

Postnatal mortality from meningococcal infections during the period 1950–1991 in the US

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Abstract

Research has been conducted on the relationship between postnatal mortality from meningococcal infections and age, using data from the US during the period 1950–1991. The logarithm of mortality caused by meningococcal infections fell linearly with the logarithm of age, during the interval of 1–30 years for men and women in the US. The slope of this straight line is equal to -1 . The mortality from meningococcal infections is inversely proportional to the age in the US. The risk of death at age 2 is one half of the risk at age 1, at age 3 it is one third of the risk of death at age 1, etc. up to the age of 30 in the US. The same decline was observed for the risk of death from congenital anomalies and pneumonia. © 2000 Elsevier Science Ireland Ltd. All rights reserved.

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1. Introduction

It is the age of individual that affects the mortality rate most. The main part of population dies at the age for which it applies the exponential relationship (Strehler and Mildvan, 1960; Harman, 1984; Hayflick, 1985; Riggs, 1990, 1992).

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$$R(t) = C \cdot e^{\gamma \cdot t} \quad (1)$$

where t is age and C ; γ are constants. We can assume that the population is homogenous and the same process (aging) applies to every individual. The increase of mortality with age is caused by deterioration of the state of every organism. That is why mortality can be used as a criterion of the population's state.

The total mortality falls linearly in log-log scale up to the age of 10. The organism at the age of 10 years has lower risk of death if compared with the situation at the age of 1 year. The risk of death corresponds with a state of organism and the process, which was applied in every individual, caused the decline. (This assumption will be discussed later).

The Weibull distribution is used to describe mortality dependence on age up 10 years. The mortality corresponding to the Weibull distribution is

$$R(t) = \frac{dF_w}{dt} \cdot \frac{1}{(1 - F_w)} = \frac{m}{a} \cdot t^{(m-1)} \quad (2)$$

The slope of the linear decrease in log-log scale is equal to $(m - 1)$, where m and a are the Weibull parameters. The mortality rate at the age of 1 is equal to m/a . The Weibull distribution is not defined for $m \leq 0$ (the Weibull function does not have basic properties of distribution function).

It was observed that the slope of mortality decline in log-log scale is equal to -1 ($m = 0$) for Congenital anomalies and Pneumonia (Dolejs, J., 1998; Dolejs and Kozak, 2000). The same phenomenon for Meningococcal infections (the evidence that mortality is inversely proportional to the age) is presented at this paper.

2. Methods

The mortality rate was calculated using the WHO database for men and women in the US (the Internet address: www.who.ch/whosis/mort/mort.htm). The database contains the numbers of living people and the numbers of deaths from individual causes. The age categories 1, 2, 3, 4, 5–9, 10–14, 15–19, 20–24, 25–29 years were used in this study. The number of deaths was added up in a particular age category for the entire period 1950–1991. The mortality of this period should not be used the same way as mortality in 1 year. This quantity was used to demonstrate the decline of risk only. The evidence that mortality is inversely proportional to the age enable to add up the mortality in long period. We added up more fractions (mortality in particular year) with the same denominators (age).

The number of living people was calculated by the same method. The ICD 6, 7, 8 and 9 revision coding systems were valid at this period (WHO, 1948, 1957, 1967, 1977). The code 057 was used in the ICD 6 and 7 systems and the code 036 was used in ICD 8 and 9 systems for meningococcal infections. The mortality rate was calculated per 1000 living people and it describes the decline of risk during entire period 1950–1991. The slope of the mortality dependence on age in log-log scale is not influent of this evidence.

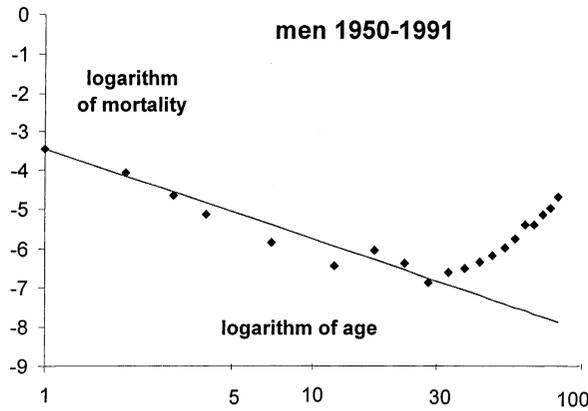


Fig. 1. Plot of logarithm of mortality rates from meningococcal infections for men in the US versus logarithm of age during the period 1950–1991.

3. Results

The dependence of logarithm of mortality on logarithm of age is shown in Figs. 1 and 2 for men and women in the US for the period 1950–1991. Mortality from meningococcal infections declines linearly in log-log scale. The straight lines in log-log scale correspond to the relationship

$$R(t) = \frac{R(1)}{t} \tag{3}$$

where $R(1)$ is actual mortality at the age of 1. (These straight lines are not results of linear regression). No parameter was calculated for these straight lines. The slope

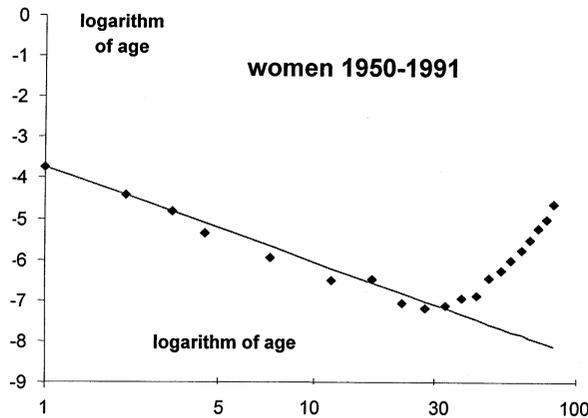


Fig. 2. Plot of logarithm of mortality rates from meningococcal infections for women in the US versus logarithm of age during the period 1950–1991.

is accurately -1 . We can see that the relationship (Eq. (3)) is appropriate for this decline at the interval 1–30 years. The variance of the logarithm of mortality was independent of age. (It was not confirmed for mortality in standard scale). The hypothesis that the mortality is inversely proportional to the age was tested in log-log scale. The linear regression was used to calculate the parameter α for the model Eq. (4)

$$\ln R(t) = \alpha \ln(t) + \beta \quad (4)$$

where β and α are after constants. The slope α and 95% confidence intervals were calculated for men and women in the US for the age categories 1, 2, 3, 4 and 5–9, 10–14, 25–29 years. The confidence interval of the parameter α for men is equal to (-0.99 ± 0.21) and for women is equal to (-1.06 ± 0.10) . The correlation coefficients are 0.975 for men and 0.994 for women. It follows from these results that the model Eq. (3) is suitable for description of the mortality dependence on age in the US up to the age of 30 years.

The decline of risk of death from meningococcal infections in the US with age can be expressed by the equation Eq. (3). The distribution function (the distribution of probability of death) which corresponds to this mortality dependence on age is

$$F(t) = 1 - t^{-R(1)} \quad \text{for } t \geq 1 \quad (5)$$

It is the actual mortality $R(1)$ at age 1, which is the only parameter of this distribution Eq.(5).

4. Discussion

The mortality from meningococcal infections is inversely proportional to the age at the interval 1–30 years for men and women during the period 1950–1991 in the US. The risk of death from pneumonia and congenital anomalies also declines with the first power of age (Dolejs, J., 1998; Dolejs and Kozak, 2000). Two possible assumptions should explain this decline.

1. The first assumption: the decline of mortality is caused due to the depletion of weak individuals (for example the subpopulation with congenital anomalies). This explanation was theoretically tested in (Dolejs, J., 1998). To explain the mortality rates decline, the extinction of different subpopulation was mathematically tested for both constant and the Gompertzian decline of mortality rate in subpopulation. The resulting theoretical mortality rates calculated from those models turned to fall more slowly, when compared with the actual dependence.
2. The second assumption: the risk of death from disease could apply in every individual. We assume that there is no subpopulation with handicap (Dolejs and Kozak, 2000). The decline of risk after birth is caused by the adaptation of every individual (development of immune system). It means that the same rule (Eq. (3)) is valid for development of every organism in childhood.

There are arguments against both explanations. In any case from the evidence that Eq (3) is valid for three groups of diseases it follows that this rule should be important for development of whole population in childhood.

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