

CONTEMPORARY DEMOGRAPHIC CHANGES AND THE INCREASE IN THE INCIDENCE OF CANCER IN GERMANY AND POLAND – A STATISTIC ANALYSIS

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Abstract

A characteristic feature of modern demographic processes in highly developed countries is the decrease in population mortality, which contributes to the increase in the share of the population in older age groups (over 65 years) and to the extension of the life expectancy of the population. Increasing the share of the elderly population also affects the increase in the incidence of diseases of the modern civilization, i.e. cancer. According to data from "Krebs in Deutschland" and the Polish National Cancer Registry (PNCR) cancer is still and will be a severe threat to the health of a population. Considering the latest demographic trends, i.e. the increase in the percentage of older people (over 65 years) and the increase in the life expectancy of the population, it should be expected that about one in two people will get cancer once in a lifetime and that every fourth person will die from it. In Germany, the chances of survival after the diagnosis of cancer are among the highest in Europe. Understanding the latest trends in cancer incidence and mortality in Germany, the data can be used to improve the prevention methods and to take control of the development of cancer in the future. Indicators characterizing the condition and structure of cancer incidence were used in the research: i.e., raw and standardized morbidity and mortality rates, death rate by sex and individual age groups, and cumulative incidence (death) risk and relative survival.

Key words: cancer, incidence, mortality, Poland, Germany

JEL Code: : J11, J24, I10

Introduction

A characteristic feature of contemporary demographic processes in highly developed countries is the decrease in the mortality of the population, which contributes to the increase in the share of the population in older age groups (over 65 years) and to the extension of the life expectancy of the population. In 2016, the life expectancy of the population in Germany was 80.7 years and was 3.2 years longer than in Poland (77.5 years). The prolonged period of life, which we owe to the development of science and technology, as well as to public health awareness means

that the processes of carcinogenesis (formation of cancer cells) are more likely to occur. Cancer is one of the most serious diseases associated with the aging of the population, which is why cancer is sometimes referred to as "old age disease" (Arndt, et al. 2019). Aging is a major problem for healthcare providers and society. In Germany, as well as in Poland, the number of cancer cases is increasing (Flegar, et. al. 2014; Hermann, et. al.2019). According to the Krebs in Deutschland and Polish National Cancer Registry (PNCR) data, cancer is the second main cause of death in Germany and Poland. The high mortality rate is associated with the low five-year survival rate of cancer patients in Poland (Cancer..., 2006, 2016; Brunssen, et. al. 2018). Considering the latest demographic trends, i.e. an increase in the percentage of elderly people and an increase in life expectancy, it is expected that about one in two people will develop cancer once in a lifetime and every fourth will die because of it. Therefore, early cancer detection and therapy including the latest medical achievements are of great importance for the health of the population. The incidence of cancer increases with age. Statistical data show that about 60-70% of cancer patients are people over 60 years of age. Demographic indicators, that forecast further growth in the share of the elderly population, predict that a doubling of the number of patients diagnosed with cancer in this age group will be recorded within the next 15-20 years.

The aim of the research was to present and discuss trends in cancer incidence and mortality in Germany and Poland on the background of the contemporary demographic processes in 2006-2016. An important element of the research was the statistic analysis and comparative analysis of the cancer incidence and mortality (Germany-Poland) in the spatial arrangement as well as identifying similarities and differences.

1. MATERIAL AND METHODS

The following indicators were used in the research to present contemporary demographic changes: life expectancy, share of the elderly (over 65 years), mortality rate by sex and individual age groups and the demographic aging index. The dynamics of the aging process of the population are presented using the demographic aging index calculated according to the formula¹⁰:

$$R_{oa} = [P(0-15)_t - P(0-15)_{t+n}] + [P(>65)_{t+n} - P(>65)_t] \quad (1)$$

$P(0-15)_t$ - % of the population at the age of 0-15 years at the beginning of the period considered

$P(0-15)_{t+n}$ - % of the population at the age of 0-15 years at the end of the period considered

$P(>65)_t$ – % of the population at the age of 65 years and older at the beginning of the period considered

$P(>65)_{t+n}$ – % of the population at the age of 65 years and older at the end of the period considered

The higher the value of the demographic aging index, the faster is the aging process of the population.

To present the health status of the population, indicators characterizing the status and the structure of cancer incidence were used, i.e.⁽¹¹⁾:

- the crude cancer incidence rate and the mortality rate (the number of cases (deaths) per 100,000 of the studied population),
- the standardized cancer incidence and the mortality rate. (The number of cases (deaths) that would occur in the studied population if the age structure of this population were the same as the age structure of the population adopted as the standard population. As the standard population, the standard population of the world or Europe can be selected),
- the death rate by sex and age,
- the cumulative risk of morbidity, death and relative survival.

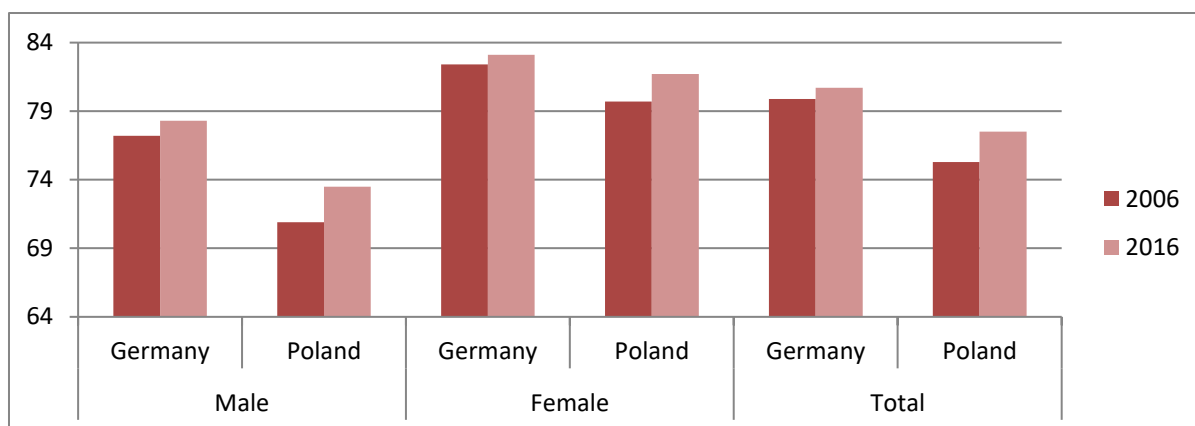
The indicators were developed on the basis of data from “Krebs in Deutschland” (Cancer in Germany) and the Polish National Cancer Registry (PNCR) (Hoebel, et. al., 2018, Krebs, 2019). The spatial analysis concerned federal states in Germany and voivodeships in Poland.

2. Demographic changes

2.1. Life Expectancy

In 2006-2016, the life expectancy of the population increased by almost 1 year in Germany (from 79.9 to 80.7 years) and by 2 years in Poland (from 75.3 to 77.5 years), with an average life expectancy of 80.9 years in the European Union. The difference between the life expectancy in Germany and Poland decreased from 4.6 to 3.2 years (Jeziarska-Thöle, 2016). At the same time, the life expectancy for women increased by 0.7 years in Germany and by 2 years in Poland. The difference between the average life expectancy of men and women decreased from 5.2 to 4.8 years in Germany and from 8.8 to 8.2 years in Poland (Fig.1).

Fig. 1: Dynamics of changes of life expectancy by sex in Germany and Poland in 2006-2016

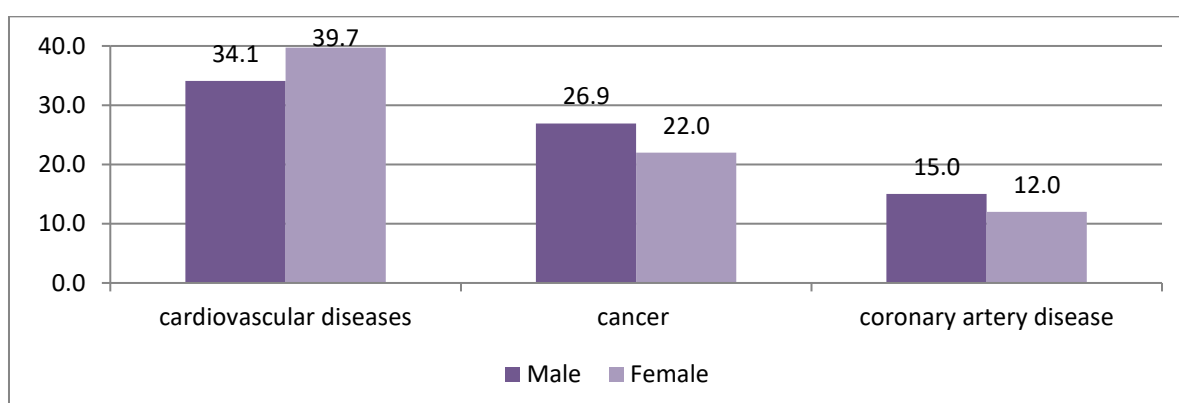


Source: Own elaboration based on www.stat.gov.pl, www.destatis.de, Polish National Cancer Registry

According to the method applied by the WHO (Hryniewicz et al., 2018), if the growth rate of the life expectancy of the Polish population will continue to be as in recent years, the current life expectancy of women and men in Germany will be reached by Polish women in 5 years and Polish men in 10 years (Thole, Jezierska-Thole, 2019).^{14,15}

Despite the extension of the life expectancy of men in Poland (from 70.9 to 73.5 years) and of women in Poland (from 79.7 to 81.7 years), the difference between the life expectancies of Polish men and women still remains at the level of 8 years (Fig. 2). The phenomenon of excess mortality among men is observed in both Germany and Poland in all age groups, with the difference between men and women increasing with age. The reason for this is the higher mortality of men in comparison to women from modern civilization diseases, including cancer, which was rated the second main cause of death in Germany (25.3%) and Poland (25.7%) in 2016.

Fig. 2: Causes of mortality in Germany and Poland by sex in 2016



Source: Own elaboration based on www.stat.gov.pl, www.stat.gov.lt, www.destatis.de.

2.2. Participation of Older People

An important element to characterize the aging process of a population is the old-age rate. The old-age rate is defined by the share of the population over the age of 65 in the total population.¹⁶ In 2016, the old-age rate was definitely higher in Germany (21.2%) than in Poland (16.4%), which is an indicator that advanced aging processes occur. In the spatial analysis, a high share of the elderly population was observed in the eastern federal states of Germany and above all in Sachsen (25.5%) and Sachsen-Anhalt (25.5%). It should be emphasized that the lowest values of the old-age rate were recorded in Hamburg (18.5%) and in Berlin (19.2%). They were still higher than the maximum value of this indicator in the Łódzkie Voivodeship (18.3%) in Poland. These data prove the trend of an aging society in Germany. However, it is alarming that while there has been some stabilization in the aging process of the population in Germany, a sharp increase in the share of older people can be observed in Poland ((Jeziarska-Thöle, Janzen, 2016; Kraywinkel, 2018).

The dynamics of the aging process of the population in 2006-2016 were presented using the demographic aging index (R_{oa}), which takes into account both the share of the very young population (up to 15 years) and the older population (65 years and more). The higher the indicator value, the more intensive the aging processes occur in a population. In Poland (3.1) a higher value of the demographic aging index was recorded than in Germany (1.9). It shows the advanced aging process of the Polish population, which is largely influenced by an increase in the share of the older population by 3.0% and a decrease in the share of the very young population by 0.8%. In the spatial distribution, a high value of the indicator, proving the progress of the aging process of the population, was recorded in the Zachodniopomorskie Voivodeship (5.3), the Warmińsko-Mazurskie Voivodeship (4.9) and Kujawsko-Pomorskie Voivodeship (4.9). The lowest values of the demographic aging index were recorded in the federal states: Hamburg (-1), Berlin (-0.6) and Sachsen (-0.2). These federal states are also characterized by an increase in the share of the very young population (Tab. 1).

Tab. 1: Demographic aging index (R_{oa}) by federal state and voivodeship in 2006-2016

Federal state	2006	2016	2006-2016	Voivodeship	2006	2016	2006-2016
	65 years and more		(R_{oa})		65 years and more		(R_{oa})
Schleswig-Holstein	20.4	22.7	3.8	Dolnośląskie	13.6	17.0	3.7
Hamburg	18.6	18.5	-1.0	Kujawsko-pomorskie	12.4	15.9	4.9
Niedersachsen	20.0	21.6	3.2	Lubelskie	14.4	16.9	4.3
Bremen	20.8	21.1	0.0	Lubuskie	11.8	15.5	4.7
Nordrhein-Westfalen	19.7	20.7	2.2	Łódzkie	15.0	18.3	3.8
Hessen	19.3	20.4	1.8	Małopolskie	13.4	15.7	3.4
Rheinland-Pfalz	20.1	21.2	2.5	Mazowieckie	14.6	16.7	1.7

Baden-Württemberg	18.7	19.9	2.5	Opolskie	14.0	17.1	4.5
Bayern	18.9	20.1	2.6	Podkarpackie	13.0	15.4	4.7
Saarland	21.6	23.1	2.7	Podlaskie	14.6	16.5	3.8
Berlin	17.9	19.2	-0.6	Pomorskie	12.1	15.3	3.7
Brandenburg	10.7	23.7	0.8	Śląskie	13.6	17.3	3.9
Mecklenburg-Vorpommern	20.6	23.6	1.0	Świętokrzyskie	14.9	17.8	4.7
Sachsen	23.1	25.5	-0.2	Warmińsko-mazurskie	11.7	14.7	4.9
Sachsen-Anhalt	22.5	25.6	1.1	Wielkopolskie	11.9	15.2	3.8
Thüringen	21.6	24.8	1.1	Zachodniopomorskie	12.2	16.2	5.3
Germany	19.8	21.2	1.9	Poland	13.4	16.4	3.3

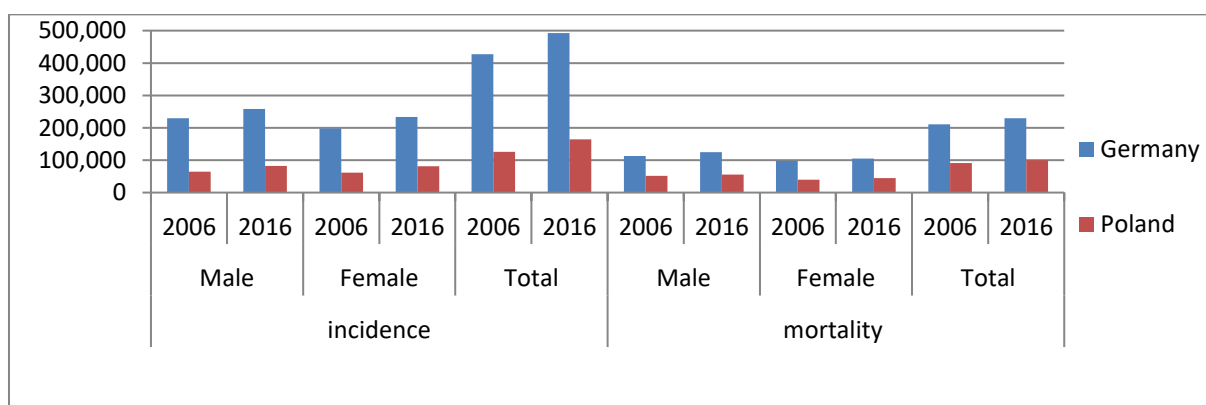
Source: Own elaboration based on www.stat.gov.pl, www.destatis.de, Polish National Cancer Registry.

3. Trends in Cancer

3.1. Diversification of the Cancer Incidence

In 2006-2016, Germany noted more dynamics in cancer incidence than in cancer mortality. The number of new cancer cases increased from 426,800 to 492,090 people by +15.3% and was more dynamic among women (+ 18.2%) than among men (+ 12.8%). In the same period, the number of cancer deaths increased from 98,492 to 104,469 people by +7.9% and was more dynamic among men (+ 9.5%) than among women (+ 6.1%). In Poland, the dynamics of cancer incidence and mortality were much higher than in Germany. In the analyzed period, the number of new cancer patients increased from 125,672 to 164,140 people by +30.6%, and greater dynamics were observed among women (+32.3%) than among men (+29.0%). The number of cancer deaths increased from 91,632 to 99,965 people by +9.1% and was characterized by higher growth dynamics among women (+ 12.2%) than men (+ 6.7%).

Fig. 3: Cancer incidence and mortality by sex in 2006 and in 2016, absolute numbers

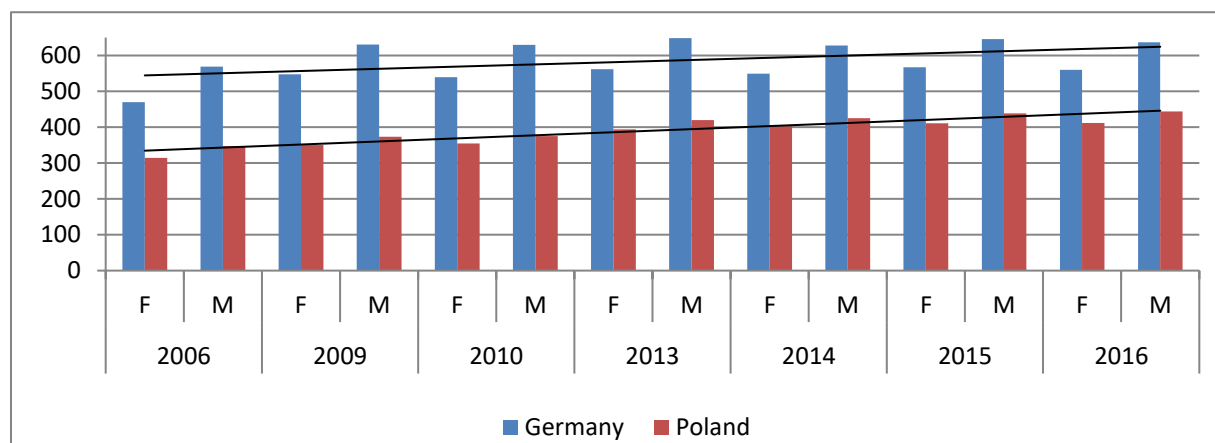


Source: Own elaboration based on www.stat.gov.pl, www.destatis.de, Polish National Cancer Registry.

In 2016, the crude cancer incidence rate was higher among men both in Germany ($636.7/10^5$) and in Poland ($443.9/10^5$). Based on Figure 4, the crude incidence rate trend line from the years 2006-2016 has got a rising character, which means an increase in the cancer

incidence in the society (Figure 3). A higher increase in the crude incidence rate was observed in Poland for both women (+ 30.9%) and men (+ 27.7%) than in Germany (respectively + 19.1% and + 12.0%).^{19,20}

Fig. 4: Crude cancer incidence rate by sex in 2006-2016, per 100,000 population



Source: Own elaboration based on www.stat.gov.pl, www.destatis.de, Polish National Cancer Registry.

The crude cancer incidence rate shows a wide variation in individual voivodeships depending on sex. Most cancer cases, with 70% in men and 60% in women, occur after the age of 60. The risk of developing cancer increases with age reaching a peak in the age group 75-80 years in Germany and 85-90 years in Poland. In 2016, the crude cancer incidence rate for men ranged from 527.9/10⁵ in the Świętokrzyskie and 516.4/10⁵ in the Pomorskie to 372.6/10⁵ in the Podlaskie and 378.9/10⁵ in the Mazowieckie voivodeships, for women from 465.6/10⁵ in the Łódzkie and 462.7/10⁵ in the Pomorskie up to 351.9/10⁵ in the Mazowieckie and 367.6/10⁵ in the Podkarpackie voivodeships. (Tab. 2).

Tab. 2: Crude cancer incidence rate in Poland by sex in 2016, per 100,000 population

Voivodeship	Male	Female
Dolnośląskie	471.6	453.0
Kujawsko-pomorskie	494.3	452.5
Lubelskie	450.8	410.7
Lubuskie	398.6	395.8
Łódzkie	471.2	465.6
Małopolskie	415.0	371.1
Mazowieckie	378.9	351.9
Opolskie	418.0	395.6
Podkarpackie	448.0	367.6
Podlaskie	372.6	344.0
Pomorskie	516.4	462.7
Śląskie	447.5	410.7
Świętokrzyskie	529.7	457.7

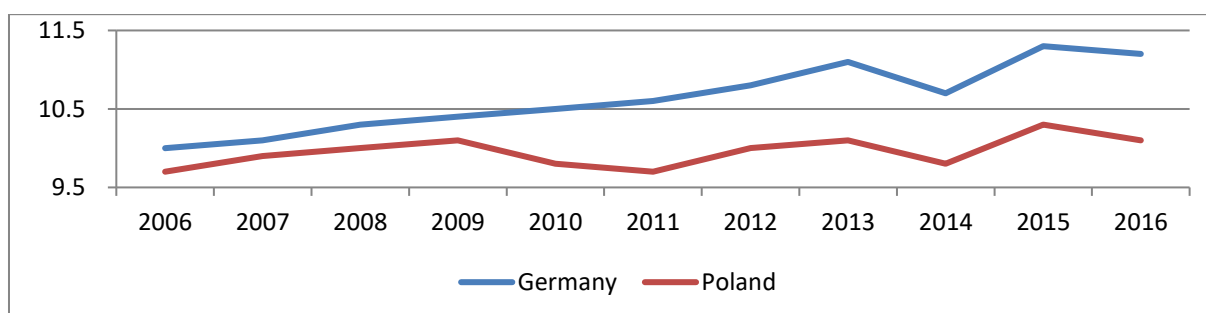
Warmińsko-mazurskie	443.5	427.6
Wielkopolskie	468.3	444.8
Zachodniopomorskie	411.3	418.1
Poland	443.9	411.5

Source: Own elaboration based on www.stat.gov.pl, www.destatis.de, Polish National Cancer Registry

3.2. Diversification of the Cancer Mortality

Based on Figure 5, it can be seen that in 2006-2016 there was an increase in the total death rate (per 1,000 population), with the growth rate being much faster in Germany (+ 1.2 ‰) than in Poland (+ 0.4 ‰). In 2016, the mortality rate in Germany (11.2 ‰) was higher by 0.9‰ than in Poland (10.1 ‰). This phenomenon is associated with an increase in deaths and the "aging" of the society. As the average life expectancy increases, the maximum death rate shifts to older age groups. The high mortality rate reflects the age structure of the population (greater likelihood of death in the aging population as well as a greater likelihood of developing cancer).

Fig. 5. Total death rate per 1,000 population in Germany and Poland in 2006-2016, ‰



Source: World Bank Data, www.stat.gov.pl, www.destatis.de, Polish National Cancer Registry

It is alarming that, while the overall growth rate of deaths in Germany is higher than in Poland, the growth rate of cancer deaths is higher in Poland. In 2006-2016, the number of cancer deaths increased from 210,930 to 229,595 people by +7.3% in Germany, and from 91,632 to 99,965 people by +9.1% in Poland. In 2016, the share of cancer deaths in Germany was 25.3%, including the highest share in the federal states Berlin (27.5%) and Hamburg (27.1%), and the lowest share in Sachsen (23.9%). The trends in cancer incidence vary depending on gender and age group. Both in Germany and in Poland, the phenomenon of excess mortality amongst men (death rates of men are higher than of women) is observed in all age groups, with the difference between men and women increasing with age. In 2016, the share of deaths for men in Germany (54.2%) and Poland (55.2%) was higher than for women. Based on Table 3, it is noted that the cancer mortality (measured by the crude cancer mortality rate per 100,000 population) is definitely higher for men in both Germany ($307/10^5$) and Poland ($297/10^5$). The spatial diversity in the intensity of cancer deaths shows great similarity with the participation of the elderly population. In Germany, the most endangered federal states in terms of high mortality rates of

men were in the eastern federal states: Sachsen-Anhalt (409/10⁵), Mecklenburg-Vorpommern (386/10⁵) and Brandenburg (375/10⁵). The lowest mortality rates were recorded in the western federal states Baden-Württemberg (265/10⁵) and Bayern (252/10⁵). In Poland, the highest cancer mortality rates were recorded in the following voivodeships: Świętokrzyskie (328/10⁵), Łódzkie (324/10⁵) and Dolnośląskie (321/10⁵), while the lowest cancer mortality rate was recorded in the Opolskie (236/10⁵). The crude cancer mortality rate for women ranged in Germany from 303/10⁵ in Sachsen-Anhalt and 297/10⁵ in Saarland to 217/10⁵ in Baden-Württemberg, in Poland from 253/10⁵ in the Dolnośląskie and 250/10⁵ in the Łódzkie to 171/10⁵ in the Opolskie and 182/10⁵ in the Podkarpackie Voivodeships.

Tab. 3: Crude cancer mortality rate by federal state and voivodeship in 2016

Federal state	Total	Male	Female	Voivodeship	Total	Male	Female
	per 100.000 population				per 100.000 population		
Schleswig-Holstein	312	347	279	Dolnośląskie	287	321	253
Hamburg	258	276	242	Kujawsko-pomorskie	271	307	236
Niedersachsen	288	320	256	Lubelskie	244	291	197
Bremen	286	300	272	Lubuskie	257	307	206
Nordrhein-Westfalen	301	328	274	Łódzkie	287	324	250
Hessen	255	279	231	Małopolskie	241	274	209
Rheinland-Pfalz	283	311	256	Mazowieckie	262	295	229
Baden-Württemberg	235	252	217	Opolskie	203	236	171
Bayern	244	265	224	Podkarpackie	215	249	182
Saarland	327	357	297	Podlaskie	246	281	212
Berlin	262	288	237	Pomorskie	264	298	229
Brandenburg	325	375	277	Śląskie	283	318	248
Mecklenburg-Vorpommern	337	386	289	Świętokrzyskie	280	328	232
Sachsen	313	351	275	Warmińsko-Mazurskie	263	303	224
Sachsen-Anhalt	355	409	303	Wielkopolskie	254	288	220
Thüringen	318	363	273	Zachodniopomorskie	269	304	235
Germany	280	307	252	Poland	261	297	225

Source: Own elaboration based on www.stat.gov.pl, www.destatis.de, Polish National Cancer Registry

The analysis of deaths by individual age groups shows that every second detected cancer death occurred in the age group over 65 years. Its share was very high and had an amount of 75.8% in Poland and 77.6% in Germany, including the highest shares of deaths in Sachsen and Hessen (78.7% each). The second place was taken by the age group of young and middle-aged people (15-65 years). Its share was in Germany (22.3%) and in Poland (24.2%), which indicates a high incidence of cancer in people of the working age. In the spatial analysis, this share of deaths in Germany ranged from 26% in Mecklenburg-Vorpommern to 20.8% in Hamburg. In

the youngest age group (0-15 years) the share of cancer deaths was very low and had amount up to only 0.1% (Tab. 4).

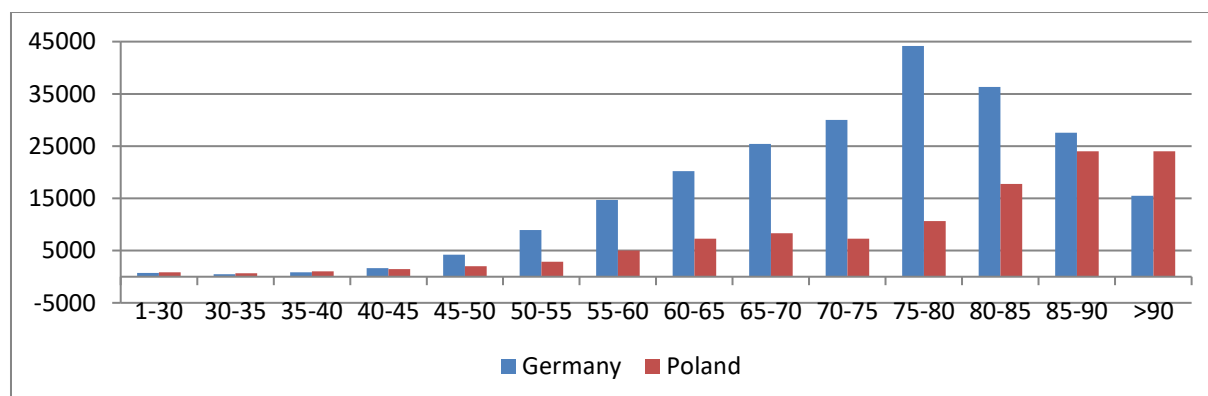
Tab. 4: Share of deaths from all cancers by age and sex in Germany in 2016, in %

Federal state	0-15	15-65	<65	Male	Female
	by age			by sex	
Schleswig-Holstein	0	22	78	14.5	12.1
Hamburg	0.1	20.8	79	14.1	12.9
Niedersachsen	0.1	22.8	77.1	13.6	11.1
Bremen	0.1	21.9	78	13	12.1
Nordrhein-Westfalen	0.1	22.1	77.8	14.2	12.4
Hessen	0	21.3	78.7	13.4	11.4
Rheinland-Pfalz	0.1	22.2	77.7	13.6	11.5
Baden-Württemberg	0.1	21.5	78.3	12.9	11.2
Bayern	0.1	22.1	77.7	13.1	11.3
Saarland	0	22.6	77.4	13.5	11.7
Berlin	0.2	22.9	77	14.9	12.7
Brandenburg	0	25.2	74.8	15	11.4
Mecklenburg-Vorpommern	0.1	26	73.9	15	11.5
Sachsen	0.1	21.2	78.7	13.2	10.7
Sachsen-Anhalt	0	23.6	76.4	14.3	10.9
Thüringen	0	23.1	76.9	13.7	10.5
Germany	0.1	22.3	77.6	13.7	11.6

Source: Own elaboration based on www.stat.gov.pl, www.destatis.de, Polish National Cancer Registry

Based on Figure 6, it may be noted that among the youngest (1-20 years) and middle-aged groups (20-40 years) the number of cancer deaths increased slightly at a similar rate in Germany and Poland. In the older age group (40-65 years) the number of cancer deaths was higher in Germany than in Poland. The highest number of cancer deaths in Germany occurred in the 75-80 year-old age group (44,186 deaths) and in Poland in the 85-90 year-old age group (27,541 deaths).

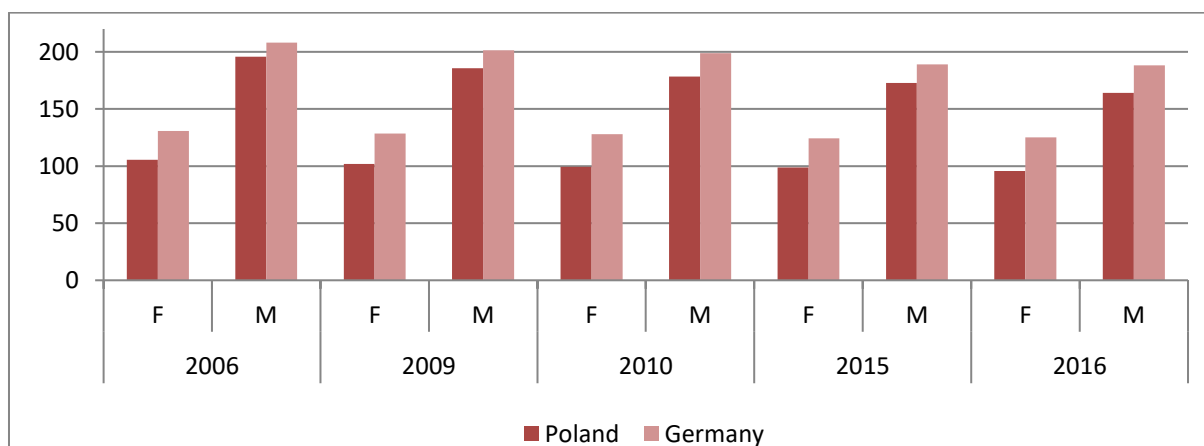
Fig. 6: Cancer deaths by age in Germany and Poland in 2016, absolute numbers



Source: Own elaboration based on www.stat.gov.pl, www.destatis.de, Polish National Cancer Registry

Considering two age groups: the working age group (15-65 years) and the post-working age group (65 years and more), it may be noted that in the working age group a higher share of cancer deaths was recorded in Poland (24.2% to 22.3%), while in the post-working age group a higher share of cancer deaths was recorded in Germany (77.6% to 75.8%). In 2006-2016, the risk of cancer mortality (measured by the standardized cancer mortality rate) was higher for both women and men in Germany than in Poland. In the male population, the risk of cancer mortality decreased in Germany from 208/10⁵ to 188,3/10⁵, in Poland from 195.7/10⁵ to 164.2/10⁵. The spatial analysis shows that in 2016 the following voivodeships were characterized by the highest risk of cancer mortality: Warmińsko-Mazurskie (184.8/10⁵) and Lubuskie (179.8/10⁵). The Opolskie (124.7/10⁵) and the Podkarpackie Voivodeships (142.5/10⁵) were characterized by the lowest risk of cancer mortality (Fig. 7).

Fig. 8: Standardized cancer mortality rates, Female (F) Male (M)



Source: Own elaboration based on www.stat.gov.pl, www.destatis.de, Polish National Cancer Registry.

In the female population, the risk of cancer mortality decreased from 130.6/10⁵ to 125.1/10⁵ in Germany and from 105.4/10⁵ to 95.8/10⁵ in Poland. In 2016, the highest risk of cancer mortality was recorded in Poland in the following voivodeships: Kujawsko-Pomorskie (104.9/10⁵), Pomorskie (103.3/10⁵) and Śląskie (102.9/10⁵). The lowest risk of cancer mortality was recorded in the voivodeships: Opolskie (69.1/10⁵), Podkarpackie (80.5/10⁵), Lubuskie (82.9/10⁵) and Podkarpackie (189/10⁵). In Germany, the highest number of male deaths was recorded in Sachsen-Anhalt and Mecklenburg-Vorpommern, while the lowest number of deaths was recorded in Baden-Württemberg and Bayern. In contrast, the highest number of female deaths was recorded in Bremen and Berlin, the lowest number of female deaths was recorded in Baden-Württemberg and Bayern.

CONCLUSION

The research has shown that the spatial diversity of the cancer mortality is largely a consequence of the distribution of the age structure of the population. In 2016, the share of the older population (65 years and more) was definitely higher in Germany (21.2%) than in Poland (16.4%), which indicates advanced aging processes in the German society. However, the dynamics of the aging process of the population, measured by the demographic aging index, were definitely higher in Poland (3.1) than in Germany (1.9). The cancer mortality in Poland was much higher than in Germany. The number of cancer cases and deaths will systematically increase, becoming the main cause of death before the age of 65 for both men and women in the near future. In 2006-2016, the dynamics in cancer incidence and mortality were much higher in Poland than in Germany. The crude incidence rate trend line has got rising character, which means an increase in the cancer incidence in the population. The risk of developing cancer increases with age, reaching a peak in the age groups 75-80 years in Germany and 85-90 years in Poland. The spatial distribution of the cancer death rates shows a great similarity with the share of the older population.

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