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Mechanisms of Ageing and Development
114 (2000) 15–20

mechanisms of ageing and development

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Postnatal mortality from pneumonia

J. Dolejs [a,*], T. Kozak [b]

[a] *Department of Social Medicine and Health Care Administration, Medical Faculty, Masaryk University, Joštova 10, 662 46 Brno, Czech Republic*
[b] *Department of Clinical Haematology, Third School of Medicine, Charles University, Srobarova 50, 100 34 Prague 10, Czech Republic*

Received 9 June 1999; received in revised form 24 November 1999; accepted 26 November 1999

Abstract

Research has been conducted on the relationship between postnatal mortality from pneumonia and age, using data from the USA, Japan, former Czechoslovakia, Italy, Portugal and the UK during the period of 1979–1993. The logarithm of mortality caused by pneumonia fell linearly with the logarithm of age, during the interval of 1–10 years. This linear log–log dependence corresponds to the two-parametrical Weibull distribution, if the slope is greater than -1. However, the logarithm of mortality from pneumonia declined with the slope equal to -1. The mortality from pneumonia is inversely proportional to the age. The risk of death at age of 2 is one half of the risk at the age of 1, at the age of 3 it is one third of the risk of death at the age of 1…, etc. up to the age of 10. We assumed that no subpopulation susceptible to pneumonia exists and the risk of death from pneumonia applies in whole population. Consequently, there was applied another distribution function described at this paper. © 2000 Published by Elsevier Science Ireland Ltd. All rights reserved.

Keywords: Pneumonia; Mortality; Adaptation; Ageing; Distribution of probability of death

1. Introduction

Any research which deals with description of the mortality rate curves is very important as medicine considers the deferral of the moment of death for as long as possible to be its main stimulating task. The total mortality rate within the whole

* Corresponding author. Tel.: +420-49-5067111; fax: +420-49-5210002.
E-mail address: dolejs@faf.cuni.cz (J. Dolejs)

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PII: S0047-6374(99)00116-5

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

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

where t is age and C and γ are constants. Generally it is assumed that increase of mortality with age is caused by deterioration of the state of organism. That is why mortality can be used as a criterion of the population's state. The age up to 10 is the period during which mortality falls in the course of age. The total mortality falls linearly in log–log scale up to the age of 10. The Weibull distribution is used to describe mortality dependence on age up to 10 years. The mortality corresponding to the Weibull distribution is

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

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 $m < 0$ (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 for congenital anomalies ($m = 0$) (Dolejs, 1998). The Weibull distribution function cannot describe this decline. The death from congenital anomaly could happen inside a small subpopulation only. From this follows that the risk of death inside subpopulation can be described using the survival curve 3.

$$Ss(t) = 1 - Rs(1) \ln(t) \tag{3}$$

where $Ss(t)$ is the survival curve of subpopulation with congenital anomaly and $Rs(1)$ is mortality from congenital anomaly calculated inside the subpopulation at the age of 1. The situation is different with pneumonia. We assumed that no subpopulation susceptible to pneumonia exists. The population is homogenous because in principle everyone could be attacked by this disease. The risk of death from pneumonia applies to the whole population.

2. Methods

The mortality rate was calculated using the WHO database[1] for men and women in six countries. The database contains the numbers of living people and the numbers of deaths from individual causes. The age categories of 0, 1, 2, 3, 4, 5–9, 10–14…80–84 years were used in the database. The age category of 0 years was significantly influenced by childbirth and was not used. The number of deaths was

[1] The Internet address for the WHO database: www.who.ch/whoisis/mort/mort.htm

added up in a particular age category for the entire period 1979–1993. The number of living people was calculated by the same method. The ICD 9 revision coding system was valid in this period (WHO, 1977). ICD 9 codes 480–486 were used for pneumonia at the database. The database does not contain the age categories of 2, 3, 4 in some countries and for some years. These years were excluded from the calculations (the last column of the Table 1). The mortality rate was calculated per 1000 living people and it describes the entire period 1979–1993. The actual mortality $R(1)$ from pneumonia at the age of 1 year is shown in Table 1 for all populations.

3. Results

Mortality from pneumonia declines linearly in log–log scale for 12 populations after birth. The dependence of logarithm of mortality on logarithm of age is in Figs. 1–4. The straight lines in log–log scale correspond to the relationship:

Table 1
The parameters of linear regression

	Portugal women	Portugal men	Italy women
Slope	−0.9974	−1.0873	−1.1254
r	0.9304	0.9921	0.9790
Lower 95% C.L.	−1.7191	−1.3407	−1.5559
Upper 95% C.L.	−0.2757	−0.834	−0.6949
Excluded years	79, 80	79, 80	93
	Japan women	Japan men	UK women
Slope	−1.0874	−1.0548	−1.0313
r	0.9954	0.9980	0.9876
Lower 95% C.L.	−1.28	−1.1774	−1.3329
Upper 95% C.L.	−0.8949	−0.9323	−0.7296
Excluded years	No	No	93
	Italy men	Czechoslovakia women	Czechoslovakia men
Slope	−1.1209	−0.9545	−0.993
r	0.9867	0.9922	0.9935
Lower 95% C.L.	−1.4598	−1.1755	−1.2021
Upper 95% C.L.	−0.782	−0.7336	−0.784
Excluded years	93	92, 93	92, 93
	UK men	USA women	USA men
Slope	−0.9078	−0.9651	−1.0648
r	0.9946	0.9924	0.9963
Lower 95% C.L.	−1.0819	−1.1857	−1.2341
Upper 95% C.L.	−0.7338	−0.7445	−0.8955
Excluded years	93	88, 90–93	88, 90–93

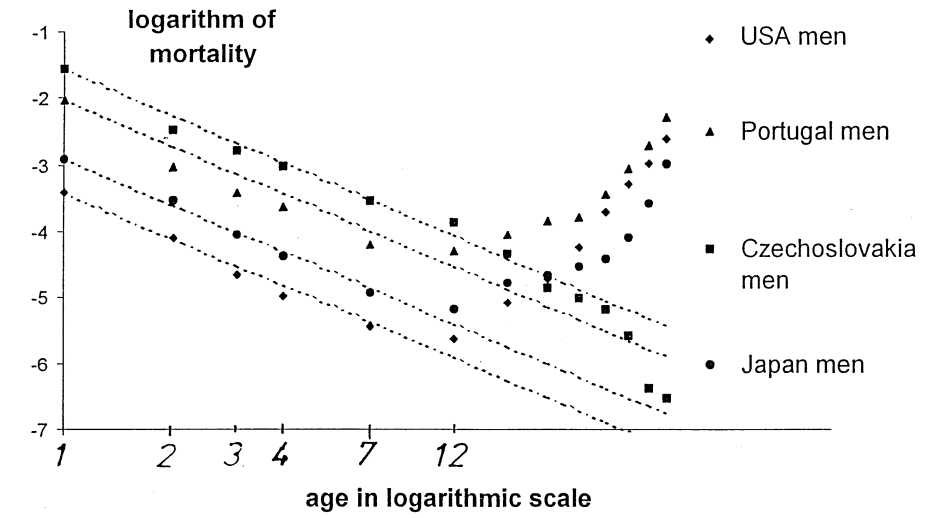

Fig. 1. Plot of logarithm of mortality rates from pneumonia for men in the USA, for men in Portugal, for men in Czechoslovakia and for men in Japan vs. logarithm of age.

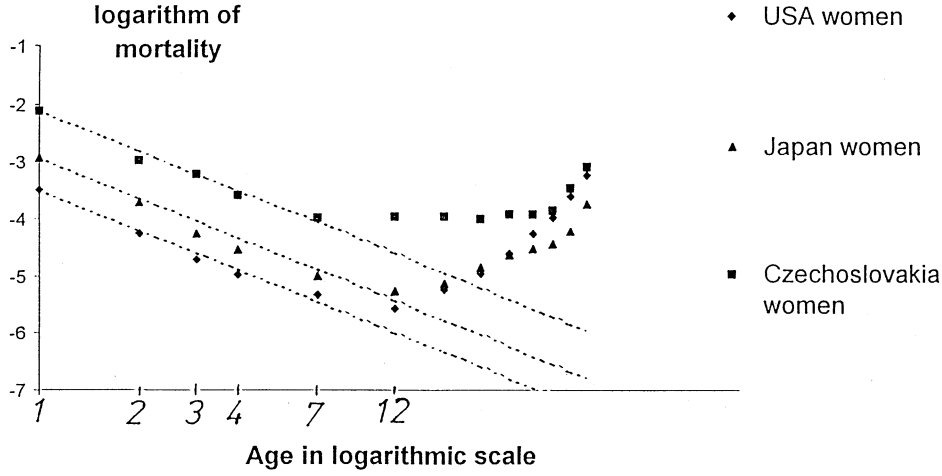

Fig. 2. Plot of logarithm of mortality rates from pneumonia for women in the USA, for women in Czechoslovakia and for women in Japan vs. logarithm of age.

$$R(t) = \frac{R(1)}{t} \tag{4}$$

where $R(1)$ is actual mortality at the age of 1. No parameter was calculated for these straight lines. The slope is accurately -1. We can see that the relationship Eq. (4) is appropriate for this decline up to the age of 10. The hypothesis that the mortality is inversely proportional to the age was tested. The variance of the

logarithm of mortality on age for 10 populations was independent of age. That is why linear regression could be used to calculate the parameter α for the model Eq. (5)

$$\ln R(t) = \alpha \ln(t) + \beta \tag{5}$$

where β and α are after constants. The age categories of 1, 2, 3, 4 and 5–9 years were used in this process. The 95% confidence intervals were calculated for the parameter α for 12 populations. These results with the correlation coefficients are shown in Table 1. All confidence interva1s contain the value -1. The average of 12 values of the parameter α is -1.032 with the standard deviation 0.058. The correlation coefficients are higher than 0.99 for eight populations, The average of

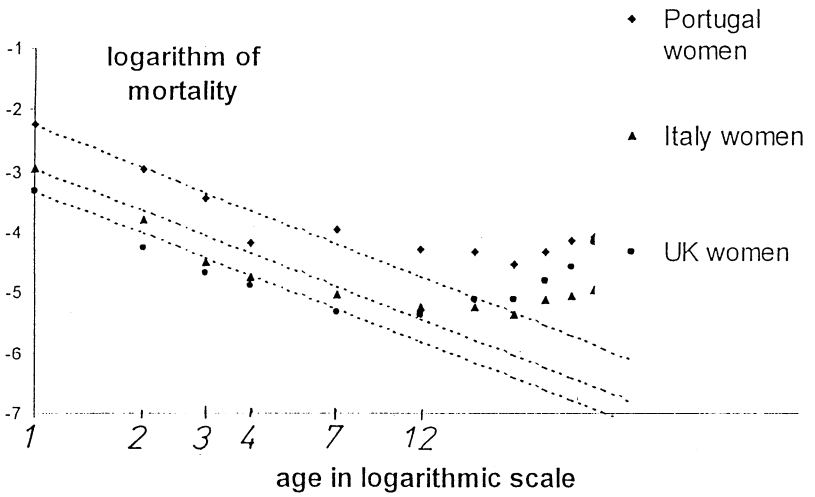

Fig. 3. Plot of logarithm of mortality rates from pneumonia for women in the UK, for women in Italy and for women in Portugal vs. logarithm of age.

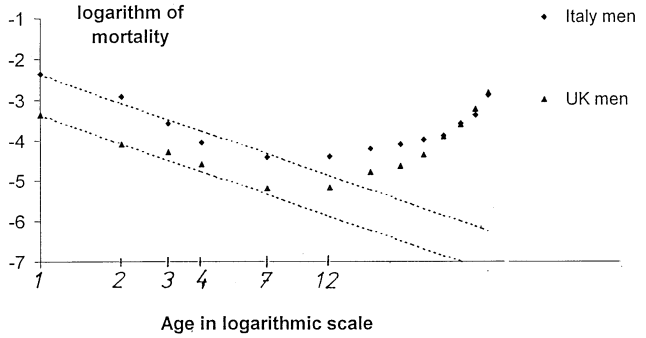

Fig. 4. Plot of logarithm of mortality rates from pneumonia for men in Italy and for men in UK vs. logarithm of age.

the slope is equal to -1.014 with the standard deviation 0.059. It follows from these results that the parameter α is equal to -1 and the model Eq. (4) is suitable for the description of the mortality dependence on age up to the age of 10 years.

The decline of risk of death from pneumonia with age can be expressed by Eq. (4) up to the age of 10. The cumulative distribution function (the distribution of probability of death) which corresponds to this mortality dependence on age is

$$F(t) = 1 - t^{-R(1)} \quad \text{for } t \geq 1 \tag{6}$$

It is the actual mortality $R(1)$ at age 1 which is the only parameter of this distribution Eq. (6).

4. Discussion

The risk of death from pneumonia could apply to every individual contrary to congenital anomalies (Dolejs, 1998). There is no subpopulation susceptible to pneumonia. It is probable that the decline of risk after birth is caused by the adaptation of every individual. We can assume that ageing of population is homogenous after the age of 20. From these evidences follows the distribution function of pneumonia has to be different if compared with the distribution function for congenital anomalies. The evidence that the risk of death from pneumonia declines with the first power of age could be important for describing of the development after birth. The mortality is different in other environments but the decline of risk does not depend on environment and population. The mortality is inversely proportional to the age in all populations and we can assume that this phenomenon could be a general rule for adaptation.

Acknowledgements

This study was supported by a grant from IGA MH CR (Grant number 4319-3).

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