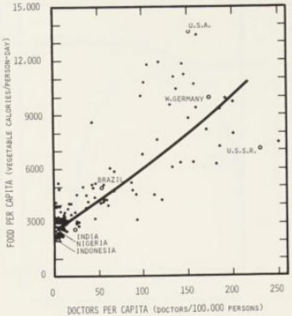

Figure 2-25 Doctors per capita versus food per capita
Source: U.N. 1972*a*.

Population	Average Age At Death (years)	Source
Neanderthal	29.4	
Upper Paleolithic	32.4	
Mesolithic	31.5	Deevey 1960
Bronze Age, Austria	38	
Classical Greece	35	
Classical Rome	32	
Geneva, 1561–1600	21	
Geneva, 1601–1700	28	
England, 1426–1450	33	U.N. 1953, pp. 50–51
Breslau, 1687–1691	33.5	
India, 1921–1931	27	
Primitive South American tribes, 1962–1970	35	Neel 1970
Latin America, 1860	25.9	Arriaga and Davis 1969
Portuguese Guinea, 1955	24.3	Keyfitz 1971*b*

Figure 2-26 Life expectancies of preindustrial populations

population with no medical advances and with a food supply near the subsistence level.

Age estimates from ancient skeletons (estimates that are probably too high because the bones of juveniles were seldom preserved) and other records suggest low average values for life expectancies in ancient societies and in preindustrial modern ones, as shown in Figure 2-26. Bogue has estimated that "throughout the long span of history prior to about 1650 the average expectation of life was 25 years or less" (1969, p. 566). Inscriptions associated with Egyptian mummies from about 100 B.C. indicate an average age of 22.5 years at death.

Thus the "normal" or reference mortality state for the model is defined as that of a preindustrial society, and the "normal" life expectancy is set at 28 years. Then each of the four lifetime multipliers expresses the effects of variations in one factor (such as food per capita) on the life expectancy of the preindustrial population, assuming that the other three factors (health services, crowding, and pollution) remain constant. For our reference population, the values of all four multipliers are defined as 1.0.

The life expectancy equation is written in multiplicative form, rather than additive or some other arithmetic form, to express a slight synergy among the influencing factors. For example, if at a given time the level of food available to a population is enough to raise its life expectancy above the reference by 30 percent, and no other factor is changed from its preindustrial value, LE would be calculated as follows:

$$\mathrm{LE} = \mathrm{LEN} \times \mathrm{LMF} \times \mathrm{LMHS} \times \mathrm{LMC} \times \mathrm{LMP}$$
$$36.4 = 28 \times 1.3 \times 1.0 \times 1.0 \times 1.0$$

If, in addition to the food increase, an increase in health services occurs that would also be sufficient to raise life expectancy 30 percent, all else being equal, the calculation would be:

$$\mathrm{LE} = \mathrm{LEN} \times \mathrm{LMF} \times \mathrm{LMHS} \times \mathrm{LMC} \times \mathrm{LMP}$$
$$47.3 = 28 \times 1.3 \times 1.3 \times 1.0 \times 1.0$$

The increase in life expectancy from 28 to 47.3 years is somewhat larger than it would be if the two 30 percent increases had been added rather than multiplied ($28 \times 1.6 = 44.8$). The multiplicative equation also allows us to capture more easily the shifting dominance of the four interacting factors. We can, for example, easily construct the lifetime multiplier from food LMF function so that zero food gives zero lifetime, regardless of the values of the other three multipliers.

Lifetime Multiplier from Food LMF The relationship between the average amount of food available to a person and that person's life expectancy is easy enough to postulate qualitatively. It is difficult to quantify exactly, especially since it is influenced by each person's age, genetic background, environment, food and exercise habits, and many other factors. Here we present data to establish the range and the general nonlinear shape of the food-mortality relationship aggregated over a large number of people, races, cultures, and climates. We also estimate the relative weight of the lifetime multiplier from food LMF with respect to other influences on life expectancy LE.