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FACTORS INFLUENCING THE DEATH RISK FROM CARDIOVASCULAR DISEASES OF MEN OF WORKING AGE IN POLAND. I. PLAN AND METHODS OF THE STUDY

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Abstract. The objective of this work was to present the plan and methods of an epidemiological study of the risk of death from cardiovascular diseases in males and females of working age exposed to risk factors related to this group of diseases. The survey covered random samples of the general population, 20–64 years of age, living in areas of two regions (voivodeships) as well as families of all the deceased from cardiovascular diseases, coming from the same areas. Data on risk factors characteristic for this group of diseases in the general population and in the deceased were obtained. The method of assessment of death risk in persons exposed to given factors is presented. In the method, a standardized mortality ratio (SMR) was used. Organization of the study and its results will be discussed in Section II of this work.

INTRODUCTION

Recent demographic analyses have revealed an impressive reduction in the mortality rate in the majority of developed countries (11, 13). At the same time, the analyses revealed that in Poland, and other countries of Eastern Europe, a continuous increase in mortality rates has been observed since mid 1970's. Initially, this phenomenon was observed only in males, but during recent years, the same observation has been made in the female population. In the age group 40–59, increase of mortality is very strongly manifested which has far-reaching consequences for the country, not only in terms of biological losses but also having great impact on the society and economy (2, 3, 6, 10, 12).

Data of life expectancy are most emphatic. Compared to the global figures for life expectancy, the levels in Western Europe are high. The mean is 74 years,

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and its continuous increase is observed, while in Poland and in other countries of Eastern Europe the mean is 71 years and it continues to show a downward tendency. Fox example, in Poland, Czechoslovakia and Hungary, life expectancy at age 30 has decreased by 2–3 years during the past 15 years, whereas in France and the United States a two year, and in Japan a five year, increase of life expectancy has been noted. An upward tendency of mortality in countries of Eastern Europe, revealed in demographic studies, is attributed to the worsening of living conditions, inadequate health care, bad sanitation and environmental health hazards (11).

Diseases of the cardiovascular system, malignant neoplasms, accidents and poisonings are the main causes of increased mortality in Poland and its neighbouring countries. It should be stressed, however, that cardiovascular diseases deserve special attention since they have proved to be the cause of over 50% of all deaths in the adult population (3, 5, 13).

Bearing all these factors in mind, the authors of this work have made an attempt to verify some of the existing hypotheses on causes of male over-mortality at working age (in the age group 20–64) through an epidemiological retrospective analysis. The study was preceded by a very thorough analysis of mortality and male to female mortality ratio in this age group (14, 15). The following conclusions were formulated as a result of the analysis:

1. About 80% of deaths in the population of working age may be, at present, attributed to three groups of causes in the following order: cardiovascular diseases, malignant neoplasms, accidents and poisonings.

2. As a result of the decreased female mortality and the increased male mortality (during the years 1951–85), the male to female mortality ratio grew by 60.4%.

3. The most dynamic increase of male to female mortality ratio is attributed to cardiovascular diseases (89%).

The afore-said conclusions proved that cardiovascular diseases are the main killers of the population, hence the studies focussed on this particular cause of death.

Objectives of the study

The two following objectives were established:

1. to identify risk factors which have a special impact on the higher risk of death from cardiovascular diseases in males;

2. to point out those factors which cause a significantly higher risk of death in males in comparison with females.

When the objectives of study were formulated, it was assumed that differences in mortality from cardiovascular diseases according to age might result from differences in prevalence of risk factors observed in male and female populations, or from differences in the way they affect both groups, measured by the value of relative risk.

Plan of the study

The study comprised measurements of basic factors which increase the risk of cardiovascular diseases or mortality from these diseases. An attempt was made to include all hazards of the proved or suspected effect. The possibility of reliable measurements by means of the retrospective method was taken into consideration in defining particular variables.

The following variables were finally identified:

1. personal information,
2. occupational history,
3. working conditions,
4. living conditions (dwelling-unit, leisure, food),
5. behaviour and life-styles conducive to health (habits, use of health care).

The reason why the afore-said variables were selected comes from the fact that they are well-recognized in numerous epidemiological surveys throughout the world, they are quite common in the general population and some of them may be eliminated through modification of life style.

METHODS

Bearing in mind that the study was focussed on social, occupational and behavioural factors responsible for high mortality of males from cardiovascular diseases in the age group 20–64, considerably higher than in females, the study was classified as analytical (etiological). A follow-up of the cohort, in which it would be possible to evaluate both risk factors and incidence of cardiovascular diseases, as well as mortality from these diseases, would be the best way to solve the issue. In order to obtain sufficiently large groups exposed, appropriate numbers of new cases and deaths in a large population should be followed up. Such studies should have been carried on for a period of ten years, at least.

Since the problem must be well recognised, it was decided to undertake, as the first stage, a cross-sectional study in order to assess the prevalence of cardiovascular diseases' risk factors and to estimate the mortality rates for males and females in groups exposed.

It was taken for granted, that the outcome of this study would become a base for cause-effect hypotheses to be verified in the course of the prospective study.

According to the plan and in order to reach the objectives of the study, it was necessary to collect information on persons who died from cardiovascular diseases, and on the general population. As has been already mentioned, the prevalence of risk factors in the general population and death rates from cardiovascular diseases in males and females in the age group 20–64, had to be estimated in all identified sub-groups of independent variables, and the appropriate comparisons made.

An epidemiological survey, based on a specially designed questionnaire provided the required data. Studies on deceased persons and on the general

population were carried out in the same areas and in the same time employing comparable methods of measurement.

In order to obtain information on the deceased, family members were interviewed (in their place of residence). In addition, last employers or general practitioners who had taken care of them, were interviewed (mailed questionnaires) to confirm or to supplement the information obtained.

Random samples of the general population from the same areas were taken. Interviews were conducted in the place of residence of persons selected in this way.

It was decided that the study would be carried out in two regions: one highly industrialized and another typically agricultural. Following a thorough analysis of mortality in this age group according to regions (voivodeships), the Wroclaw region was selected among the highly industrialised and the Ciechanow region among the typically agricultural.

Both regions were carefully characterised. Significant differences in the conditions of their natural environments, levels of socio-economic developments and health service resources were revealed.

Population of the deceased

Persons from the Wroclaw and Ciechanow regions who died due to cardiovascular diseases between the age of 20–64 years in 1987 were eligible

TABLE 1. Persons who died from cardiovascular diseases in 1987, 20–64 years of age, according to sex and place of residence, Wroclaw region (50% sample).

Place of residence	Males	Females	Total
Urban areas	383	150	533
Rural areas	100	32	132
Total	483	182	665

TABLE 2. Persons who died from cardiovascular diseases in 1987, 20–64 years of age, according to sex and place of residence, Ciechanow region (100%).

Place of residence	Males	Females	Total
Urban areas	139	43	182
Rural areas	228	81	309
Total	367	124	491

for the study, namely 491 persons who had lived and died in the Ciechanow area, and 665 persons, 50% of the sample, from the Wroclaw region.

The deceased were sampled from registers of Departments of Health in those regions. On this basis, names, dates of birth, dates and causes of death as well as places of residence were identified.

Tables 1 and 2 show the number of the deceased classified for the study, according to sex and place of residence.

The general population

Bearing in mind the scope of the analysis, it was necessary to stratify the respondents in each region under study in four sub-groups according to sex and place of residence: males in urban areas; females in urban areas; males in rural areas and females in rural areas. A minimum size for each sub-group was established in view of the various possible frequencies of phenomena under study, and various precisions of estimations. It was decided that a population of at least 300 persons, in each sub-group (stratum of sample, namely: males in urban areas, females in urban areas, etc.) should satisfy the methodological requirements of the study. This permitted an estimation of the phenomenon of 10% frequency with absolute precision of 3 to 4% and the phenomenon of 5% frequency with absolute precision of about 2.5%.

The list of voters in the election to Provincial Councils in 1988 was used for sampling. Samples of about 1,200 persons were, thus, obtained for each region.

In order to evaluate the representativeness of samples obtained, the distribution of age in male and female samples was compared with similar distributions of the inhabitants of the Wroclaw and Ciechanow regions. The comparison showed no significant differences in distribution.

Method of analysis

During the first part of analysis, proportions of persons with the risk factors under study were estimated in the general population. A traditional procedure for a representative sample and two-stage sampling were adopted (17). That is why a detailed description of the procedure was skipped, whereas the way the standardized mortality ratio (SMR) was calculated by the authors deserves a more lengthy description. SMR is an essential measure which permits the assessment of death from cardiovascular diseases in persons with given risk factors.

Procedure principles

Indirect standardization

Age groups		Population under study	Reference population
w-age group	Deaths observed	Y(w)	Y(wr)
	Expected	X(w)	X(wr)
Total	Deaths observed	Y	Y(r)
	Expected	X'	X(t)

$X' = \sum_{w} X(w)$ $\quad SMR = Y/Yexpect$ $\quad Y = \sum_{w} X(w)$

Where:

$Yexpect = \sum_{w} Y_{(wr)}/X_{(wr)}X_{(w)}$ is an expected number of deaths, and $X_{(wr)}$ is a number of w-age group of reference population.

As mentioned before, the reply to the question whether significant differentiation of death risk according to sex exists in persons threatened with selected individual risk factors, was the essence of the study. The comparative analysis of SMR calculated for males and females in groups of risk factors gave the reply to this question. Nevertheless, before the analysis was begun, the necessity had occurred to identify clearly those factors which, in view of the study performed, were increasing the risk of death from cardiovascular diseases in males. Thus, among all the variables under study, only these cardiovascular risk factors were identified as a result of the analysis (through the comparison of SMRs in groups of males exposed to a given factor in relation to those non-exposed), which significantly increased the risk of death from cardiovascular diseases in males exposed to a given risk.

Below, there is a detailed description of a comparison between two standardised mortality ratios (both for the selected risk factor and for the assessment of differences of the death risk according to sex).

Let Y_1, Y_1expect, Y_2, Y_2expect be the numbers of deaths observed and expected in two populations under study. The maximum likelihood estimator of a relative risk is:

$$\psi = \frac{SMR_1}{SMR_2} = \frac{Y_2 Y_1 expect}{Y_1 Y_2 expect}$$

On order to compare two standardized mortality ratios, an interval estimator of a relative risk was calculated (1, 8).

$$\psi = \frac{\pi Y_1 expect}{(1-\pi) Y_2 expect}$$

$$\pi_1 = \frac{Y_2}{Y_2 + (Y_1 + 1) F_{\alpha/2}(2Y_1 + 2.2Y_2)}$$

$$\pi_u = \frac{(Y_2 + Y_1) F_{\alpha/2}(2Y_2 + 2.2Y_1)}{Y_1 + (Y_2 + 1) F_{\alpha/2}(2Y_2 + 2.2Y_1)}$$

where: $F_{\alpha/2}(V_1, V_2)$ means upper $100_{\alpha/2}$ percentile of distribution with Y_1, Y_2 degreees of freedom. This relationship limits the confidence for ψ. If the interval (ψ_l, ψ_u) covers 1, the hypothesis H_0: $\psi = 1$ cannot be rejected; but when the interval does not cover 1 an alternative hypothesis H_1: $\psi \neq 1$ should be accepted.

Bearing in mind that the analysis aimed, first of all, at comparing values of risk of death due to cardiovascular diseases in males and females with given individual risk factors – living in urban and rural areas in both regions – it appeared necessary to sample the same reference population (standard) for

each of the eight stratified sub-groups in order to compare standardized mortality ratios. Since it was not possible to interpret directly SMR values as a risk measure, the adoption of such a common standard, which comprised populations of males and females living in urban and rural areas, proved to be an obvious consequence. Hence, assessment of the risk by means of the value equal to the quotient of two standardized mortality ratios.

DISCUSSION

As appears from the above, the main purpose of the analysis was to identify and apply a measure of mortality which could facilitate, on the one hand, assessment of the risk of death from cardiovascular diseases in persons with given risk factors, and comparison of risk values in male and female sub-groups, on the other.

In such cases the most common mortality measures are: Standardized Mortality Ratio (SMR), Relative Risk (RR) and Standardized Risk Ratio (SRR) (16). It also happens that in epidemiological surveys the magnitude of risk is assessed by means of Relative Standardized Mortality Ratio (RSMR) and Standardized Proportional Mortality Ratio (SPMR). Calculations of the afore-said ratios, their applications and interpretations are discussed in literature (4, 7, 8, 9).

In this study, the authors decided to use SMR as a basic measure of mortality. The possibility of comparing values in two different populations an essential element of the analysis, proved the predominance of Standardised Mortality Ratio. In calculation of SMR an indirect standardization method, according to age, was used. As it is well known, this method is based on specific coefficient of deaths in the reference population (standard) and on the structure of the population investigated according to age. Given those data, an expected number of deaths in the population under study was calculated and then compared with the observed number of deaths. The quotient of these two figures makes a standardized mortality ratio.

$$\text{SMR} = \frac{\text{observed number of deaths in the population under study}}{\text{expected number of deaths in the population under study}}$$

SMR value below "1" indicates that the number of deaths in the population under study of known size and age structure was smaller than had been expected while SMR value above "1" indicates a higher than expected number of deaths. The SMR value multiplied by 100 gives ground for a similar interpretation but in percentage values.

Observation of the cohort (prospective or historical) and its results are the base of SMR calculations. In order to asses the risk of death in the population at working age (20–64 years of age) a cohort born during the years 1923–1967 should be found. A historical observation of such a cohort would not be possible because of the absence of retrospective information on risk

factors whereas a prospective observation of a cohort would produce results after 10–15 years, at the earliest.

The cross-sectional study was used to formulate hypotheses for further prospective observation. Selection of the method which departed from a classic observation of the cohort was associated with the application of defined assumptions. One of the basic assumptions was that the population of persons who died during one year (1987) became the representation of total number of deaths (because of the occurrence of factors related to cardiovascular diseases) which would take place in a hypothetical (model) cohort born during the years 1924–1968.

An assumption of equal value referred to the estimation of a population with individual risk factors. This became a base for calculation of the number of expected deaths. This estimation has been done only on the basis of a cross-sectional study of alive persons. It should be stressed, however, that this limitation did not prove to be a probable source of significant errors (the deceased persons constitute only a small per cent of the general population living in a given area).

The fact that the main purpose of the study was not only to estimate the level of the risk itself, but rather to compare its values for males and females in homogeneous risk groups, was an additional advantage of the cross-sectional study in assessment of the death risk. Assuming that an indirect method of measurement as well as one year measurement are biased, to a certain extent, the bias should be similar in the stratified sub-groups.

To sum up, the two-stage scheme of the analysis, in the first stage, aimed at identifying which of the factors under study significantly increased in males the risk of death from cardiovascular diseases. This aim was reached through a statistical assessment of significance of SMR quotient in males "exposed" and "non-exposed".

The other stage of analysis was focussed on diferrences in effects of risk factors on mortality in males and females. It comprised a statistical assessment of the significance of SMR ratio in males and females with the same risk factors.

The results will be presented in section II of this work.

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