CAUSES OF INFANT MORTALITY IN CHINA: 1988-1990

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ABSTRACT

Using the data for infant mortality in China in 1988-1990 from the World Health Organization, this paper offers a preliminary examination of causes of infant mortality in China during the period from 1988 to 1990. The major findings of the study are 1) the pattern of Chinese infant mortality is generally consistent with that of most developing countries; 2) diseases of the respiratory system, perinatal mortality and accidents as well as injuries consist of the 3 major categories which all together account for about 80 to 90 percent of overall infant mortality rates; 3) rural infants still die at a higher rate than urban infants; and 4) no significant gender discrepancy exists between male and female infant deaths the different causes. The study shows although Chinese infant mortality rates have declined dramatically during the last few decades, the infant mortality patterns still resemble those in less developed nations. Hence, there is room for improvement in sanitary conditions and public health measures, for economic development and higher living standards, and for advance in medical technology.

INTRODUCTION

Since 1960, worldwide infant mortality has fallen from 130 to 60 per 1,000 live births and child mortality has fallen from 180 to 80 per 1,000 live births. The number of countries with an infant mortality rate of below 50 per 1,000 live births has risen from 77 (with a total population of 1.3 billion) in 1980 to 103 (with a total population of 3.2 billion) in 1995 (United Nations World Health Report 1996). In 1978, the Alma Ata Conference declared its goal of "health for all by the year 2000". The conference aroused worldwide interest in primary health care programs and infant and child mortality control programs. Subsequent programs have been developed to emphasize preventive rather than curative health care. Nevertheless, the last decade or so saw stagnation in mortality decline (United Nations 1980). Yaukey (1985) points out that although there was a marked decrease in infant mortality rates over the last few decades, the amount of absolute decrease in the rate was not generally most precipitous where the rate had been the highest.

> In other words, infant mortality may be declining across the board, but gaps in infant mortality among the LDR's [less-developed regions] are not necessarily closing. Indeed, the *percentage* decline of infant mortality generally was less in the highest-mortality areas than it was in either the moderate-mortality LDR's or in the MDR's [more-developed regions]. (Yaukey 1985)

Vast differences which exist between the developed and developing world have been documented. In developed nations the infant mortality rate was only 6.9 per 1,000 live births in 1995, compared to 106.2 infant deaths per 1,000 live births in the developing world. According to the World Health Organization (1996), more than 17 million of the 52 million deaths in 1995 were due to infectious diseases. And of more than 11 million deaths among children under 5 in the developing world, about 9 million were attributed to infectious diseases, 25 percent of them preventable through vaccination. In Africa, more than 40 percent of all deaths were among children under 5.

> Despite the data limitations, it is clear that infectious and parasitic diseases—which have largely been eliminated in the more developed countries—still account for a very large proportion of all deaths in developing countries, especially among the very young (United Nations 1980).

China is a developing country with a per capita income of US $530 in 1994 (Population Reference Bureau 1996). However, China has one of the lowest infant mortality rates among the developing countries in the world. While the average infant mortality rate among the low-income developing countries (excluding China) was 73 deaths per 1,000 live births in 1996, the rate in China was about 44 infant deaths per 1,000 live births (Population Reference Bureau 1996). Clearly China has succeeded in producing a dramatic drop in infant and child mortality rates since 1949.

> Until then [1949] periodic epidemics, including plagues, cholera, and smallpox, raged across the country. Infectious and parasitic diseases such as tetanus and malaria, respiratory diseases like pneumonia and tuberculosis, and gastro-intestinal infections were widespread. As a result of a sustained health campaign that included preventive services—the renowned 'barefoot doctors' scheme—immunization, and nutrition improvement programmes, China has

> been able to register within the short period of thirty years an 'epidemiological revolution'. (D'Souza 1989)

Additionally, according to D'Souza (1989), the large drops in infant and child mortality rates in China have been accompanied by changes in mortality patterns. D'Souza (1989) used data from Beijing to show that during the period 1956-59 respiratory and communicable diseases ranked highest among the causes of death (over 40%), whereas in the period 1974-78 cardiovascular diseases (over 51%) were the most important reported causes of death (World Bank 1984). Looking at the pattern of infant mortality rates in China today, however, one can see that similar to those infants in many other developing countries, Chinese infants still die mainly from infectious and parasitic diseases, perinatal mortality, diseases of the respiratory system, congenital anomalies, and accidents as well as injuries. *In other words, although the level of infant mortality rates has dropped dramatically, the infant mortality patterns in China still resemble those in the less developed nations.*

RESEARCH ON CAUSE OF DEATH

People die generally from three major causes: 1) they die from degenerate diseases; 2) they die from diseases they contracted from someone else (communicable diseases); and 3) they die from unnatural causes such as accidents, homicides, and natural disasters, all of which are the products of the social, economic and physical environment (Weeks 1992). Degeneration refers to the biological deterioration of a body. Deterioration tends to be a gradual process. Among the three major causes of death, degeneration is the least preventable. Communicable diseases, on the other hand, are preventable to a larger extend. Access to medical technology, good sanitation and personal hygiene can greatly reduce mortality resulting from communicable diseases greatly. Researchers have found that the control of communicable diseases has been the major factor for the declining mortality rates throughout the world. In most low-income developing countries, however, high mortality rates resulting primarily from communicable diseases continue to prevail. And a major factor accounting for these differences in mortality rates is infant mortality. For instance, in India, a child has more than a 10 percent chance of dying in the first year of life, compared with a 4 percent chance in Malaysia (Weeks 1992). Deaths from accidents, suicide and homicide are largely the products of one's social and economic environment. Even deaths due to natural phenomena such as floods, tornadoes, avalanches, earthquakes, and other disasters can be attributed to human risk taking (Weeks 1992). Therefore, deaths that result from both communicable diseases and accidents reflect more than just the immediate—*or proximate*—cause of death. They also reflect the *underlying* social, economic and political conditions of a society. In order to reduce the mortality which result from these above causes, accessibility of preventative methods and changes in social and economic conditions are a must.

> If these diseases deaths [deaths from communicable diseases] are added to the deaths either caused by or associated with nutritional deficiencies, the proportion rises to a sizeable majority of all deaths. The number of deaths from the above causes can be reduced dramatically at relatively modest costs, and most of them must be characterized as preventable. (United Nations 1980)

While access to medical technology, good sanitation and personal hygiene can contribute to the reduction in mortality, the long-term impact of such programs on mortality levels may not be very great without improvements in the social and health environment, rising income levels and higher living standards, and other social reforms such as improving working conditions, reducing child labor, and rising minimum housing standards.

Bourgeois-Pichat (1978) linked mortality levels and causes of death in his study. He proposed two broad classes of causes of death, endogenous and exogenous. He described these two classes as "hard rock" and "soft rock". Bourgeois-Pichat argued that the exogenous causes of death can be controlled by public health measures, immunization, antibiotics, and improved social and physical conditions. This is like erosion of soft rock. The declining percentage of deaths from infectious diseases amongst deaths from all causes provided evidence of this phenomenon. "Hard rock" diseases or endogenous causes of death refer to diseases such as cancer and diseases of the circulatory system, or diseases of degeneration. Reduction in deaths from these diseases require more than just the improvement

in social and physical environment; it also requires advancement in medicine and technology.

Taucher (1978) used a grouping of causes of death by degree of avoidability to investigate the contribution of each group in the period 1955-1956 to 1974-1975 in the case of Chile. She proposed a two-tiered classification of causes of mortality according to their degree of avoidability consistent with current medical technology. Among the avoidable causes, Taucher found that infectious and parasitic diseases were mostly avoidable by the improvement of environmental sanitary conditions; accidents and injuries were most avoidable by mixed actions such as the improvement in social and physical environment, prevention and medical technology; while most non-avoidable deaths were the result of degenerative origin and tumors. However, critics may argue that deaths may be avoidable in one country, but not so in another (D'Souza 1989). D'Souza argued that in many low-income developing countries, preventative means may not be readily available. Hence, absolute criteria for determining preventable deaths do not exist and relative considerations have to be adopted. "Considerations of cost and feasibility of preventing deaths from particular causes within realistic country settings are also important" (D'Souza 1989). It is perhaps more accurate to use the term of "theoretically preventable diseases" (Castillo, Folis, Mardonis 1983).

The analysis of the relation between age-standardized rates by causes and age-standardized mortality rates was first carried out in UN *Population Bulletin*, No. 6 (UN 1963), where the existence of a strong relation between the general level of mortality and the causal structure of mortality was established. Preston (1976) extended the model with the aim of determining typical patterns of mortality structure and explaining regional and temporal differences in the causal structure of mortality. Cause-of-death rates from 165 countries were examined and tabulated. These populations were from Northern and Western Europe, Southern and Eastern Europe, overseas European populations, and Africa, Asia, and Latin America (D'Souza 1989). Death rates were age-standardized on the basis of standard populations. A linear model then was fitted to describe the association between particular causes of death and the overall death rate (Preston 1976). The causes of death were grouped into 11 categories. For each of the 11 causes, Preston proposed the following linear model

$$M_i = a_i + b_i * M$$

where the parameter b_i, which represents the slope of the regression line, M_i is the predicted death rate for the *ith* cause, M is the death rate for all causes combined, under the conditions that $a_i = 0$ and $b_i = 1.0$ (Espenshade 1973; Nicholson 1949).

For instance, Preston found that deaths from "influenza, pneumonia, and bronchitis" contribute about 25 percent to the overall mortality rate; those from "other infectious and parasitic diseases" account for 14 percent to the total death rate; those from "respiratory and tuberculosis" and "diarrhoeal" diseases contribute 10 percent to the overall mortality. However, critics have pointed out problems that arise from taking a population with an older age distribution as standard, since the overall mortality rate is dependent on the age structure of the population. Therefore, the use of an older population would imply more deaths from causes prevalent at older ages (Lopez, Hull 1982).

Application of Preston's cause-of-death model was made for Latin America by Palloni and Wyrik (1981), who considered data from 11 countries for several years (49 cases) and the same cause-of-death grouping used by Preston. Their study revealed that values of the regression coefficients b_i are very similar with those of Preston's. However, Palloni and Wyrik warned about the limitations of this kind of methodology: first, the slope of the regression line only considers the influence of a basic cause of death; it does not show the magnitude of its real contribution through its dependency on other causes of deaths. Secondly, only an estimate of the mean level of the contribution of one cause of death is obtained, but the heterogeneity of this process is left obscure (Chapckiel 1990).

Regional and sex differentials in infant mortality have been documented by a number of studies. In less-developed nations, female survivorship is actually superior to male through the first year of life (infancy). It is during the early childhood years (ages one through four) that the gap not only closes but in some countries male survivorship surpasses female. This implies, according to Yaukey (1985), inferior allocation of scarce survival resources

Table 1: Overall Mean Infant Mortality Rates* in China: 1988-1990

Cause of Death	1988 Mean	1989 Mean	1990 Mean
Infectious & Parasitic Diseases	252.00	284.00	189.75
Neoplasms	37.50	39.25	26.25
Endocrine, Nutritional & Metabolic Diseases	133.75	158.75	156.50
Diseases of Blood & Blood Forming Organs	23.25	26.25	19.50
Diseases of Nervous System & Sense Organs	60.25	53.25	58.75
Diseases of Circulatory System	19.00	25.50	15.50
Diseases of Respiratory System	1916.00	2142.50	1505.75
Diseases of Digestive System	320.25	326.00	252.50
Diseases of Genito-urinary System	2.00	4.00	2.75
Congenital Anomalies	844.75	1059.00	864.50
Certain Causes of Perinatal Mortality	2900.25	3451.75	2984.25
Leukemia	19.50	19.75	14.75
Injuries	628.00	679.75	507.25
Others	130.50	120.00	95.75

*The rates refer to number of deaths before age 1 per 100,000 live births.

to girl children. According to United Nations (1973), during the female reproductive ages, the female survivorship superiority again narrows and even reverses in some less-developed nations. The so-called "South Asian pattern" of sex differential in mortality indicates a higher female mortality rate than that of male in many rural places in India and Bangladesh, as well as in some other south Asian countries. Researchers have found that higher female mortality rates in childhood after the neonatal period resulted from preferential treatment of sons by family members in these countries (Basu 1989; Bhatia 1983; Chen, Huq, D'Souza 1981; Das Gupta 1987; Freed, Freed 1989; Miller 1981; Sen, Senqupta 1983). It has been found, for instance, that girls in these countries received less food, less medical care, and less clothing. Although most causes of death in the first year, especially the first month of an infant's life, may be due to either beyond families' immediate control (related to congenital malformation, birth trauma, etc.), or may not be due to sex-specific treatment of children. The exogenous factors that affect infants' survival cannot be underestimated.

This paper will address both the proximate and nonproximate causes of infant death in China during the period of 1988-1990. Then using Preston's linear regression, the relation between deaths from specific causes and the general level of mortality will be studied. Finally, differential mortality rates in terms of sex, urban and rural location during the period from 1988 to 1990 will be examined.

DATA AND METHODS

In *World Health Statistics Annual 1990* and *World Health Statistics Annual 1993*, the World Health Organization included comprehensive cause-of-death statistics for China (World Health Organization 1990, 1993). The data were compiled according to the ICD-9 and covered about 10 percent of the total Chinese population. Included in the data were 37 cities and 73 counties, most of which are located in the eastern half of the country where the majority of the population is to be found.

Infant deaths were grouped into 14 different categories. They are: 1) infectious and parasitic diseases; 2) neoplasms; 3) endocrine, nutritional and metabolic diseases; 4) diseases of blood and blood-forming organs; 5) diseases of the nervous system and sense organs; 6) diseases of the circulatory system; 7) diseases of the respiratory system; 8) diseases of the digestive system; 9) diseases of the genito-urinary system; 10) congenital anomalies; 11) certain causes of perinatal mortality; 12) leukemia; 13) accidents and injuries; and 14) ill-defined conditions.

In addition, the entire Chinese infant population was divided into four subgroups for each of the three years studied in this paper. They are: 1) urban male infants; 2) urban female infants; 3) rural male infants, and 4) rural female infants. The mean death rates for the four subgroups for each cause of death are presented in Table 1.

Table 2: Mean Infant Mortality Rates* for the Years from 1988 to 1990 for Male and Female Infants in Urban and Rural Areas in China

	Male		Female	
Cause of Death	**Urban**	**Rural**	**Urban**	**Rural**
Infectious & Parasitic Diseases	160.67	351.33	143.67	312.00
Neoplasms	43.33	33.33	34.33	26.33
Endocrine, Nutritional & Metabolic Diseases	56.67	187.33	86.67	268.00
Diseases of Blood & Blood Forming Organs	25.33	30.33	16.00	20.33
Diseases of Nervous System & Sense Organs	67.33	58.67	56.67	47.00
Diseases of Circulatory System	30.00	12.33	29.00	8.67
Diseases of Respiratory System	918.67	3046.00	724.33	2730.00
Diseases of Digestive System	176.33	443.67	129.00	449.33
Diseases of Genito-urinary System	3.00	26.67	3.00	3.00
Congenital Anomalies	1068.33	912.67	952.33	757.67
Certain Causes of Perinatal Mortality	3314.00	3990.67	2263.00	2880.67
Leukemia	20.00	10.00	13.33	18.67
Injuries & Accidents	247.67	1000.67	193.33	927.67
Others	67.67	173.00	42.00	163.33

*The rates refer to number of infant deaths per 100,000 live births.

In order to study the extent to which a particular cause contributes to the structure of mortality rates from all causes combined, Preston's linear regression model was used (Preston 1976). Preston's model allows us to choose any value of M, insert it into each of the 14 cause-specific equations and produce predicted values of M_i which sum up to the original value of M (Preston 1976). Moreover, since the predicted change in M_i per unit change in M is b_i, the predicted death rates summed over all I must equal to 1.000 per unit change in M, except for the rounding. In this manner a change in the death rate from all causes can be precisely ascribed to its individual components. The set of b_i's is probably the best single indicator of the cause structure of mortality variation. Of course, it only measures the contribution made by a cause in its "underlying" role. The actual contribution made by a disease to mortality structure includes whatever impact it may have on mortality from other underlying causes (Preston 1976).

PRELIMINARY RESULTS

Table 1 shows the overall mean infant mortality rates for the years from 1988 to 1990 for both male and female babies in both urban and rural areas combined. In many cases, the rates for 1989 were slightly higher than those for 1988 except the rates for diseases of the nervous system and sense organs. The rates then declined in most cases in 1990. For instance, the death rate from infectious and parasitic diseases was 252 in 1988, 284 in 1989, and in 1990 it was 189.75. Large drops occurred in the rates for deaths of the respiratory and digestive system. In 1988 the death rates from respiratory diseases and from digestive diseases were 1916 and 320.25 respectively. In 1989, they went up to 2142.5 and 326 respectively. In 1990, these rates went down to 1505.75 and 252.5 respectively. Since infectious and parasitic diseases, diseases of respiratory and digestive system, all represent the large bulk of deaths resulting from communicable diseases, significant drops in these death rates in 1990 may suggest a brighter future for Chinese infants.

Table 2 has broken down the overall mean infant mortality rates into separate rates for urban male infants, urban female infants, rural male infants, and rural female infants. It is clear that rural infants for both sexes died at a higher rate than their urban counterparts. Rural infants, both male and female, seem to die at a much higher rate from infectious and parasitic diseases, endocrine, nutritional and metabolic diseases, respiratory system, digestive system, genito-urinary system, perinatal mortality, injuries and accidents. Rural infants also died at a much higher rate than the urban ones in the unspecified category labeled as "others". However, rural infants died at a lower rate from diseases of nervous system and sense organs as well as the circulatory system.

The only type of diseases from which female infants, both urban and rural, died at a

Table 3: Regression Coefficients of Death Rate Cause: All Causes Combined in China in Urban and Rural Areas (Both Sexes)

	1988			1989			1990		
Cause of Death	**ai**	**bi**		**ai**	**bi**		**ai**	**bi**	
Infectious & Parasitic Diseases	311.5553	0.0389*	(0.9680)	-111.1116	0.0471*	(0.9546)	-71.8038	0.0391**	(0.9946)
Neoplasms	38.1073	-0.0001	(-0.0081)	71.3849	-0.0038	(-0.7653)	27.4500	-0.0002	(-0.1126)
Endocrine, Nutritional & Metabolic Diseases	167.6534	0.0307	(0.9000)	-169.5837	0.0391	(0.6923)	40.8907	0.0173	(0.5449)
Diseases of Blood & Blood Forming Organs	11.5623	0.0022	(0.6512)	17.4680	0.0011	(0.3728)	6.4546	0.0019	(0.5882)
Diseases of Nervous System & Sense Organs	54.5283	-0.0016	(-0.7973)	55.7305	-0.0003	(-0.0417)	61.8968	-0.0005	(-0.1239)
Diseases of Circulatory System	7.9490	-0.0031	(-0.7262)	84.7490	-0.0071	(-0.9088)	27.2718	-0.0018	(-0.7652)
Diseases of Respiratory System	250.9372	0.4720*	(0.9825)	-2430.9039	0.5451	(0.9419)	-1153.4650	0.3973*	(0.9714)
Diseases of Digestive System	369.2305	0.0613*	(-0.9734)	-273.4915	0.0715	(0.9135)	-183.3815	0.0651*	(0.9500)
Diseases of Genito-urinary System	3.0696	0.0002	(0.2665)	10.4270	-0.0008	(-0.8210)	-0.2993	0.0005	(0.8780)
Congenital Anomalies	830.6586	-0.107	(-0.3428)	1613.3971	-0.0661	(0.6139)	871.4058	-0.0010	(-0.0351)
Certain Causes of Perinatal Mortality	2978.0328	0.2238	(0.8524)	1880.9044	0.1872	(0.5827)	947.7613	0.3042	(0.8832)
Leukemia	19.4409	0.0023	(0.7360)	25.3527	-0.0007	(-0.4679)	9.1042	0.0008	(0.5295)
Injuries & Accidents	826.5273	0.1612*	(-0.9689)	-714.5021	0.1662	(0.9078)	-499.1133	0.1503*	(0.9536)
Others	130.8392	0.0230	(-0.9057)	-59.8209	0.0214	(0.8951)	-84.1723	0.0269**	(0.9905)

*p < .05; **p < .01; ***p < .001

higher rate than male infants is the endocrine, nutritional and metabolic ones. For both male and female infants, perinatal mortality caused the most deaths. For both male and female infants, both urban and rural, the next highest death rate was caused by respiratory diseases. The third highest death for both male and female infants were injuries and accidents. In other words, male and female infant death rates follow a very similar pattern.

Table 3 gives the results of applying Preston's linear regressions, i.e., linear regressions relating mortality rates from each cause to those from all causes combined for both sexes in China from 1988 to 1990. In 1988, deaths from the respiratory system contributed about 47 percent change in the overall mortality rates. Perinatal mortality accounted for about 23 percent and deaths from accidents and injuries accounted for about 16 percent of change in overall mortality rates. Again, deaths from infectious and parasitic diseases accounted for about 4 percent of the change in the total infant mortality rates. Deaths from the leading three causes—respiratory diseases, perinatal mortality, and accidents and injuries together accounted for 86 percent of the total infant mortality rate in 1988. Deaths from infectious and parasitic diseases, respiratory diseases, digestive diseases, and injuries as well as accidents are all significant at least at the 0.05 level.

In 1989, deaths from diseases of the respiratory system accounted for about 55 percent of the total infant mortality rates, while accidents and injuries accounted for another 17 percent. Another 19 percent of the total death rate was due to perinatal mortality. Deaths from the infectious and parasitic diseases remained at about 4 percent of the total infant mortality rates. Deaths from respiratory system, perinatal conditions, and injuries and accidents together accounted for 91 percent of the overall infant mortality rate in 1989. Again, mortality rates resulting from infectious and parasitic diseases are significantly related to the overall infant mortality rate. As a matter of fact, deaths from infectious and parasitic diseases are the only ones that are significant at the 0.05 level.

In 1990, deaths from diseases of the respiratory system accounted for 40 percent of change in the overall infant mortality rates, while perinatal mortality accounted for about 30 percent. Perinatal mortality seems to have increased in 1990 compared to the previous rates. Deaths from injuries and accidents accounted for another 15 percent of the change in the overall infant mortality rates, while infectious and parasitic diseases accounted for about 4 percent. In 1990, deaths from respiratory diseases, perinatal mortality, injuries and accidents together accounted for 85 percent of the overall infant mortality rate. In that year, infant deaths resulting from infectious and parasitic diseases, respiratory and digestive diseases, injuries and accidents, and other unspecified conditions were all significant at least at the 0.05 level.

CONCLUSION

Although Chinese infant mortality rates have declined greatly in the last few decades, the infant mortality patterns still resemble those of less-developed countries. Communicable diseases such as diseases of the respiratory system, infectious and parasitic diseases, digestive diseases, perinatal conditions as well as deaths from accidents and injuries are among the leading causes of infant mortality in China today. These deaths are largely the "avoidable" ones according to Taucher's grouping (Taucher 1978), or the "soft rock" according to Bourgeois-Pichat (1978) which require mixed actions such as improvement of environmental sanitary conditions and public health measures, economic development and rising income levels, and advance in medical technology. In other words, these deaths reflect not only the *immediate* causes of death, but also the underlying social and economic conditions present in the country. That Chinese infants still die mainly from "avoidable" diseases shows that there is still room for further reduction in infant mortality rates, and consequently for achieving longevity.

The results from Preston's linear regression model confirm that diseases of the respiratory system, perinatal mortality, and deaths from accidents and injuries account for about 85 to 90 percent of overall infant mortality rates. However, although perinatal mortality accounts from 18 to 30 percent of the overall mortality rate, it is not considered statistically significant in all three years. Both deaths from respiratory system and injuries as well as accidents are significantly related to the overall infant mortality rates in 1988 and 1990.

Finally, Chinese infants are much better off in urban areas rather than rural areas. Urban infants, both male and female, have a much

better chance of surviving their first birthday. Overall, gender does not have a significant effect on infant death rates. In other words, there seems to be no evidence to suggest any significant gender discrepancy. Female infants in almost all categories seem to have had lower death rates than their male counterparts. This finding seems to be consistent with that of the United Nations (1973). If the United Nations' (1973) finding is correct, the gender discrepancy may not occur until early childhood. This analysis is unable to draw any conclusion beyond the first year of infants. Further studies with more complete data, especially data which provide information on mortality during the early childhood, are called for.

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