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Predictions of cancer mortality in Poland in 2020

Research Article

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Abstract: Introduction. The future burden of cancer deaths will be the effect of demography changes and the influence of the risk factors. Goal. Making prognosis of number of cancer deaths in Poland in 2020. Methodology. These predictions of number of cancer deaths in 2020 (all cancers and the most frequent cancers for men and women) has been based on the historical trends of cancer mortality in Poland in 2001-2010 and the demographical prognosis made by Central Statistical Office using the method of Hakulinen and Dyba. Results. There will be 58 147 cancer deaths in men and 45 970 deaths in women in 2020. Compare to the period 2006-2010 the number of cancer deaths in Poland will increase by 12.0% for men and by 13.9% for women. In 2020 the big increase in number of deaths of melanoma skin cancer and multiple myeloma for both sexes, colorectal and pancreatic cancers for men and lung, endometrial and brain cancers for women will be observed. Conclusions. The predicted increase in number of cancer deaths for Poland in 2020 will be the results of: the demographical changes, changes of the cancer risk factors, the participation in the screening programs and treatment improvement.

Keywords: Cancer • *Mortality* • *Predictions* • *Demography* • *Risk*

1. Introduction

Estimating current cancer mortality rates is important for defining priorities for prevention, management and treatment. Predictions of cancer mortality provide an estimate of the future burden of cancer and are fundamental to the process of planning of cancer control programmes and healthcare interventions. Projections become a valuable tool in evaluating the effectiveness of screening programmes which are directed to the reduction of cancer mortality [1].

Estimates of current cancer mortality statistics, extrapolated from official data of a few years earlier, have long been available for the USA [2-4] and have been published for the years 2011 and 2012 for the European Union (EU) as a whole and for its six most populous countries [5-6], based on the World Health Organization (WHO) mortality database [http://www3.who.int/whosis/menu.cfm].

In this report, we present projections of mortality rates of cancer in Poland in 2020 for 24 major cancers on the basis of the observed trends in mortality rates during 2001–2010, and estimate the implication in terms of expected deaths using government population projections.

2. Materials and methods

The cancer mortality rates for Poland in years 2001-2010 were calculated using the National Cancer Registry data (number of cancer deaths) and the Statistical Office population data. World Standard Population was used to calculate the age-standardized rates. For this analysis the 10th Revision of the International Classification of

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Diseases (1994) was used. The estimated annual percentage change in age-standardized mortality rates for 2001-2010 period and 95% confidence intervals were calculated using the Joinpoint Regression Program 4.0.4 (http://surveillance.cancer.gov/joinpoint/).

The predicted numbers of cancer deaths and age-standardized rates for the most frequent cancer sites among men and women in 2020 were calculated on the basis of the historical mortality trends for Poland in years 2001-2010 and demographic prognosis created by the Central Statistical Office (http://demografia.stat.gov.pl/BazaDemografia/Prognoza.aspx) using the method of Dyba and Hakulinen. The underlying theoretical assumptions apply to these analyses:

1. Future mortality trends can be modeled by extrapolating historical trends.
2. The lengths of the data time-series permit the estimation of models that take account of age-sex group specific trends.
3. The numbers of cancer deaths in each age-sex-time-period stratum are Poisson distributed.
4. Where historic trends in standardized mortality are decreasing, a log–linear model is appropriate to estimate the average rate, whereas a linear model is used for increasing or constant trends to avoid explosive growth.

Models were fitted to age-specific cancer mortality rates for the age groups 0-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, 85 and over. Due to the small number of cancer deaths in the youngest age groups, the groups have been aggregated into one 0-44. For some of the cancers a particular division into age groups representing the characteristic of these cancers was applied. For testicular cancer, Hodgkin disease and non-Hodgkin lymphoma (NHL) the youngest age-groups have been aggregated into one 0-19 and the oldest into one 75+, while the remaining age groups were grouped into 5-year bins. For brain, central nervous system cancers (brain CNS) and leukaemias, the models were fitted to binned 5-years age groups from 0-4 to 85+. Non-melanoma skin cancers (NMSC) are omitted from estimates of trends as they rarely cause serious illness or death.

Simple Poisson linear or log-linear models offer a good fit to the data giving reasonably precise predictions. The linear model assumes that the mortality rate for each age-group changes by a fixed quantity each year (linear change), while the log-linear models assumes that it changes by a fixed percentage (exponential change). The model provides 95% confidence limits of the estimates based on the uncertainty in the model parameters, and 95% prediction intervals, which include an additional uncertainty term based on the Poisson uncertainty of the individual death numbers/rate estimates. The 95% prediction intervals, which are given here, are a truer estimate of the uncertainty of the prediction. Estimates of the parameters for each of the models were calculated using the STATA 11.0 Statistical package for Windows [7-10].

The predicted values for 2020 were compared to the years 2006-2010 (the 2006-2010 period is used as a baseline because a five-year average gives the most stable estimate of current number of deaths). The percentage change in the number of deaths from 2006-2010 to 2020 was divided into two parts: one part due to the change in risk of cancer death, and another part due to the additional change connected with population size and age distribution [11].

3. Results

The historical trends of cancer mortality are the basis for the future prognosis. Figures 1 and 2 show the changes in the age-standardized mortality rates for Poland for the commoner cancers between 2001 and 2010. There has been a mortality decrease for all cancers combined in men and women. Significant decrease of mortality was observed for stomach cancer and Hodgkin lymphoma for both sexes, for esophagus, larynx and lung cancer in men, and liver and gallbladder cancer in women. Decrease of mortality was also observed for breast, colorectal and cervical cancer in women, liver cancer and NHL in men and for kidney cancer and leukaemias for both sexes. A statistically significant increase of mortality has occurred for colorectal cancer and melanoma skin cancer in men, and for lung, pancreatic and endometrial cancer in women.

On the basis of the historical trends and the future prognosis we can predict the decrease in all cancer mortality and in the same time the increase in number of cancer deaths. During the last 40 years cancers have become one of the major health problems in Poland. When considering the overall prognosis for Poland in 2020, the number of all cancers deaths combined (excluding non-melanoma skin cancer) is predicted to increase for both sexes. The predicted number of cancer deaths in Poland in 2020 is 104 117 (58 147 for men and 45 970 for women). There will be 12.0% increase in number of cancer deaths in men and 13.9% increase in women. For both sexes all increase will be attributable to demographic changes. Despite the decreasing tendency connected with risk (-13.4% for men, -4.6% for women) there will be an overall increase in number of deaths because of the strong increasing tendency connected with demography (25.4% for men, 18.5% for women) (Table 1, 2).

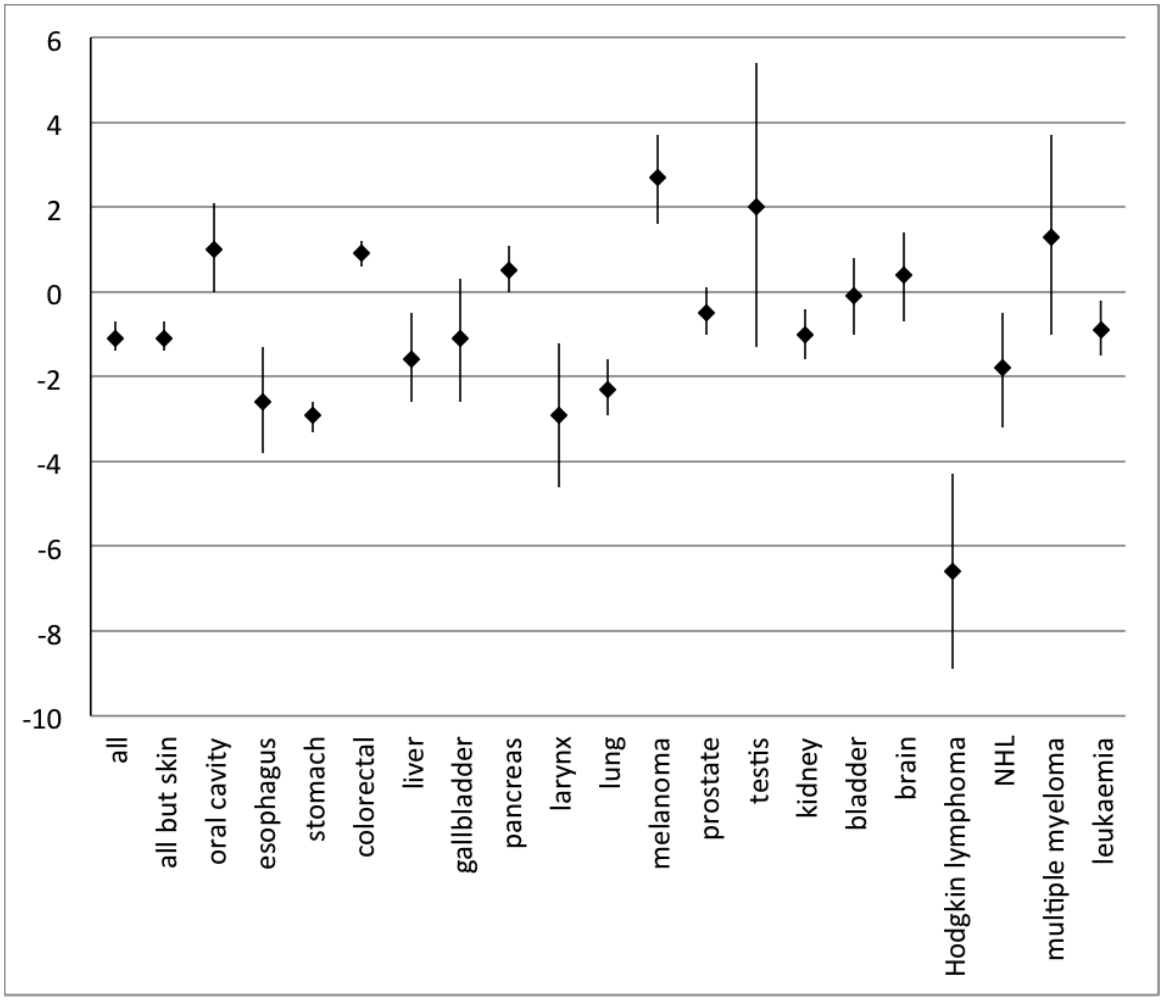

Figure 1 Estimated annual percentage change in age-standardized mortality rate for 2001-2010 (95% confidence intervals), males.

The structure of cancer mortality in Polish males will not be significantly altered. The contribution of lung and stomach cancer to mortality will decrease while the impact of colorectal, prostate, pancreatic and bladder cancer will increase (Figure 3). The major predicted change in cancer mortality in Polish women will be dominated by lung cancer, which will be the most frequent cancer death in female population in 2020. Lung cancer contribution, as well as ovarian, pancreatic and brain cancer will increase in the upcoming future while the contribution from colorectal cancer and breast cancer will not change significantly (Figure 4).

Tables 1 and 2 show the forecasted change in the number of cancer deaths in Poland and the break down of the change in mortality into the contribution from change in risk and additional change connected with population structure. For most cancers the effect of demography is between 16% and 32%. The strongest positive influence of demography will be observed for endometrial and brain cancer in women, multiple myeloma, bladder, colorectal and prostate cancer in men, and for melanoma skin cancer for both sexes, while the smallest positive effect will be characteristic of cervical cancer in women and testicular cancer in men. The only cancer for which there is a decreasing trend in number of deaths connected with changes in population is Hodgkin disease in men. For women there will be very small positive influence of demography for Hodgkin disease.

The most notable increase in number of cancer deaths due to both risk and demography will be observed for colorectal cancer, melanoma skin cancer, pancreatic cancer and multiple myeloma in men, for endometrial, lung and brain cancer in women, and for oral cavity and pharyngeal cancers in both sexes. While the increasing tendency for melanoma skin cancer in men will be caused by risk as well as demography influence, the predicted increase in number of deaths in women will be the effect of demography influence only. For some cancers (prostate, bladder, brain in men, and bladder,

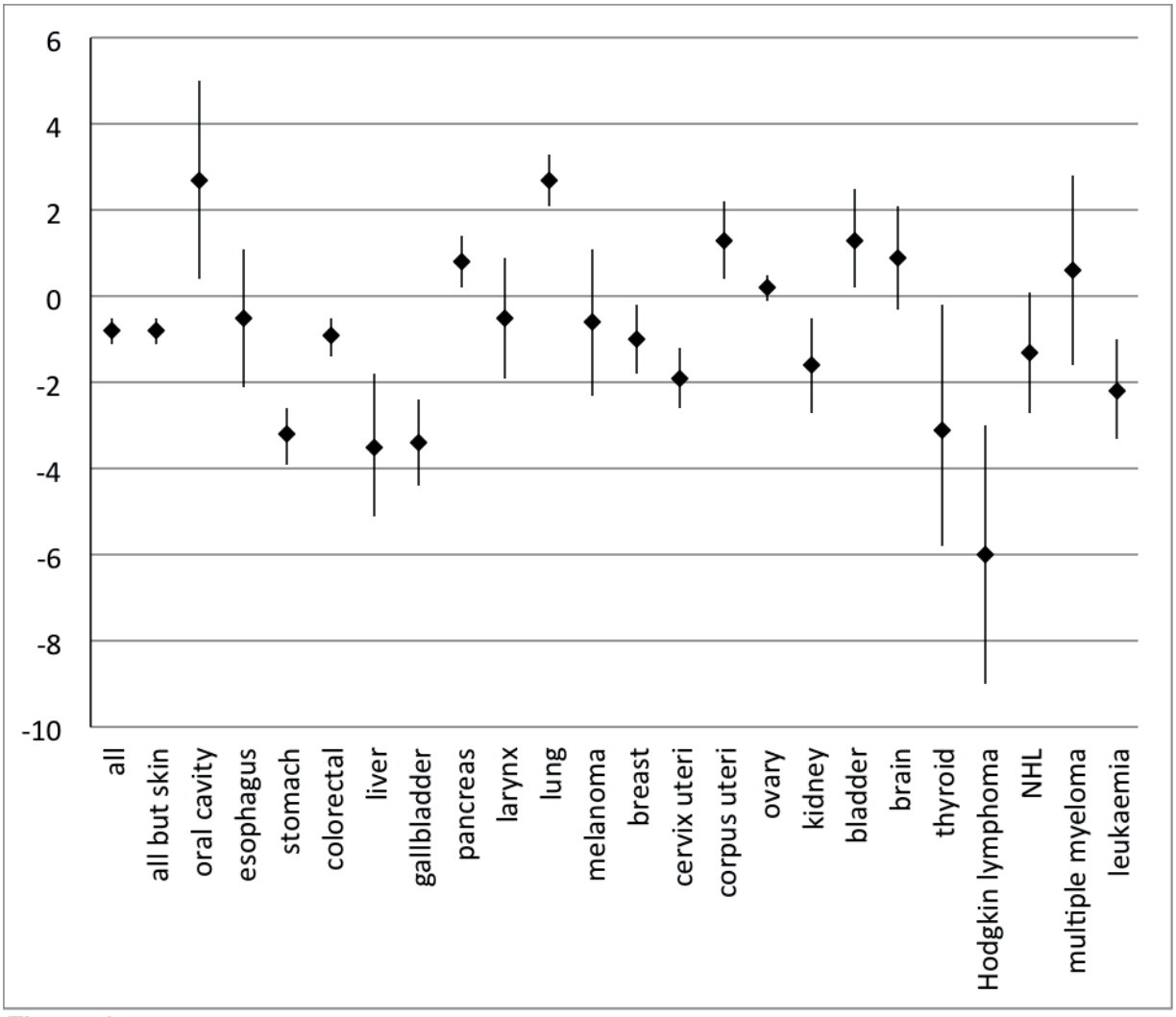

Figure 2. Estimated annual percentage change in age-standardized mortality rate for 2001-2010 (95% confidence intervals), females.

ovarian, melanoma and multiple myeloma in women) nearly the whole (or completely whole) increase in number of deaths will be related to the demography influence. The changes in risk will be the reason for predicted increase in number of testicular cancer deaths. For stomach, liver, thyroid and gallbladder cancer in women there will be an overall decrease in number of deaths because of the strong decreasing tendency connected with risk despite the increasing tendency connected with demography. For esophageal, stomach, liver and lung cancer in males the increasing tendency due to changes in population is compensated by the decreasing trend connected with risk so the predicted number of cancer deaths in 2020 is stable comparing to the period 2006-2010. For leukaemias and NHL the decrease tendency connected with risk is overcompensated by the positive effect of demography so the number of deaths caused by these cancer will increase. The predicted dramatic decrease in number of deaths from Hodgkin disease in males and females will be connected with risk.

4. Discussion

Future predictions depend on the multiple assumptions, but the basic one is that the various factors which affect the mortality of a particular cancer (risk factors, case finding procedures, diagnostic methods, cancer survival) vary approximately linearly with time for each of the age groups under consideration, and therefore the sum of their effects is also approximately linear. Consequently, the relative contribution of these factors to cancer mortality does not need to be known, and their aggregate future contribution to mortality can be modeled as a linear combination of their individual contributions. These predictions assume that current

Table 1. Mean annual number of cancer deaths as observed in 2006-2010 in Poland and predicted for 2020 by site, males. Corresponding percentage change in mortality, decomposed into changing risk and additional change.

ICD 10	cancer type	deaths 2006-2010	deaths 2020	overall change (%)	change in risk (%)	additional change (%)
C00-C14	oral cavity, pharynx	1652	2133	29,1	7,6	21,5
C15	esophagus	1145	1093	-4,5	-25,2	20,7
C16	stomach	3522	3458	-1,8	-21,3	19,5
C18-C21	colorectal	5615	7972	42,0	10,3	31,7
C22	liver	1027	1038	1,1	-16,7	17,8
C23-C24	gallbladder	486	542	11,4	-7,0	18,4
C25	pancreas	2227	2931	31,6	5,1	26,5
C32	larynx	1468	1339	-8,8	-26,7	17,9
C33-C34	lung	16543	17056	3,1	-20,3	23,4
C43	melanoma	591	963	63,0	30,6	32,4
C61	prostate	3897	4833	24,0	-6,5	30,5
C62	testis	130	161	24,0	20,7	3,3
C64-C66, C68	kidney	1621	1915	18,1	-7,1	25,2
C67	bladder	2383	3093	29,8	-1,5	31,3
C71-C72	brain CNS	1455	1832	25,9	2,1	23,8
C81	Hodgkin disease	135	66	-51,1	-48,3	-2,8
C82-C85	NHL	789	850	7,8	-15,0	22,8
C88, C90	multiple myeloma	554	763	37,7	5,0	32,7
C91-C95	leukaemia	1446	1722	19,1	-8,4	27,5
C00-C97 exclud. C44	all site but skin	51908	58147	12,0	-13,4	25,4

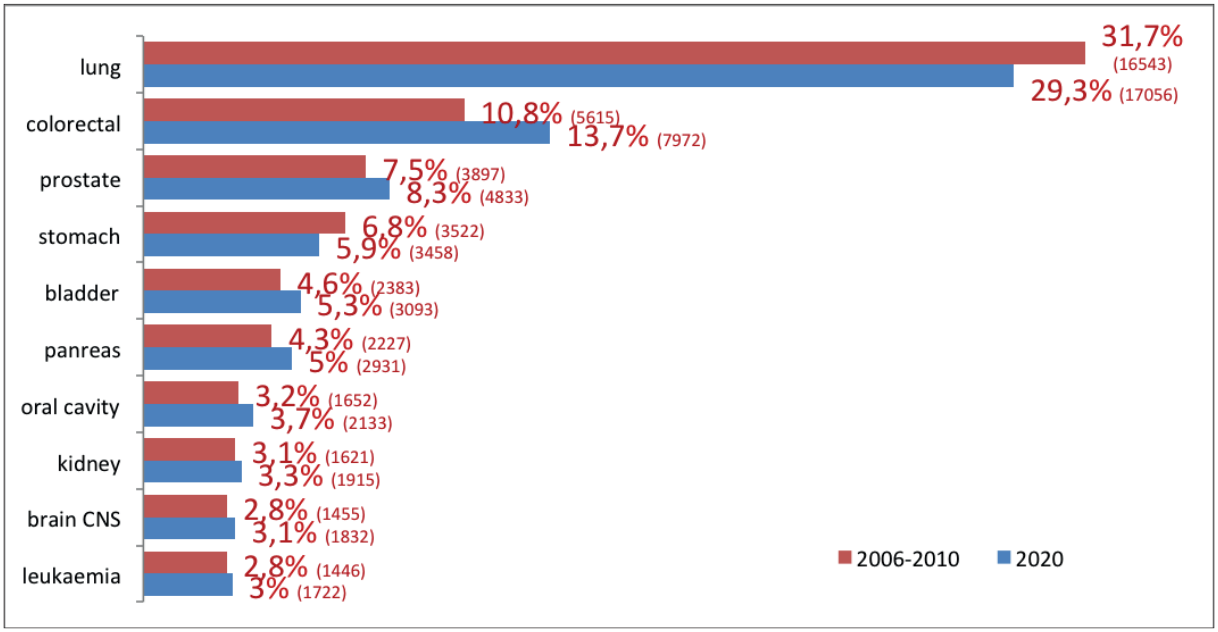

Figure 3. The structure of cancer mortality in males in Poland, 2006-2010 and 2020 (%)

trends will remain unchanged in the future and makes no assumption about changes in the exposure to risk factors but relies entirely on the extrapolation of the recorded rates in the past. It should be emphasized that the predicted numbers of deaths are uncertain and the prediction holds true as long as there are no qualitative or major quantitative changes in any of the underlying factors (smoking habits, screening programs, diagnostic methods etc.). Projections do not take into account the impact of possible future changes in the incidence of

Table 2. Mean annual number of cancer deaths as observed in 2006-2010 in Poland and predicted for 2020 by site, females. Corresponding percentage change in mortality, decomposed into changing risk and additional change.

ICD 10	cancer type	deaths 2006-2010	deaths 2020	overall change (%)	change in risk (%)	additional change (%)
C00-C14	oral cavity, pharynx	482	637	32,2	17,2	15,0
C15	esophagus	293	321	9,6	-2,8	12,4
C16	stomach	1956	1543	-21,1	-29,5	8,4
C18-C21	colorectal	4660	5131	10,1	-8,8	18,9
C22	liver	964	805	-16,5	-31,2	14,7
C23-C24	gallbladder	1379	1107	-19,7	-31,4	11,7
C25	pancreas	2208	2786	26,2	7,3	18,9
C32	larynx	167	203	21,8	0,0	21,8
C33-C34	lung	5690	8579	50,8	28,4	22,4
C43	melanoma	535	705	31,7	0,0	31,7
C50	breast	5259	5847	11,2	-6,0	17,2
C53	cervix uteri	1792	1652	-7,8	-15,4	7,6
C54	endometrium	925	1390	50,3	15,4	34,9
C56	ovary	2488	3078	23,7	3,4	20,3
C64-C66, C68	kidney	985	1139	15,7	-9,9	25,6
C67	bladder	628	813	29,5	4,5	25,0
C71-C72	brain CNS	1448	2113	45,9	11,6	34,3
C73	thyroid	191	176	-7,9	-31,8	23,9
C81	Hodgkin disease	108	47	-56,6	-60,5	3,9
C82-C85	NHL	673	770	14,5	-13,8	28,3
C88, C90	multiple myeloma	621	811	30,6	2,7	27,9
C91-C95	leukaemia	1219	1373	12,7	-12,3	25,0
C00-C97 exclud. C44	all site but skin	40370	45970	13,9	-4,6	18,5

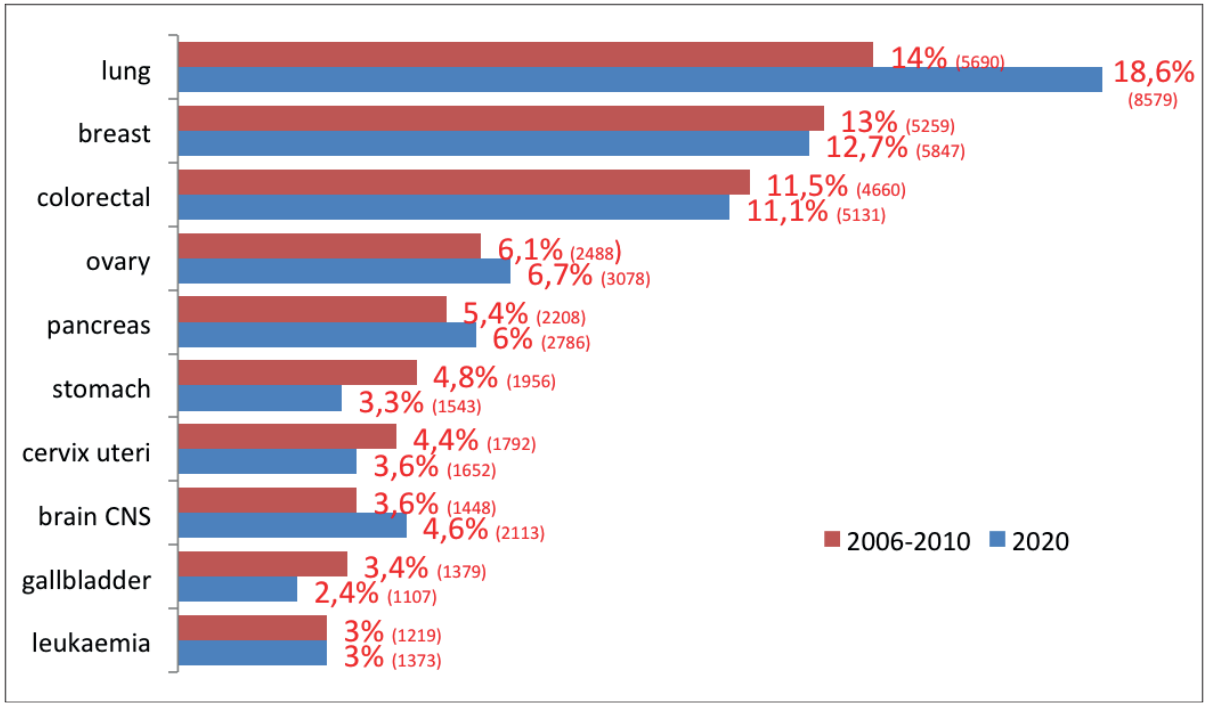

Figure 4. The structure of cancer mortality in females in Poland, 2006-2010 and 2020 (%)

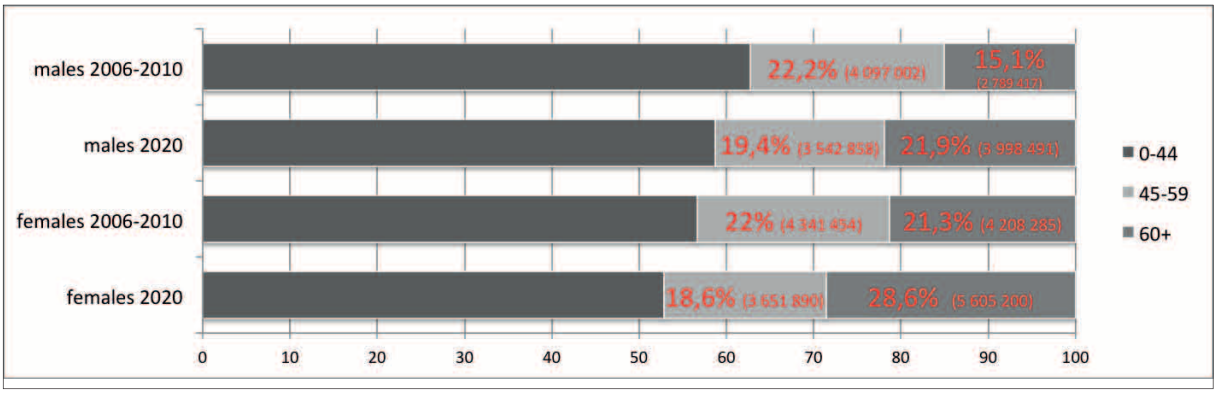

Figure 5. Demographic prognosis for Poland

cancer, or of dying from cancer, other than in a general way. A prediction made by extrapolation shows how large the mortality would be if the trend in the mortality could not be affected. They are, therefore, a useful basis for examining the possible scenarios resulting from the changes in policy with respect to prevention, screening or treatment. The fact that the prediction does not come true may indicate the success of cancer prevention and treatment. The improvement in prognosis for some cancers partly as a result of screening and partly because of better treatment may result in lower than predicted cancer mortality. Deaths trends are affected by changes in survival as well as changes in incidence [12-16].

Most of the anticipated increase in number of cancer deaths will be caused by the growing number of older people in the population. Between 2006-2010 and 2020, the age-adjusted mortality rates from all cancers combined excluding non-melanoma skin cancers are predicted to fall by 13% in men and by 5% in women. But the increase in number of deaths is still predicted and will be connected with increasing number of older people. This can lead to confusion in the interpretation of the results where the decreasing trend of the rates is accompanied by the increase of number of deaths. The increase in number of older people directly corresponds to an increase in number of people who will get cancers, the diseases which are characteristic for older population.

The process of aging of the population is the biggest determinant of the level of cancer mortality in the short future. In Polish population all increase in number of deaths will be connected with demography and will be caused by changes in the population size and structure. The number of deaths is projected to increase for most types of cancer even for those with decreasing rates because of the increase in the size of the population and ageing. The World Health Organization report shows that the future cancer risk will be based mostly on the increasing trend of an ageing population [17].

Most cancer deaths (75.8% in men and 76.1% in women) in Poland occur in the population 60 and older, so any changes in the size of this population will be an important factor for the future cancer mortality. Figure 5 shows the composition of Poland population in years 2006-2010 and the predicted structure of this population in 2020. The male population aged 60 and over will increase from 2 789 417 (average mean for 2006-2010 period) to 3 998 491 in 2020. The percentage of this population will increase from 15.1% to 21.9%. The number of females aged over 60 will change from 4 208 285 to 5 605 200 and the percentage from 21.3% to 28.6%.

All-cancer mortality in Poland is the highest in the European Union for both sexes. The predicted all-cancer mortality for 2013 in Poland will be 25% higher than the average rates for the European Union in men and 13% higher in women [18].

Male all-cancer mortality rates for 2006-2010 were about 86% higher than in women and the predicted greater fall in men only marginally reduces the gap. Based on the predictions for 2020, male all-cancer mortality (which is predicted to fall by 13.4%) will be higher than in women by about 69%. The slower decrease in female all-cancer mortality rates (4.6%) is largely due to the differential trends between the two sexes in lung cancer mortality, which is decreasing in men and increasing in women. This mirrors the differential trends in smoking prevalence observed in the past between the two sexes [19-20].

The steady increase in lung cancer mortality for women in Poland is expected to continue. Breast cancer rates are expected to be lower than lung cancer rates and the difference will be bigger than for 2006-2010 (predictions for 2020: 20.0/100 000 for lung cancer, 13.5/100 000 for breast cancer) because of the opposite trends which are predicted for these cancer, increasing mortality trend for lung cancer and decreasing trend for breast cancer. The change in lung cancer deaths will be connected with a rapid increase of mortality due to lung

cancer as well as demographic changes. Trends in lung cancer mortality can be affected by smoking patterns 20-30 years previously. Mortality from breast cancer is falling rapidly due to earlier diagnosis and advances in treatment. However the number of breast cancer deaths in 2020 will be higher than in 2006-2010 because of the changes in the population structure and aging.

The steady decline in stomach cancer mortality that started several decades ago is still continuing. This may reflect declines in the prevalence of Helicobacter pylori infection, the main identified risk factor for gastric cancer, but dietary habits, as well as the fall of smoking in men, may also have played a role [21].

Mortality rate for colorectal cancer is predicted to decline by 8.8% in women and to increase by 10.3% in men. Despite the decreasing rate trend in women there will be the increase in number of deaths for both sexes because of the demographic changes. The number of deaths will increase by 10.1% in women and by 42% in men. The participation in the organized colorectal cancer screening program, which has been introduced relatively recently, may affect the mortality above a certain age.

The predicted increase in number of prostate cancer deaths (24%) will be much lower than the prognosis for prostate cancer cases (98% increase) [22]. There appears to be little correlation between the extent of the increase in incidence and the recent declines in mortality. It remains unclear to what extent the increasing trends in incidence rates indicate true risk and how much is due to detection of latent disease. The decreasing prostate cancer mortality rates may be attributable to improvements in treatment and to an effect of prostate specific antigen (PSA) testing [23].

A general conclusion which can be drawn from these predictions is the necessity to prepare the health care system educationally, diagnostically, medically, economically and logistically to the growing number of cancer patients. Hospital care and long-term care will also need improvement in order to cater for the explosion in the number of cancer patients in the future.

Conflict of interest statement

Authors state no conflict of interest.

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