Secular Trend in Neonatal Mortality in the Mountain States

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ABSTRACT Reviewing trends in neonatal mortality from 1957 to 1967, it is clear that neonatal and infant mortality has declined faster in the mountain states than in the low altitude states. Accordingly, the increased neonatal and infant mortality at high altitudes or in the mountain states cannot be attributed to high altitude hypoxia alone. Furthermore, the decline in neonatal mortality in the mountain states has not been accompanied by a decrease in the frequency of low birth weight (below 2500 gm) and is therefore not a product of increasing body size in the neonate.

From previous investigations, both in the United States and abroad, it is known that the frequency of low birth weights (less than 2500 gm) and neonatal mortality of high altitude populations is markedly greater than those at sea level (Vilchez, '54; Lichty et al., '57; Howard et al., '57; Jara, '61; James, '66; Chabes et al., '66; Heer, '67). Studies on the USA and those on Peru suggest that the reduction in birth weight is a response to the stress of high altitude hypoxia independent of socioeconomic factors (Lichty et al., '57; Howard et al., '57; Grahn and Kratchman, '63; McClung, '67; Frisancho, '70). However, it is not known whether the same principle is applicable in explaining the increased neonatal and infant mortality of high altitude populations. With this purpose in view, we have analyzed the trends from 1957 to 1967 for birth weight, neonatal and infant mortality in both the high altitude mountain states and at low altitudes.

MATERIALS AND METHODS

Neonatal mortality (deaths during the first 28 days after birth per 1,000 live births) from 1957 to 1967 was tabulated by states (U. S. Department of Health, Education and Welfare, '62–'68). In addition, data on infant mortality (deaths under 1 year per 1,000 live births) from 1957 to 1967 were obtained from published reports (Wegman, '58–'68). Percentage of live births of 2500 grams or less was calculated by state (U. S. Department of Health, Education and Welfare, '62–'68). These data due to unavailable information, were limited to the period of 1960 to 1966.

Throughout the analysis, both the data on birth weights and neonatal and infant mortality were tabulated by state and then divided into mountain and low altitude states. The high altitude mountain group included Arizona, Colorado, Wyoming, New Mexico, and Nevada. The low altitude group included the states of Illinois and Indiana. The mean altitude for the mountain states was 5,000 feet, as compared to 630 feet for the low altitude states. These states were chosen because of their completeness of information and good medical facilities and also to make our results comparable to those of Grahn and Kratchman ('63).

RESULTS

As shown in table 1 and figure 1, from 1957 to 1967 the neonatal mortality in the high altitude mountain states has declined at a rate of 0.43 per year, while at the low altitudes there has been no change. In other words, in 1957 the mountain states had a neonatal death rate of 21.7 as compared to 18.0 in the low altitude states. Thereafter, in the mountain states there has been a definite decline so that by 1967 the neonatal mortality rate is equal to 17.7, a value which is essentially the same as that of the low altitude states.

The decline in infant mortality rate in the mountain states follows the same trend

TABLE 1

Mean neonatal mortality, infant mortality, and percentage of birth weights of 2,500 gm or less in the mountain and low altitude states

States	Year										
	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Mountain											
Neonatal mortality	21.5	20.6	21.4	20.2	20.1	19.5	19.7	18.6	16.9	17.7	17.7
Infant mortality	33.0	32.9	32.5	30.6	29.2	28.3	28.3	26.8	24.5	25.8	22.5
Percent birth weight 2,500 gm or less	—	—	—	10.0	10.1	10.3	10.1	10.1	10.0	10.4	—
Low altitude											
Neonatal mortality	17.9	18.0	17.6	17.8	17.7	17.6	17.7	18.1	18.1	17.9	—
Infant mortality	24.5	24.8	24.2	24.5	24.2	23.2	24.0	23.8	24.3	23.8	22.6
Percent birth weight 2,500 gm or less	—	—	—	7.3	6.6	7.5	7.7	7.8	7.9	8.0	—

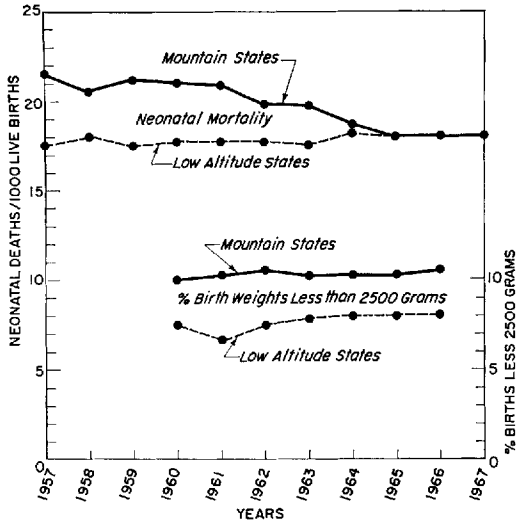

Fig. 1 Secular trend in neonatal mortality in the mountain and low altitude states. Note that the neonatal mortality rate from 1957 to 1967 in the high altitude mountain states has declined at a faster rate than in the low altitude states so that by 1967, both high altitude and low altitude states have essentially the same values. This occurs without a change in the frequency of low birth weights.

as that of the neonatal death rate. Throughout 1957 to 1967, infant mortality has declined from a high value of 33.0 in 1957 to 22.5 in 1967. In the low altitudes, infant mortality has declined slightly from a value of 24.5 in 1957 to 22.6 in 1967.

As summarized in table 2, both the neonatal and infant mortality in the mountain states exhibit a significant negative correlation with years ($p < 0.01$). In contrast,

TABLE 2

Decrease in neonatal and infant mortality from 1957 to 1967

States	Year (1957–1967) r
Mountain States	
Neonatal mortality	−0.93
Infant mortality	−0.98
Low altitude states	
Neonatal mortality	0.28
Infant mortality	−0.71

in the low altitude states, neonatal death rate exhibits little change through years, while the infant mortaity rate shows a moderate negative relationship with years ($p < 0.05$).

Table 1 and figure 1 also show the frequency of live birth weights of 2,500 gm or less in the mountain states and low altitude states. It is evident that throughout 1960 to 1966 the frequency of immature birth weights in the mountain states has been maintained above 10.0 while in the low altitude states this value is below 8.0. In other words, there is no trend toward heavier weights at either high altitude or sea level.

DISCUSSION

The neonatal and infant mortality in the mountain states from 1957 to 1967 have declined at a markedly faster rate than in the low altitude states. These indications suggest that the increased neonatal mortality of the mountain states in the 1950's, as reported by previous investigators (Grahn and Kratchman, '63), probably reflected the limited medical facilities and

poor socioeconomic conditions, rather than the direct effects of high altitude hypoxia alone. The frequency of low birth weight neonates between 1960 and 1966 has remained unchanged in the mountain and low altitude states. This would suggest that the decrease in neonatal mortality in the mountain states is not a product of increasing body size in the neonate. It is quite possible that the changing patterns of population might be favoring delivery of medical care in the mountain states, as might improvement in transportation facilities and medical care in general. On the other hand, the large influx of Negroes, Indians and Spanish-Americans from the mountain states into the cities of Illinois and Indiana during the late fifties might be weighting the statistics for these states toward increased infant mortalities, since this immigration may have outrun the existing medical facilities in many cities. In any event, the neonatal and infant mortality in the mountain states as of 1967 is undistinguishable from those in the low altitude states.

The extent to which the present findings are applicable to those reported from South American countries is obvious. It has been indicated that the neonatal mortality is much greater in the highlands than in the lowlands of Peru, Bolivia and Ecuador (Mazess, '65; James, '66; Heer, '67). Taking into account that in these three countries general medical facilities and socioeconomic conditions are poorer at high altitudes than at the coastal sea level areas, the increased neonatal mortality at high altitudes probably reflects these factors rather than the direct effect of high altitude hypoxia alone (James, '66; Heer, '67; Mazess, '65). All these indications suggest that when interpreting differences in neonatal mortality rate, all possible factors must be explored before a single cause-effect relationship is established.

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LITERATURE CITED

Chabes, A., A. Mayorga and H. Rendon 1966 "Pesos de la placenta y el recien nacido a diferentes altitudes." In: Actas de la Cuarta Conferencia de Anatomia Patalogica (Jan., '65), Establecimientos Graficos La Colmena, Arequipa, Peru.

Frisancho, A. R. 1970 Developmental responses to high altitude hypoxia. Am. J. Phys. Anthrop., *32*: 401–408.

Grahn, D., and J. Kratchman 1963 Variation in neonatal death rate and birth weight in the United States and possible relations to environmental radiation, geology and altitude. Am. J. Hum. Genet., *15*: 329–352.

Heer, D. M. 1967 Fertility differences in Andean countries: A reply to W. H. James. Population Studies, *21*: 71–73.

Howard, R. C., J. A. Lichty and P. D. Bruns 1957 Studies of babies born at high altitude. II. Measurement of birth weight, body length and head size. Am. J. Dis. Child., *93*: 670–674.

Jara Velarde, J. A. 1961 Evaluación y somatometría del recien nacido, estudio comparativo. Thesis de Bachillerato, Universidad Nacional Mayor de San Marcos, Facultad de Medicina, Lima, Perú.

James, W. H. 1966 The effects of altitude on fertility in Andean countries. Population Studies, *20*: 97–101.

Lichty, J. A., R. Y. Ting, P. D. Bruns and E. Dyar 1957 Studies of babies born at high altitudes: I. Relation of altitude to birth weight. Am. J. Dis. Child., *93*: 666–669.

Mazess, R. B. 1965 Neonatal mortality and altitude in Peru. Am. J. Phys. Anthrop., *23*: 209–213.

McClung, J. P. 1967 Effects of high altitude on human birth: observations on mothers, placentas, and the newborn in two Peruvian populations. B. A. Thesis, Radcliffe College, Cambridge, Massachusetts.

U. S. Department of Health, Education and Welfare 1962–1964, 1966–1968 Vital Statistics for 1960; . . . 1961; . . . 1962; . . . 1963–1964; . . . 1965; . . . 1966–67. U. S. Government Printing Office, Washington.

Vilchez, H. 1954 Caracteres fisicos de la placenta y el cordon en nuestro medio. Thesis de Bachillerato. Universidad Nacional Mayor de San Marcos, Facultad de Medicina, Lima, Peru.

Wegman, M. E. 1958–1968 Annual Summary of Vital Statistics; 1957 thru 1967. Pediatrics; 22: 1189–1192, 24: 1108–1111, 26: 1018–1121, 29: 324–327, 30: 1000–1004, 32: 1102–1105, 35: 142–145, 36: 951–955, 38: 1063–1067, 40: 1035–1045, 42: 1005–1008.