Numerical Estimation of the Effect of Environmental Factors and Public Sanitary Measures

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The rate of infant mortality has been the subject of analyses for many decades in all advanced countries, since it is generally believed to reflect social, economic, cultural conditions, and quite particularly the level of maternity and infant welfare. Indices of infantile mortality admit of inferences regarding the expectations, the mental and physical development of the survivors. Such estimations, however, often lead to erroneous results. Utterly different social, hygienic and cultural conditions may be in the background of identical statistical results, while despite similar conditions of life and similar conditions regarding mother and infant care the rates of infant mortality may widely differ. It sometimes happens that the mortality rate is higher in hygienically better organized populations. Statistical data concerning infant mortality should, therefore, be evaluated with due criticism.

The rate of infant mortality in 1961 amounted to 4.24 per cent in Budapest against 2.97 in Dresden which would justify the inference that environmental conditions in the latter city were superior. The numerical estimation of life conditions and public hygiene cannot, however, be correct unless statistical data refer to a possibly homogeneous population. A population consisting of all newborn infants is by no means homogeneous since it includes babies with a birth weight below 1000 g with a mortality rate of about 95 per cent, and at the same time, mature babies whose mortality rate in advanced countries amounts to less than 1 per cent. The percentage of deaths occurring in the first year of life among mature infants with a birth weight exceeding 2500 g is much more suitable for inferences because the population composed of such infants is considerably less heterogenous. The percentage of mature infants who died in the first year of life amounted to 1.64 per cent in Dresden and to 1.12 per cent in Budapest. The situation in this respect was, thus, rather paradoxical: the overall rate of infant mortality was considerably higher and the percentage loss of mature babies lower in Budapest than in Dresden. Statistical data in this respect are assembled in Table I.

First year mortality rate in different weight groups of
mature infants in Dresden and Budapest 1961

Birth weight	Mortality rate in the first year of life (per mille)	
(g)	Dresden	Budapest
2500 — 2999	24.5	20.0
3000 — 3499	15.3	7.7
3500 — 3999	12.2	9.1
4000 — 4499	15.5	6.9
Above 4500	26.2	20.0
Mature infants	16.5	11.2
Overall infant mortality rate	29.7	42.4

It is seen from Table I, although the population of mature infants contains groups with mortality rates two or three times higher than those of other groups of the same population, babies with birth weights above 2500 g form, as regards life expectation, a more homogenous category than the total stock of newborn infants. Within the category of mature infants, the mortality rate in all weight groups in Budapest was lower than in Dresden.

Mortality rates of mature babies, arranged according to birth weight, offer a comparatively true picture of the level of infant care. These rates invariably increase under the influence of exogenous noxious factors such as influenza epidemics, widespread enteral infections, major calamities, social upheavals, etc. Changes in mortality among mature infants' groups according to weight categories as illustrated in Table II, show the development achieved in Hungary during the last 10 years.

While, out of a total of 1000 mature babies born in Hungary, 36.7 died in 1955, this figure was only 15.6 in 1965, so that the rate of mortality decreased by 57.5 per cent in 11 years. This rate is particularly striking if it is borne in mind that the corresponding decrease of mortality among all newborn infants amounted to not more than 35.3 per cent. Improvement of life conditions and the development of maternity and infant welfare measures yielded, thus, much better results of survival among mature babies than in the general infant population.

That the figures of mortality among mature infants, arranged according to weight groups, offer a reliable index of peristatic factors, is evidenced by Table III.

The rate of mortality among all newborn babies of New York was lowest in the weight group 3500—3999 g as regards white infants, and in the weight group 3000—3999 g as regards coloured ones.

TABLE II

First year mortality rate in different weight groups of mature infants
in Hungary 1955—1965

Birth weight (g)	1955	1956	1957	1958	1959	1960 1961 per mille		1962	1963	1964	1965
2500—2999	55.0	52.5	51.8	50.0	43.6	36.8	33.8	35.2	28.7	26.1	23.1
3000—3499	33.1	30.8	32.6	30.7	24.8	22.9	18.4	20.8	16.3	15.6	13.2
3500—3999	30.3	29.3	32.5	29.3	23.9	19.7	17.3	18.5	15.6	13.5	12.2
4000—4499	29.2	24.8	28.9	27.3	25.2	19.6	17.1	17.1	15.9	11.5	12.2
Above 4500	56.4	44.7	67.2	62.9	55.5	48.2	35.7	48.8	51.4	31.4	20.8
Mature infants	36.7	34.7	36.9	34.8	29.4	25.5	22.1	24.1	19.6	17.8	15.6
Overall infant mortality rate	60.0	58.8	63.1	58.1	52.4	47.6	44.1	47.9	42.9	40.0	38.8

The mortality rates were, as can be seen from Table III, higher in all weight groups of the coloured babies, this excess being least marked in the lowest weight category of mature infants. The situation was the opposite in the category of prematures (not shown in the Table). Mortality rate was lower among coloured babies in all groups below 2000 g birth weight, and the same as among white babies in the weight group 2000—2499 g. The figures indicating mortality among mature infants can only be regarded as true reflections of the difference between the white and the coloured as regards conditions of life and sanitary care. The fact that the mortality rate of coloured prematures was lower than the corresponding figure for white infants has given food for numerous disputes.

TABLE III

First year mortality rate in different weight groups
of mature infants in New York City, 1959

Birth weight (g)	Number of deaths within a year, referred to 1000 live births in the corresponding weight groups		
	Total	White	Coloured
2500—2999	15.7	15.0	17.9
3000—3499	9.7	8.7	13.8
3500—3999	8.5	7.6	13.6
4000—4499	9.9	9.0	16.0
4500—4999	12.5	8.9	38.0
Above 5000	73.6	58.8	148.1
Overall infant mortality rate	26.5	22.1	43.5

Data from Baumgartner 's paper. [5]

The higher mortality rate of the coloured infants is caused partly by their higher mortality rates within the full term categories, partly by the fact that 13 to 14 per cent of their live borns has a birth-weight less than 2500. g.

A survey of statistics regarding infantile mortality in Hungary, Czechoslovakia and Budapest makes it clear that, during more than 10 years, the lowest mortality rate did in no instance occur in the weight group 3000—3499 g, although this group shows the highest quota of live births (39.5 to 40.2%). The lowest death rate in the first year of life was always in the weight groups 3500—3999 or 4000—4499 g. Statistical data from Dresden and New York reveal a similar situation. That life expecta-tion is not the most promising in the most numerous and supposedly most physiological but in a considerably less populous and supposedly less desirable higher weight groups, is a peculiar — so far not sufficiently elucidated — biological phenomenon. It is in any case evident that the mortality rate in the weight groups between 3000 and 4500 g (which represented 64 to 75 per cent of live births) was invariably lower than that in any other group. As regards now dynamics of mortality in the various groups from the point of view of maturity, Table IV presents statistical data for Hungary, Budapest, and Czechoslovakia, concerning mortality among prematures, mature infants, and babies with birth weights between 3000 and 4500 g.

TABLE IV

Mortality rate of prematures, mature babies, and infants with birth weights of 3000—4499 g. referred to 1000 live births in the corresponding weight groups, in Hungary, Budapest, and Czechoslovakia, 1955—1963

Year	Prematures			Matures			3000—4499 g		
	Hungary	Budapest	Czechoslovakia	Hungary	Budapest	Czechoslovakia	Hungary	Budapest	Czechoslovakia
1955	318.4	305.4	237.3	36.7	26.2	22.5	31.7	23.1	19.4
1956	311.1	276.6	216.3	34.7	25.3	20.7	29.7	22.1	17.9
1957	320.0	297.6	211.7	36.9	22.4	22.7	32.2	19.5	19.6
1958	297.9	284.1	198.4	34.8	19.8	19.6	29.9	16.6	16.8
1959	285.1	273.1	182.7	29.4	19.1	16.3	24.6	13.9	13.9
1960	257.3	277.5	177.0	25.5	16.2	16.9	21.6	14.5	11.4
1961	242.2	282.3	160.8	22.1	11.2	13.3	17.9	8.1	11.1
1962	253.1	277.7	175.0	24.1	12.5	13.4	19.8	9.8	11.2
1963	240.1	254.6	173.8	19.6	11.5	12.7	16.0	8.0	10.6
Decrease (1955 = = 100)	24.6	16.6	26.8	46.6	56.1	43.6	49.5	65.4	45.4

It is evident that mortality among premature infants was many times higher than among mature babies, and that improvement along the years was less marked than in the mature category. The mortality rate of mature infants in Hungary decreased by 46.6 per cent against 24.6 per cent in the immature category. The corresponding figures for Budapest are still more striking: 56.1 against 16.6 per cent. While mortality among mature babies can considerably be reduced in a short time by the improvement of conditions and the development of sanitary organization, a reduction of mortality among prematures is a much more complicated and medically more difficult problem. A slight shift of the births towards the immature category may obscure the beneficial effects of hygienic and administrative efforts. Although much has been done in Budapest during the last 10 years in order to reduce mortality among prematures, its rate is still higher here than in the country, the respective figures for 1964 being 25.21 and 22.33 per cent. Mortality among mature infants, on the other hand, shows the superiority of infant care in Budapest; while in 1964 among 1000 mature babies 10.6 died in the first year of life, the corresponding figure for the province amounted to 18.7. It is evident from Table IV that not only the mortality rate was lowest in the weight group 3000—4499 g but also the rate of decrease was the highest in this group.

Between 1960 and 1962, the figures of overall infant mortality and of the mortality of full-term babies of weight group 3000—4499 g were widely discrepant in the various districts of Budapest. Overall infant mortality was 3.47 per cent in the X, 4.01 per cent in the IX, and 5.19 per cent in the III district, while the corresponding figures in respect of mortality in the weight group 3000—4499 g were 1.15, 1.10, and 1.03 per cent, respectively. Considering that economic, cultural conditions, and maternity and infant care are more or less identical over the entire town, the differences between the various districts regarding overall infantile mortality are striking. Figures for mortality in the weight group 3000—4499 g are, on the other hand, fairly uniform and reflect existing conditions more reliably.

Data for 1965 received from the various counties and towns of county rank show that the rate of overall infant mortality was 4.18 per cent in Borsod county and 3.48 per cent in Hajdu county, while the corresponding figures for the weight group 3000—4499 g were but slightly different from one another (1.63 and 1.53 per cent, respectively). Infantile mortality rate was 3.03 per cent in Szolnok county, and 4.41 per cent in Budapest. Mortality in the weight group 3000—4499 g, however, shows that global rates are misleading. While mortality rate in this group was 1.11 per cent in Szolnok county, it amounted to 0.78 in Budapest. It is worthy of note that the 1.11 per cent mortality rate of full term-

infants in Szolnok county for 1965 is fairly near to the rates of the III, IX and X districts of Budapest for 1960—1962, a proof of the satisfactory results achieved by the county in question which had to overcome much graver difficulties than the capital. That the rate of infant mortality amounted to 4.01 per cent in the IX and to 5.19 per cent in the III district of Budapest, was due to endogenous factors.

At the same time, each weight group includes infants of very different expectations for development and each category covers a wide range of individual variations. And yet, as regards mortality, each represents a fairly homogenous and closed group.

To sum up, it is safe to state that out of the entire newborn population it is the weight group 3000—4499 g which starts life with the most promising prospects of growth, physical and mental development. It is in this group that the general improvement of life conditions and the development of infant care produce the most conspicuous results, consequently that conclusions regarding economic, social, cultural and hygienic conditions should be based on the rate of deaths occurring in the first year of life among babies with birth weights between 3000 and 4499 g. Their rate of deaths occurring in the first week of extrauterine life is the index of the efficiency of perinatal hygienic and medical measures, while that of deaths during the remaining 51 weeks is a good index of conditions concern-

ing the care and medical treatment of infants.

In 1964, the mortality rate of the weight groups 3000—4499 g was 1.46 per cent in Hungary, but only 0.84 in Budapest; it shows the superiority of the capital's welfare measures which could not be inferred to from the rate of overall infantile mortality. Overall Hungarian mortality rate was 0.41 per cent in respect of the first six days of life and 1.05 per cent in that of the following 359 days. The corresponding figures for Budapest were 0.28 and 0.56 per cent, respectively. These data show the effect of the capital's superior hygienic conditions during both the first and the following days of life. In 1965 the undivided mortality rate for the whole first year of life amounted to 1.29 per cent for Hungary and 0.78 per cent for the capital.

A comparison of the overall mortality rates (i.e. for all weight groups) yields a different result. They amounted in 1964 to 4.0 per cent in respect of the whole country and to 4.07 per cent in that of the capital. The corresponding figures for 1965 were 3.88 and 4.41 per cent so that these figures fail to illustrate the superiority of the capital as regards conditions of life and sanitary organization.

That reliable conclusions should be based on figures concerning mortality in the weight group 3000—4499 g is, to a certain extent, in harmony with the principle followed by statisticians that exogenous causes of deaths have to be distinguished from

endogenous ones. While external factors — hygienic measures in the first place — are suitable for counteracting the effect of exogenous damages, the prevention and neutralization of harmful endogenous factors is a quite different and considerably more difficult task. That this is so is strikingly illustrated by the great difference between normal and immature infants in the matter of mortality and the way it can be influenced. Sharp differentiation between fatal endogenous and exogenous factors is but exceptionally possible. Pathological phenomena are mostly rooted in congenital disposition and developed by environmental factors, while endogenous factors mostly become fatal by association with external damaging elements. The present study had the object to suggest a method for estimating the quality and effect of the exogenous factors making thus possible to obtain a clear picture of the effect of one of the two groups that form the whole complex. Investigations into the role played by endogenous factors in the mortality of premature and immature infants are in progress.

SUMMARY

Infant mortality rate conveys but an approximate picture of the effect of environmental conditions and public health measures on the health of the infant population in a given area. Conclusions drawn in this respect should be based on the rate of deaths occurring in the first year of life among babies with birth weights between 3000 and 4500 g. Statistical data are adduced to prove the value and practicability of the suggested index. In order to compute this index it is necessary to know the number of live births and deaths in the said weight group. The percentage of babies who die in the first year of life is always and everywhere lowest in the weight group 3000—4500 g. The usefulness of the suggested index is increased by the fact that it is the mortality rate of this weight group which responds most readily to the improvement of the general conditions of life and the development of health care.

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