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Predictions of cancer incidence in Poland in 2019

Research Article

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Abstract: Introduction: The future burden of cancer can be quantify from two different perspectives: the number of new cancer cases and age-standardized rates. Goal: Making prognosis of number of cancer cases in Poland in 2019. Methodology: These predictions of number of cancer cases in 2019 has been based on the historical trends of cancer incidence in Poland in 2000-2009 and the demographical prognosis made by Central Statistical Office using the method of Hakulinen and Dyba. Results: There will be 76 629 new cancer cases in men and 75 815 cases in women in 2019. Compare to the period 2005-2009 the number of cancer cases in Poland will increase by 25.1% for men and by 26.1% for women. In 2019 the increase in number of colorectal cancer cases for both sexes, lung, breast and endometrial cancer for women and prostate cancer for men will be observed. For stomach cancer for both sexes, cervical cancer in women and lung cancer in men the predicted number of cases will decrease. Conclusions: The predicted increase in cancer incidence for Poland in 2019 will be the results of: the demographical changes, the influence of the cancer risk factors and the participation in the screening programs.

Keywords: *Cancer • Incidence • Prediction • Demography • Risk*

1. Introduction

The predictions of cancer incidence may be constructed for administrative and scientific reasons. For administrative purposes it is important that these predictions come true. The resources allocated on diagnostic, treatment and rehabilitation can be optimally allocated only if the prognosis are as accurate as possible. However the predictions that did not come true can also be useful. The fact that the predictions missed the real incidence may be a sign of changes in etiological factors, screening policy effectiveness, improvement of primary prevention as well as the changes in diagnostic methods or the definition of cancer [1].

Theoretically the predictions of incidence should take into account the changes in cancer causes and demographic changes. Unfortunately the causes of most of the cancers are not sufficiently known so their inclusion in the prediction models is almost impossible [2,3]. The demographical prognosis included in the predictions are based on the historical trends, so the future population is the estimated one.

The predicted number of cancer cases in the future will be the results of changes in the age composition of the population, size of the population and historical trends of cancer incidence. We can quantify the future burden of cancer from two perspectives. Firstly, age-standardized rates describe the occurrence of cancer on a per capita basis, taking account of changes in age composition and size of the population. Secondly, from the point of view of cancer care and cancer services provision, the burden of cancer is more usefully measured as the total number of persons with cancer who require diagnostic, therapeutic, supportive or palliative services [4-6].

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2. Materials and methods

The cancer incidence rates for Poland in years 2000-2009 were calculated using the National Cancer Registry data (new cancer cases) and the Statistical Office population data. World Standard Population was used for calculation the age-standardized rates. In Poland the 10th Revision of the International Classification of Diseases (1994) is currently binding. The estimated annual percentage change in age-standardized incidence rate for 2000-2009 period and 95% confidence intervals were calculated by Jointpoint Regression Program 3.5.2 (http://surveillance.cancer.gov/joinpoint/).

The predicted numbers of cancer cases, age-specific rates and age-standardized rates for the most frequent cancer sites among men and women in 2019 were calculated on the basis of the historical incidence trends for Poland in years 2000-2009 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 incidence 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 cases in each age-sex-time-period stratum are Poisson distributed.
4. Where historic trends in standardized incidence 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 incidence 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 cases 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, thyroid cancer, Hodgkin lymphoma 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 5-years. For brain, central nervous system cancers and leukemia models were fitted for the 5-years age groups from 0-4 to 85+. Non-melanoma skin cancers (NMSC) are omitted from estimates of trends for a number of reasons—they are very common cancers, they rarely cause serious illness or death and they are more likely to be missed by cancer registration than most other cancers.

Simple Poisson linear or log-linear models offer a good fit to the data giving reasonably precise predictions. The linear model assumes that the incidence 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 case number/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 2019 were compared to the years 2005-2009 (the 2005-2009 period is used as a baseline, as a five-year average gives the most stable estimate of current numbers). The percentage change in the number of cases from 2005-2009 to 2019 was divided into one part due to increased risk of being diagnosed with cancer, and another due to changes in the population size and age distribution [11].

3. Results

The historical trends of cancer incidence are the basis for the future prognosis. Figure 1 and 2 show the changes in the age-standardized incidence rates for Poland for the commoner cancers between 2000 and 2009. There have been the statistically significant increase for all cancers combined in women. For men the stability were observed for all cancer incidence. Statistically significant increase of incidence for both sexes have

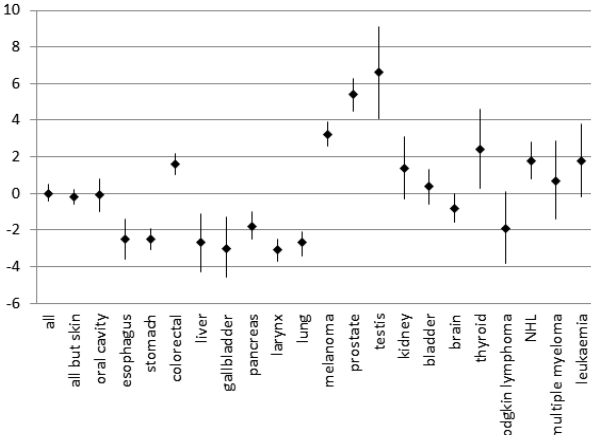

Figure 1. Estimated annual percentage change in age-standardized incidence rate for 2000-2009 (95% confidence intervals), males.

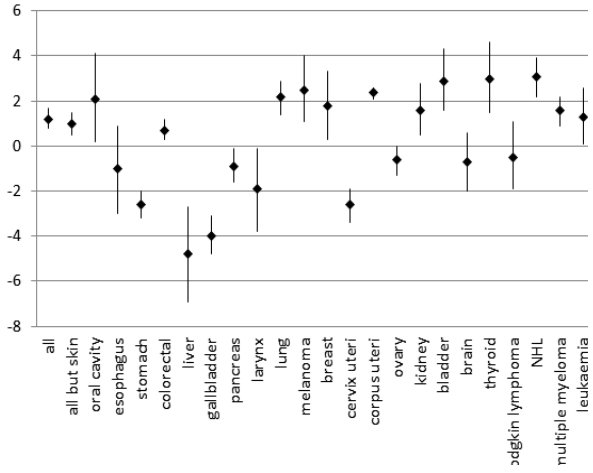

Figure 2. Estimated annual percentage change in age-standardized incidence rate for 2000-2009 (95% confidence intervals), females.

occurred for colorectal cancer, melanoma skin cancer, thyroid cancer and for NHL. There was also the significant increase for cancers of the oral cavity, lung, breast, corpus uteri, urinary tract, for leukemia and multiple myeloma in females and for prostate and testicular cancers in males. Significant decrease of incidence occurred for cancers of the stomach, liver, gallbladder, pancreas and larynx for both sexes, for lung and esophageal cancer in males and for cervical cancer in females.

Considered overall the prognosis for Poland in 2019, the number of all cancers combined (excluding non-melanoma skin cancer) is predicted to increase for both sexes. The predicted number of cancers in Poland in 2019 is 152 444 (76 629 for men and 75 815 for women). There will be 25.1% increase in number of cancer cases in men and 26.1% increase in women. For male population nearly all increase will be attributable to demographic changes (94.7%). For females a big part of the change will be attributable to change in risk (43.8%) (Table 1,2).

The major predicted change in structure of cancer incidence in Polish men will be the dominant role of prostate cancer, the most frequent cancer in male population in 2019. Lung cancer contribution, as well as stomach cancer, will decrease in the upcoming future while the colorectal cancer share will increase (Figure 3).

The structure of cancer incidence in females will not be alerted significantly with the dominant role of breast cancer. The contribution of breast cancer, lung cancer and endometrial cancer will increase while the decrease of share of cervical cancer, ovarian cancer and stomach cancer will be observed (Figure 4).

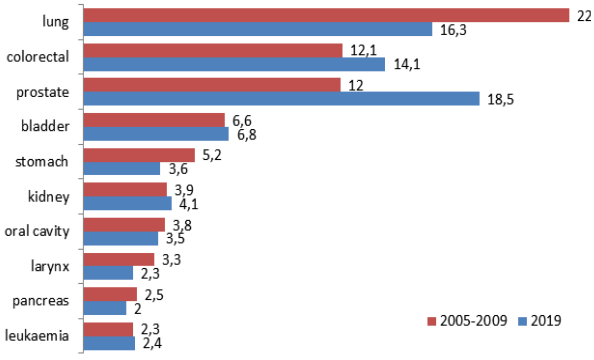

Figure 3. The structure of cancer incidence in males in Poland, 2005-2009 and 2019 (%).

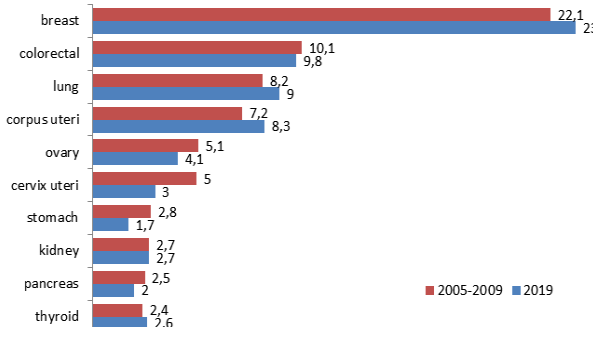

Figure 4. The structure of cancer incidence in females in Poland, 2005-2009 and 2019 (%).

Table 2. Contribution of demographic change to projected cancer numbers (all sites excluding non-melanoma skin cancer).

	projected number of cancer cases		% attributable to demographic change	
	males	females	males	females
2005-2009	61 247	60 123		
2019	76 629	75 815	94.7	56.2

Table 1. Mean annual number of cancer cases as observed in 2005-2009 in Poland and predicted for 2019. Corresponding percentage change in incidence, decomposed into changing risk and demographic components.

ICD-10	Site	Number of cancer cases			Change overall	Change overall (%)	Change due to change in:	
		2005-9	2019	95%CI			population (%)	risk (%)
C00-C97, D00-D09 excluding C44	ALL SITES EXCLUDING NMSC* *MALES*	61 247	76 629	75 244 – 78 014	15 382	25.1	23.8	1.3
C00-C97, D00-D09 excluding C44	ALL SITES EXCLUDING NMSC* *FEMALES*	60 123	75 815	74 322 – 77 308	15 692	26.1	14.7	11.4

**NMSC =Non-melanoma skin cancer.*

Tables 3 and 4 show the forecasted change in number of cancer cases in Poland and break down the change in incidence into the contribution from change in population and change in risk. For most cancers the effect of demography is between 16% and 26% for men and between 11% and 21% for women. The only cancers for which there is a decreasing trend in number of cases connected with changes in population are testicular cancers and Hodgkin lymphoma. The most notable increase in number of cancer cases due to both risk and demography will be observed for prostate cancer. For stomach cancer, liver cancer and gallbladder cancer for both sexes, laryngeal cancer and lung cancer for men and cervical cancer for women despite the increasing tendency connected with demography there will be an overall decrease in number of cases because of the strong decreasing tendency connected with risk. For esophageal cancer in males and females, pancreatic cancer in men and ovarian cancer in women the increasing tendency due to changes in population is compensate by decreasing trend connected with risk so the predicted number of cancer cases in 2019 is stable comparing to the period 2005-2009. The predicted increase in number of cases for colorectal cancer, melanoma skin cancer, kidney cancer, thyroid cancer, NHL, multiple myeloma and leukemia in both sexes and for oral cavity cancer, lung cancer, breast cancer, endometrial cancer, bladder cancer and brain cancer in women will be caused by both changes in population and risk. The increasing tendency in number of cases for bladder cancer and brain cancer in men and laryngeal cancer in women will be caused mainly by changes in population. Changes in risk will be the reason for predicted increase in number of testicular cancers and decrease tendency for Hodgkin lymphoma in men.

4. Discussion

Future predictions depend on the multiple assumptions, but the basic one is that the various factors which affect the incidence of a particular cancer (risk factors, case finding procedures, diagnostic methods) vary in an approximately linear way with time for each of the age

Table 3. Mean annual number of cancer cases as observed in 2005-2009 in Poland and predicted for 2019 by site, males. Corresponding percentage change in incidence, decomposed into changing risk and demographic components.

ICD-10	Site	Number of cancer cases			Change overall	Change overall (%)	Change due to change in:	
		2005-9	2019	95%CI			population (%)	risk (%)
C00-C14	ORAL CAVITY, PHARYNX	2468	2941	2709 - 3173	473	19.1	16.8	2.3
C15	ESOPHAGUS	984	949	828 - 1070	-35	-3.6	22.3	-25.9
C16	STOMACH	3368	3065	2858 - 3271	-303	-9.0	25.2	-34.2
C18-C21	COLORECTAL	7926	11836	11409 - 12262	3910	49.3	26.1	23.2
C22	LIVER	716	633	541 - 726	-83	-11.6	23.8	-35.4
C23-C24	GALLBLADDER	451	393	322 - 464	-58	-12.8	25.3	-38.1
C25	PANCREAS	1626	1652	1465 - 1839	26	1.6	22.8	-21.2
C32	LARYNX	2128	1907	1707 - 2107	-221	-10.4	19.7	-30.1
C33-C34	LUNG	14813	13713	13145 - 14281	-1100	-7.4	24.9	-32.3
C43	MELANOMA	1056	1699	1553 - 1845	643	60.9	18.6	42.3
C61	PROSTATE	7859	15565	14889 - 16241	7706	98.0	32.5	65.5
C62	TESTIS	947	1366	1249 - 1483	419	44.3	-6.6	50.9
C64-C66, C68	KIDNEY	2576	3418	3149 - 3686	842	32.7	21.5	11.2
C67	BLADDER	4322	5754	5382 - 6126	1432	33.1	26.7	6.4
C71-C72	BRAIN	1460	1624	1443 - 1805	164	11.2	13.7	-2.5
C73	THYROID	324	472	393 - 551	148	45.5	12.5	33.0
C81	HODGKIN LYMPHOMA	386	315	249 - 381	-71	-18.3	-3.3	-15.0
C82-C85	NHL	1286	1842	1678 - 2006	556	43.3	18.1	25.2
C88, C90	MULTIPLE MYELOMA	568	752	619 - 884	184	32.3	22.8	9.5
C91-C95	LEUKAEMIA	1473	2026	1823 - 2230	553	37.5	19.5	18.0

groups under consideration, and therefore the sum of their effects is also approximately linear. Consequently, the relative contribution of these factors to cancer incidence does not need to be known, and their aggregate future contribution to incidence can be modeled as a linear combination of their individual contributions. These predictions assume that current 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 cases 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, etc.). On the other hand, the failures of the predictions related to specific cancers may be used to study the effect of changes in etiologic factors, mass screening effectiveness, diagnostic methods or definition of cancer. As the predictions calculated here are only for up to ten years, the effect of uncertainty is likely to be minimal. Generally, the models provide a very good fit to the data [4,10,12,13].

Most of the anticipated increase in cancer numbers will be caused by the growing number of older people in the population. The process of aging of the population is the biggest determinant of the level of cancer incidence in the short future. In the male Polish population, nearly all increase will be connected with demography, 14 572 out of 15 382 cases which consist the changing number of cases will be caused by changes in the population size and structure. The number of cases 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 aging. The World Health Organization report shows that the future cancer risk will based mostly on the increasing trend of aging of population [14].

Most cancers (69% in men and 60% in women) in Poland occur in the population over 60, so any changes in the size of this population will be an important factor

Table 4. Mean annual number of cancer cases as observed in 2005-2009 in Poland and predicted for 2019 by site, females. Corresponding percentage change in incidence, decomposed into changing risk and demographic components.

ICD-10	Site	Number of cancer cases			Change overall	Change overall (%)	Change due to change in:	
		2005-9	2019	95%CI			population (%)	risk (%)
C00-C14	ORAL CAVITY, PHARYNX	844	1165	1039 - 1292	321	38.1	13.4	24.7
C15	ESOPHAGUS	246	256	190 - 322	10	4.1	20.8	-16.7
C16	STOMACH	1834	1453	1303 - 1603	-381	-20.8	18.7	-39.5
C18-C21	COLORECTAL	6542	8184	7817 - 8550	1642	25.1	19.2	5.9
C22	LIVER	612	381	318 - 444	-231	-37.8	20.0	-57.8
C23-C24	GALLBLADDER	1138	802	707 - 897	-336	-29.5	20.9	-50.4
C25	PANCREAS	1586	1708	1537 - 1879	122	7.7	20.7	-13.0
C32	LARYNX	298	335	251 - 419	37	12.3	11.0	1.3
C33-C34	LUNG	5281	7523	7139 - 7906	2242	42.4	16.5	25.9
C43	MELANOMA	1211	1701	1554 - 1849	490	40.5	11.9	28.6
C50	BREAST	14303	19520	18524 - 20515	5217	36.5	12.4	24.1
C53	CERVIX UTERI	3258	2545	2339 - 2750	-713	-21.9	7.8	-29.7
C54	CORPUS UTERI	4619	6901	6597 - 7205	2282	49.4	16.6	32.8
C56	OVARY	3323	3440	3207 - 3673	117	3.5	11.5	-8.0
C64-C66, C68	KIDNEY	1719	2289	2106 - 2472	570	33.2	17.8	15.4
C67	BLADDER	1206	1807	1649 - 1964	601	49.8	19.1	30.7
C71-C72	BRAIN	1394	1879	1581 - 2177	485	34.8	11.4	23.4
C73	THYROID	1554	2189	2001 - 2377	635	40.9	7.4	33.5
C81	HODGKIN LYMPHOMA	372	330	260 - 400	-42	-11.2	-7.7	-3.5
C82-C85	NHL	1184	1847	1693 - 2000	663	56.0	14.1	41.9
C88, C90	MULTIPLE MYELOMA	630	833	719 - 947	203	32.2	19.0	13.2
C91-C95	LEUKAEMIA	1232	1546	1391 - 1701	314	25.5	15.3	10.2

for the future cancer incidence. Figure 5 shows the composition of the Polish population in years 2005-2009 and the predicted structure of this population in 2019. Male population over 60 will increase from 2 707 445 (average mean for 2005-2009 period) to 3 928 857 in 2019. The percentage of this population will increase from 14.7% to 21.6%. The number of females over 60 will change from 4 112 320 to 5 526 863 and the percentage from 20.8% to 28.2%.

While age standardized rates may decrease, due to public health initiatives, the absolute number of cases diagnosed and requiring treatment is likely to rise. The increase in cancer numbers will place a major additional burden on cancer diagnostic and treatment services and must be considered in current planning for staffing and capital investment.

The single most critical aspect of these predictions concerns the future numbers of prostate cancer. The standard set of assumptions would predict a doubling in the number of cases. Very sharp increase in incidence is predicted also for Poland in 2025 in the analysis made by Didkowska and co-authors [2]. There is considerable uncertainty in predicting prostate cancer incidence, which is being driven not only by an inherent increase in the risk of the disease, the influence of the demography changes but also by the over-diagnosis as a consequence of testing with Prostate Specific Antigen (PSA) [15]. The number of new prostate cancer cases connected with demography will increase as a consequence of aging of the population. The standardized rates for Poland increased but the continuation of this trend is uncertain. In some countries with very high rates (Sweden, Finland, the Netherlands) after the dramatic increase, the incidence has begun to fall in the last years [16]. The future use of the PSA test will be critical for the number of predicted prostate cancer cases. If the PSA testing in asymptomatic older men increases, the prostate cancer rates and numbers may increase above our predictions.

The fact that the prediction does not come true may indicate the success of cancer prevention. A prediction made by extrapolation shows how large the incidence would be, if the trend in the incidence could not be affected [1]. When prediction for breast cancer cases in Poland were restricted only to females 50-69 age, the increase of 55.0% is achieved (36.5% for the whole females population). The contribution of the increase due to risk rise from 24.0% for all females to 40.7% for the age group 50-69. An improvement of the screening participation rate will increases the diagnosed number of breast cancer cases so may appear that the predicted values are too low. The coverage of the breast screening program in Poland is 41.4% (http://www.wco.pl/wok/aktualnosci/106/). The effective implementation of screening programs for cervical and colorectal cancers will also affects the predictions. In case of cervical cancer the predicted number of cases would be too high because of diagnosing the precancerous lessons in the screening program.

The success of primary prevention on the field of reduction of exposition to cigarette smoking and changes in smoking habits will affect the prediction for smoking related cancers. As tobacco is causally implicated in around a third of all cancers, significant efforts made now, in tobacco control, could counterbalance the pressures due to demographic change and halt the predicted rise in cancer cases. The cessation of smoking, even well into middle age, can avoid most of the subsequent risk of lung cancer, stopping before middle age avoids more than 90% of the risk attributable to tobacco. If current smokers can succeed in giving up the habit, incidence and mortality from lung cancer in the near future could be substantially reduced [17, http://info.cancerresearchuk.org/cancerstats/causes/lifestyle]. Our projections do not explicitly model smoking rates or take account of the most recent changes in smoking prevalence. Indeed, changing rates of smoking over the last decade will continue to affect lung cancer rates into the next decade due to the cohort effect.

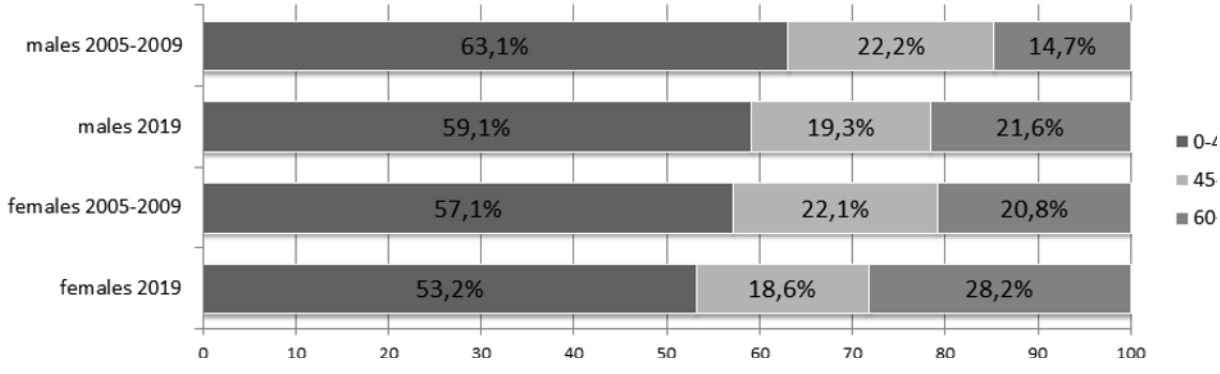

Figure 5. Demographic prognosis for Poland.

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