de la Oficina Sanitaria Panamericana*, 1975.

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⁴An investigation coordinated by the Pan American Health Organization on a continental scale in order to explore in depth the causes of excessive mortality in infancy and early childhood in the Americas. The investigation was made possible by a contract between the Agency for International Development of the United States and the Pan American Health Organization.

⁵The neonatal period encompasses the first 28 days of life.

Results

The California Project found an infant death rate of 18.5 per 1,000 live births in San Francisco and a slightly lower infant mortality of 17.2 per 1,000 live births in the three-county suburban area. Neonatal mortality (13.0 per 1,000 live births in San Francisco and 12.7 in the suburban area) accounted for two-thirds of these deaths. Most of the neonatal mortality (11.3 and 11.0 deaths per 1,000 live births, respectively) occurred in the first seven days of life, and almost half the neonatal mortality took place within the first 24 hours after birth.

The infant death rate was highest among blacks (28.8 per 1,000 live births), next highest among whites (15.7), and lowest in the "other" group including orientals (11.2). Similar ethnic differences were observed in the rates of both neonatal and postneonatal death.

Infant Mortality

Immaturity was found to be the most prominent cause of infant mortality in the California Project, playing a role as an associated cause of death in over half of the 784 cases. Congenital anomalies were the second most prominent, accounting for approximately one-sixth of the 2,137 underlying and associated causes of death cited. Anoxia, which ranked third, accounted for nearly one-sixth of the associated causes of death. In addition, sudden death was found to be a prominent cause of postneonatal mortality in the California study.

Neonatal Mortality

Almost all of the neonatal deaths occurred among infants who were born in a hospital and who died in a hospital. Autopsies were performed in connection with 77.5 per cent of the neonatal deaths.

Leading causes of mortality in the first seven days of life were pregnancy complications, conditions of the placenta and cord, congenital

anomalies, anoxia, and other maternal conditions. In the group 7-27 days of age, major causes of death were congenital anomalies, diseases of the respiratory system, pregnancy complications, and conditions of the placenta and cord. Almost four-fifths of the neonatal deaths were associated with immaturity. The prominent role that was played in neonatal mortality by premature separation of the placenta is of particular interest.

The Role of Birth-Weight

Babies weighing 2,500 grams or less at birth accounted for 443 of the 570 neonatal deaths (77.7 per cent). This demonstrated the importance of low birth-weight in neonatal and infant mortality (see Table 1 and Figure 1). Analysis by birth-weight group showed that 33.0 per cent of the neonatal deaths occurred in infants weighing 1,000 grams or less at birth, and that 44.7 per cent occurred in infants with birth-weights of 1,001-2,500 grams.

Indeed, it was observed that the lower the birth-weight group, the higher the mortality. For example, 94.0 per cent of those babies weighing 1,000 grams or less at birth died in the neonatal period; in the next weight group (1,001-1,500 grams) 43.5 per cent died; in the next (1,501-2,000 grams) 10.7 per cent died; and in the next (2,001-2,500 grams) 2.8 per cent died. The most favorable weight group was 3,501-4,000 grams, in which only 0.2 per cent of the babies died.

Although the dividing line for low birth-weight is drawn at 2,500 grams, our study found the death rate for those in the next 500-gram weight group (2,501-3,000 grams) to be over twice that for babies weighing 3,501-4,000 grams (5.4 and 2.2 per 1,000 live births, respectively). The data thus show weight at birth to be an extremely important determinant of neonatal mortality.

The first day of life. This role of birth-weight was very evident during the first day of life. The death rates observed on this first day, broken down by birth-weight group, are shown in Table 1 and Figure 1. Since deaths in the

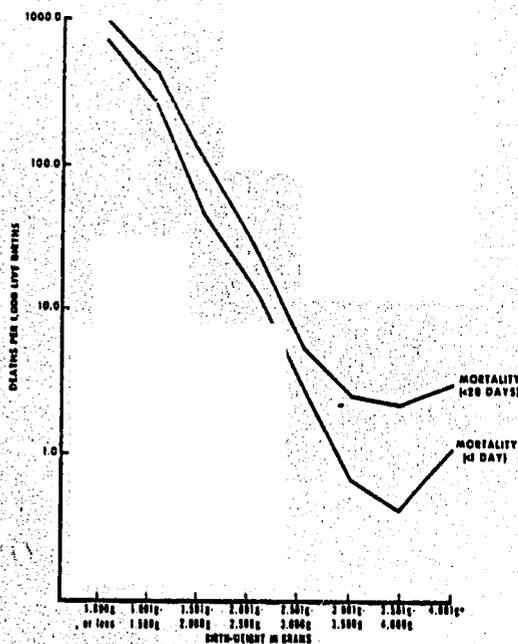
TABLE 1—Neonatal mortality and mortality in the first day of life, by weight at birth, in the California Project.

Birth-weight ^a	Estimated live births	Neonatal deaths		Deaths in first day of life	
		No.	Rate ^b	No.	Rate ^b
Total	44,740	570	12.7	327	7.3
1,000 g or less	200	188	940.0	145	725.0
1,001-1,500 g	276	120	434.8	73	264.5
1,501-2,000 g	664	71	106.9	30	45.2
2,001-2,500 g	2,271	64	28.2	32	14.1
2,500 g or less	3,411	443	129.9	280	82.1
2,501-3,000 g	8,550	46	5.4	26	3.0
3,001-3,500 g	17,661	45	2.5	12	0.7
3,501-4,000 g	11,619	25	2.2	5	0.4
4,001 g and over	3,499	11	3.1	4	1.1
2,501 g and over	41,329	127	3.1	47	1.1

^aIn cases where birth-weight was not stated, this weight was estimated.

^bDeaths per 1,000 live births.

FIGURE 1—Mortality in the first day and first 28 days of life, by weight at birth, in the California Project.



first day of life usually occur soon after birth in the hospital where delivery took place, these rates are useful in evaluating the experience in hospitals. All but 47 of the 327 fatalities in the

first day of life (14.4 per cent) were babies with low birth-weights. Thus, reducing mortality in the first day of life depends on preventing delivery of babies with low birth-weights—in other words, preventing the serious problem of prematurity.

Multiple births. In the California study, multiple births had a neonatal mortality rate of 85.9 per 1,000 live births, compared with 11.3 for single births. All but two of the 76 neonatal deaths associated with these multiple births involved infants weighing 2,500 grams or less at birth, again demonstrating the major role of low birth-weight in neonatal mortality.

The Role of Maternal Age and Birth Order

The California study showed that babies born to girls under 20 years of age and to women 35 years and over experienced higher neonatal and infant mortality than those born to women 20 through 34 years of age (see Figure 2). The hazards were especially great for babies of teenage mothers (see Table 2). That is, the death rate in the first year of life for babies born to mothers under age 20 (26.2 per 1,000 live births) was 65 per cent higher than the rate for babies born to mothers 20 and over (15.9 per 1,000).

FIGURE 2—Neonatal and infant mortality, by age of mother, in the California Project.

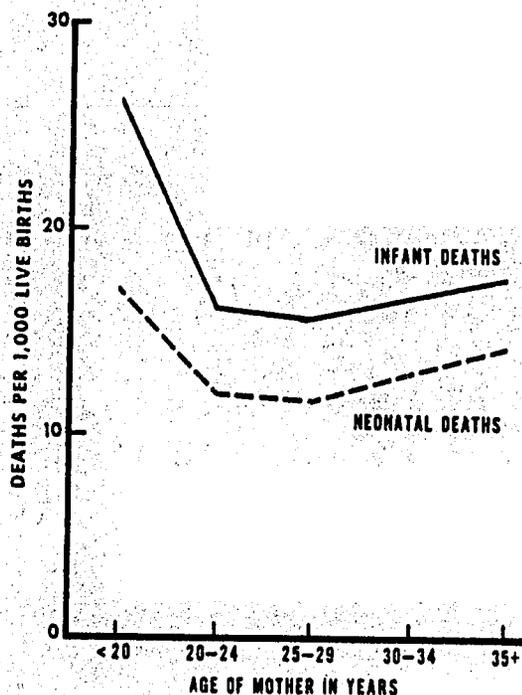
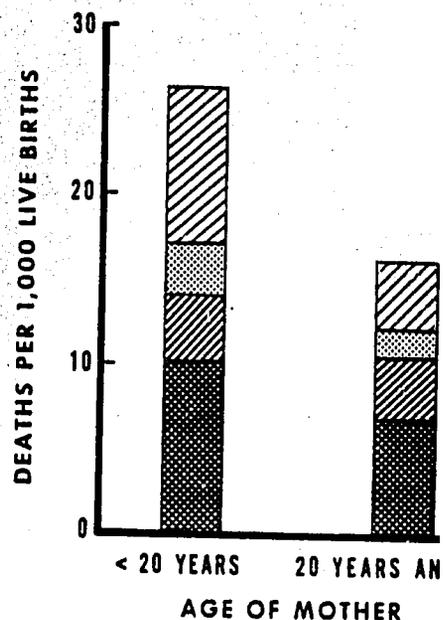


FIGURE 3—Infant mortality in the California Project, by the infant's age at death and the mother's age when it was born.



The death rate in the first day of life for infants of young mothers (10.3 per 1,000 live births) was also higher than the combined rate of 6.7 for infants of mothers in the other age groups. These high death rates for infants of young mothers (Figure 3) are evidence that pregnancies of teenage girls pose a serious problem in terms of mortality. Obstetricians

and prenatal clinics should therefore devote special attention to these girls in order to help ensure the birth of healthy babies.

TABLE 2—Infant mortality in the California Project, by the infant's age at death and the age of the mother at the time it was born.

Infant's age at death	Total infant deaths		Age of mother			
			Under 20 years		20 years and over	
	No.	Rate ^a	No.	Rate ^a	No.	Rate ^a
Total	784	17.5	186	26.2	598	15.9
Neonatal deaths	570	12.7	122	17.2	448	11.9
< 1 day	327	7.3	73	10.3	254	6.7
1-6 days	169	3.8	28	3.9	141	3.7
7-27 days	74	1.7	21	3.0	53	1.4
Postneonatal deaths	214	4.8	64	9.0	150	4.0

^aDeaths per 1,000 live births.

TABLE 3—Mortality during the first day of life in the California Project, by birth weight and mother's age.

Birth-weight ^a	Total		Age of mother			
	No.	Rate ^b	Under 20 years		20 years and over	
			No.	Rate ^b	No.	Rate ^b
Total	327	7.3	73	10.3	254	6.7
1,000 g or less	145	3.2	40	5.6	105	2.8
1,001-1,500 g	73	1.6	19	2.7	54	1.4
1,501-2,000 g	30	0.7	6	0.8	24	0.6
2,001-2,500 g	32	0.7	4	0.6	28	0.7
2,500 g or less	280	6.3	69	9.7	211	5.6
2,501-3,000 g	26	0.6	2	0.3	24	0.6
3,001-3,500 g	12	0.3	2	0.3	10	0.3
3,501-4,000 g	5	0.1	—	—	5	0.1
4,001 g and over	4	0.1	—	—	4	0.1
2,501 g and over	47	1.1	4	0.6	43	1.1

^aIn cases where birth-weight was not stated, this weight was estimated.

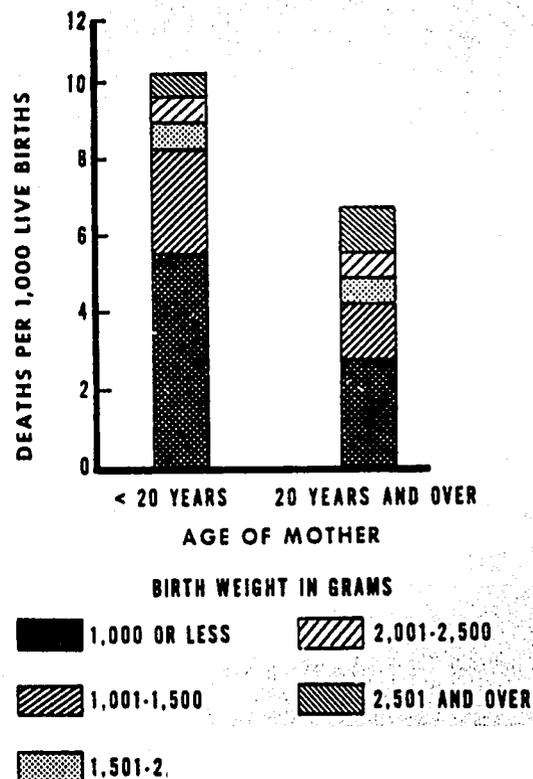
^bDeaths per 1,000 live births.

This excessive mortality in the first day of life may be due to more frequent and severe cases of immaturity among the newborn. Table 3 provides information about mortality in the first day of life, by birth-weight, for infants of young mothers and for those of mothers at least 20 years of age (the corresponding rates are shown graphically in Figure 4). The vast majority of babies that were born to young mothers and that died the first day had very low birth-weights; 59 out of 73 weighed 1,500 grams or less, and all but four weighed 2,500 grams or less and were immature.

All of this leads to the conclusion that young mothers are at great-risk of having low birth-weight babies who may die in the first day of life. Pregnancies of teenage girls thus present unique problems requiring special efforts to reduce the risks involved and to ensure the health of the babies.

The California study also found that infants of birth order five or higher ran the greatest risk of dying from perinatal causes during the neonatal period and infancy. This finding, along with those concerning young mothers, demonstrates the need for sex education and for family planning education and services.

FIGURE 4—Mortality in the first day of life, by birth-weight and mother's age, in the California Project.



Other Considerations

Congenital anomalies. Anencephaly and other malformations of the nervous system were observed to play a prominent role in those infant deaths associated with congenital anomalies. This was particularly true for infants born to mothers under 20 years of age and for infants of birth order five or more.

Outcome of previous pregnancies. In all, 27.4 per cent of the mothers of deceased infants and children in the California study reported having a previous fetal or infant death.

Mortality in preschool children. With regard to preschool children 1-4 years of age, the study found death rates of 0.8 per 1,000 in San Francisco and 0.7 per 1,000 in the three suburban counties. Accidents were the most frequent cause of death, followed by respiratory diseases. Leukemia and other malignant neoplasms began to play an important role in mortality among the children of this age group.

Comments and Recommendations

Compared with some Western European countries, infant and perinatal mortality rates in the United States still remain high; further significant reduction is essential. The following are among the steps which need to be taken: (1) The coverage of basic maternal and infant care health services should be extended to the entire population—urban, periurban, and rural. (2) All maternity patients should be screened to detect high-risk cases. (3) Special health services should be established for high-risk maternity patients and their infants. (4) Regional perinatal centers should be established in hospitals. (5) The quantity and quality of autopsies should be improved. (6) Followup services should be provided for high-risk infants after they leave the hospital. And (7) a joint obstetric-pediatric review of all perinatal deaths in every community should be conducted.

Certain general measures are also indicated.

These include improving the level of general education for the whole population, including that of the girls who will be future mothers and child-rearers; raising the nutritional status of the population; creating better housing and environmental conditions; improving the socio-economic status of the people; and making family planning and abortion services widely available.

The high mortality of infants born to mothers under 20 years of age shows that both these mothers and their infants are at very high risk. Clearly, there is need to put a variety of preventive measures into effect. The nutritional status of girls should be improved; they should be given health education about themselves and their present or future babies, as well as instruction on nutrition and the importance of family planning; prenatal care and family planning services should be provided for all, especially for teenagers; young mothers should receive guidance about infant feeding and the weaning process; and emphasis should be placed on the importance of breast-feeding.

This study provided an unusual opportunity for the University of California School of Public Health, its Berkeley faculty, and its students to investigate an important common problem (infant and early childhood mortality) with colleagues conducting 14 similar projects in nine other countries. The problem has major public health implications for nations of the Western Hemisphere.

The California Project has yielded important findings—especially those showing the high rates of death among infants and young children born to young mothers. The Project should therefore be continued. It is also hoped that the Pan American Health Organization will be able to continue sponsoring similar joint studies on this and other phases of maternal and child health, including phases relating to fertility. Highlights of the overall PAHO study were presented at the International Congress of Pediatrics in Buenos Aires in October 1974.

ACKNOWLEDGMENTS

The helpful suggestions of Dr. Ruth R. Puffer, Principal Investigator of the Inter-American Investigation of Mortality in Childhood, are gratefully acknowledged.

SUMMARY

The California Project of the Inter-American Investigation of Mortality in Childhood was carried out in San Francisco and three surrounding counties in 1969 and 1970. The study found infant death rates of 18.5 per 1,000 live births in San Francisco and 17.2 per 1,000 live births in the three counties. Mortality in the neonatal period (the first 28 days of life) accounted for two-thirds of these deaths.

Low birth-weight played a key role in neonatal mortality, one that was particularly marked during the first day of life. Overall, the study found that 77.7 per cent of the neonatal fatalities and 85.6 per cent of those dying in the first day of life weighed 2,500 grams or less at birth.

Mortality was also very high among infants

of mothers under 20 and over 34 years of age, the risks being especially great in the case of young mothers. Moreover, the vast majority of babies that were born to young mothers and died the first day had very low birth-weights.

It is therefore concluded that young mothers ran a relatively high risk of having low birth-weight babies prone to dying in the first day of life. This demonstrates a clear need for special measures capable of reducing the health risks faced by both young mothers and their children. Besides providing a more detailed explanation of these points, the authors recommend various specific measures that should be taken and present data obtained by the California Project on other aspects of mortality among infants and preschool children 1-4 years of age.

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