



# The COVID-19 pandemic and epidemiology of the most common cancers in the Subcarpathian and Silesian Provinces of Poland

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## Abstract

**Introduction and Objective.** The study aimed to assess the effect of the COVID-19 pandemic and slow cancer burden on the healthcare system of the most frequent cancers in the Subcarpathian and Silesian Provinces of southern Poland in the period 2015–2020.

**Materials and method.** Depersonalized, epidemiological data were obtained from the branches of the National Health Fund of Poland (NFZ) in the Subcarpathian and Silesian Province. The database contained 7,814,870 healthcare services granted to 385,845 patients with disease entities classified as C00–C97, according to the ICD-10.

**Results.** In the period 2015–2020, cancer diseases were diagnosed in 3,445 per 100,000 citizens of the Subcarpathian Province and 5248 per 100,000 citizens of the Silesian Province. The changes in SMR values due to cancer diseases found in the Subcarpathian Province were characterized by temporal and spatial differentiation. In the period 2016–2019, unencumbered by the COVID-19 pandemic, the SMR values had decreased on average by -13.2% in most counties of the Subcarpathian Province, but in 2020 the SMR values decreased by -14.7% compared to 2019. In the Silesian Province, similar to the Subcarpathian Province, the values of SMR decreased in the period 2016–2019 in all counties (with the exception of the town of Piekary Śląskie), on average, by -11.5%. Subsequently, in 2020, a significant reduction of SMR compared to 2019 was observed on average by -7.9%.

**Conclusions.** In 2020, a significant reduction in the diagnosis of patients with cancer was found in the one-year perspective study in both Provinces, which suggests the limitation of availability of the specialistic oncologic healthcare services due to the fight against the COVID-19 pandemic. An increased burden of cancers shortly should be expected. Thus, regional and nationwide screening programmes should be introduced to enable diagnosis at the earliest possible stage.

## Key words

epidemiology, COVID-19, oncological diseases, Silesian Province, Subcarpathian Province

## INTRODUCTION

Non-communicable diseases, including oncological diseases, are the leading cause of morbidity and mortality in European societies, and the costs of oncological healthcare have increased more than in other medical sectors, over 40% in the period 2010–2020 [1, 2, 3]. According to estimates, 4 million new incidents of cancer will be diagnosed in 2020 and there will be almost two million cancer deaths in Europe [4].

Moreover, the worldwide trends of population aging combined with an increase in non-communicable diseases burden will cause neoplastic diseases to become the leading cause of health inequalities and one of the most serious challenges for public health [5].

In the middle of this unfavorable epidemiological reality,

a new coronavirus responsible for the COVID-19 pandemic occurred in Wuhan, in the Hubei province of China [6]. This has become the most pressing health problem worldwide, as well as the leading burden for healthcare systems and resources. Involvement of the international community and medical staff in fighting the pandemic should not obscure chronic health problems, such as cancer diseases.

Poland is one of the countries of the former Communist bloc which underwent a social and economic transformation at the turn of the 1980s and 1990, the consequence of which included changes in lifestyle and the burden of risk factors of non-communicable diseases, as well as an increase in sedentary workload, urban lifestyle, and high-calorie foods intake [7]. After more than 30 years of the transformation, significant differences in terms of economic resources, social conditions, and healthcare resources between each of the Polish Provinces have occurred. From this aspect, the Subcarpathian and Silesian Provinces may be examples of the heterogeneity between Provinces.

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## OBJECTIVE

The aim of the study was to assess the effect of the COVID-19 pandemic, and the slow cancer burden on the healthcare system of the most frequent cancers constituting the most significant problem for the public health, diagnosed in two regions of southern Poland, the Subcarpathian and Silesian Provinces, in the period 2015–2020, and identification of the areas where the fight against the COVID-19 pandemic has resulted in a change in the number of diagnosed cancer patients. Moreover, the comparative epidemiological analysis of the two differing Provinces, supplemented with the assessment of selected potential social, economic, and environmental factors, allows for the identification of areas with an increased cancer burden, in which programmes for the prevention and promotion of health are necessary.

## MATERIALS AND METHOD

**Ethical approval.** Due to its retrospective character, the study did not require permission from the Bioethical Committee of the Medical University of Silesia (N° PCN/CBN/022/KB/175/21). All methods were conducted following relevant guidelines and regulations, and respected the confidentiality of biomedical data.

**Regional characteristics.** The Subcarpathian and Silesian Provinces are two regions located in southern Poland, inhabited in 2020 by 17.3% of the Polish population (2,121,229 and 4,449,330 citizens, respectively). Apart from their close proximity, the Provinces differ from one another. The Silesian Province is one of the most densely populated Provinces in Poland with a high percentage of urbanization (76.5%), and a significant density of industrial centres resulting in adverse environmental conditions. On the other hand, the Silesian Province ensures a relatively good availability of healthcare services, including high-reference specialist units and clinical centres. In turn, the Subcarpathian Province has the lowest value of urbanization's coefficient nationwide (41.4%), with simultaneously the biggest percentage of green areas in the total territory which ensure environmental conditions

conducive to maintaining health. However, despite the favourable environmental conditions, the availability and accessibility to specialist healthcare services in the Subcarpathian Province are limited.

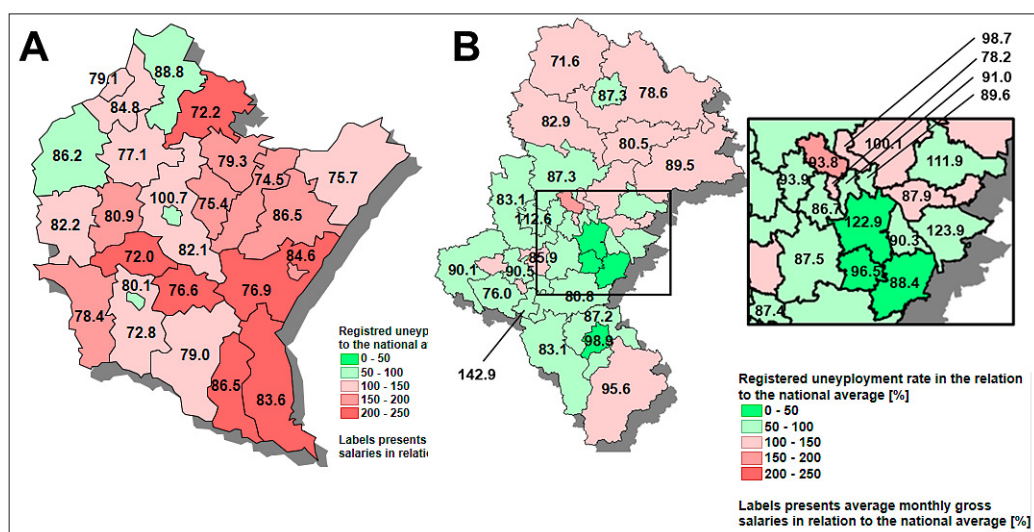
The differences described above mean that a comparative epidemiological analysis of both Provinces may allow for the identification of social and environmental factors that differentiate the burden of cancer disease (Tab. 1, Fig. 1).

**Table 1.** Baseline characteristics of the Subcarpathian and Silesian Provinces (data for 2016)

	Subcarpathian Province	Silesian Province
Population (N)	2,127,656	4,559,164
Density per 1 km <sup>2</sup>	119	370
Number of MD per 10,000 citizens	26.5	38.8
Number of hospital beds per 10,000 citizens	48.6	55.7
Number of hospital beds in oncology units per 10,000 citizens	1.4	2.0
Unemployment in relation to the national average (%)	140.2	80.5
Gross salary in relation to the national average (%)	85.2	100.1
Beneficiaries of social assistance per 10,000 citizens	887	442

The depersonalized, epidemiological data used for this retrospective, epidemiological study was obtained from branches of the National Health Fund of Poland (NFZ) in the Subcarpathian and Silesian Provinces Data within healthcare services financed by the NFZ in the following ranges, from hospitalization in clinical oncology units (including one-day hospitalizations), hospitalizations in the oncological radiotherapy units (including one-day hospitalizations and all organizational forms of radiotherapy services), hospitalizations in oncological and general surgery units and outpatient oncological specialist healthcare granted in the Subcarpathian and the Silesian Provinces in 2015–2020, to patients with diagnosed disease entities classified as C00 – C97, according to the ICD-10 classification.

The database contained 7,814,870 healthcare services granted to 385,845 patients in both regions. Patients



**Figure 1.** Average monthly gross salary in relation to the national average and unemployment rate in current counties of the Subcarpathian (A) and the Silesian (B) Provinces (data for 2016)

residing outside the Subcarpathian or Silesian Provinces were excluded from the study, and due to the different risk profiles and diagnosed neoplastic diseases, patients less than 20 years of age were also excluded.

After applying the exclusion criteria, data were aggregated and finally a total of 251,373 patients were enrolled in the analysis: 193,016 patients from the Silesian Province and 58,357 from the Subcarpathian Province.

**Epidemiological analysis.** Epidemiological analysis was performed according to the division of the Provinces into counties, according to the patients place of residence. Unlike reports based on registry data, the current study was based on an analysis of the data from the medical treatment billing process by the NFZ, which is the only entity in Poland that settles healthcare services financed from public funds. Therefore the data obtained from the NFZ can be considered the most reliable and complete.

For each of the Provinces and counties, the most frequent cancers managed in the period 2015–2020 in the whole population, as well as division according to gender, was identified. Subsequently, for the five most frequent cancers diagnosed in each of the groups, the incidence rate per 100,000 population standardized to the European Standard Population 2013 (ESP 2013), were determined with the use of Formula 1:

$$SMR = \frac{\sum_{i=1}^N \frac{k_i}{n_i} \cdot w_i}{\sum_{i=1}^N w_i}$$

where:

$N$  – number of age groups;

$k_i$  – number of cases in an  $i$ -age group;

$n_i$  – population size in an  $i$ -age group;

$w_i$  – weight assigned to an  $i$ -age group based on ESP 2013.

To assess the basic level of the burden of cancer incidence, as well as the effect of the COVID-19 pandemic, three time-points were selected: 2016, 2019, and 2020, for which the standardized morbidity rates (SMR) were calculated. Furthermore, the variability of SMR between each of the time-points as the percentage change was determined.

For gender-associated cancers, the abundance of females or males, respectively, were regarded as the exposed population. Because of the small number of incidents of breast cancer among men in 2015–2020 ( $N=231$ ), those cases were excluded, consequently women were considered to be the exposed population.

Data on the state of the population in each of the Provinces and counties, as well as selected social and economic factors, were obtained from the Statistics Poland database.

**Statistical analysis.** Statistical analyses were performed with R Cran x64 v. 3.3.1 software (Lucent Technologies FR, Vienna, Austria) and Statistica v. 13.3 software (TIBCO Software Inc., Palo Alto, CA, USA).

The interval data were expressed as mean value  $\pm$  standard deviation in the case of a normal distribution, or as median (lower quartile – upper quartile) in the case of data with a non-normal distribution. The distribution of variables

was evaluated by the Kolmogorov-Smirnov test, and the homogeneity of variances was assessed by the Levene test. To compare the average age of patients diagnosed with oncological disease variation with the domicile region and the diagnosis timepoint, two-way ANOVA was used. Categorical variables were compared using the  $\chi^2$  test. Differences were presented as mean with a 95% of confidence interval (CI). Statistical significance was set at a  $p$ -value below 0.05. Two-tailed tests were used.

## RESULTS

In the period 2015–2020, overall, 251,373 patients suffered from cancers: Subcarpathian Province ( $N=58,357$ ) and Silesian Province ( $N=193,016$ ), yielding a mean annual raw incidence rate of 689.1 and 1049.6 per 100,000 citizens, respectively.

Males constituted 44.9% of patients and the percentage of males in the group of oncological patients in the Subcarpathian Province, which was significantly higher compared to the Silesian Province (46.8% vs. 44.3%  $p < 0.001$ ). Both in the Subcarpathian and Silesian Provinces the average age of men at the time of diagnosis was higher compared to women (67 (60–74) vs. 65 (57–74) and 68 (61–75) vs. 66 (57–74), respectively ( $p < 0.001$ )). The differences between Provinces and between each of the time-points were not clinically relevant.

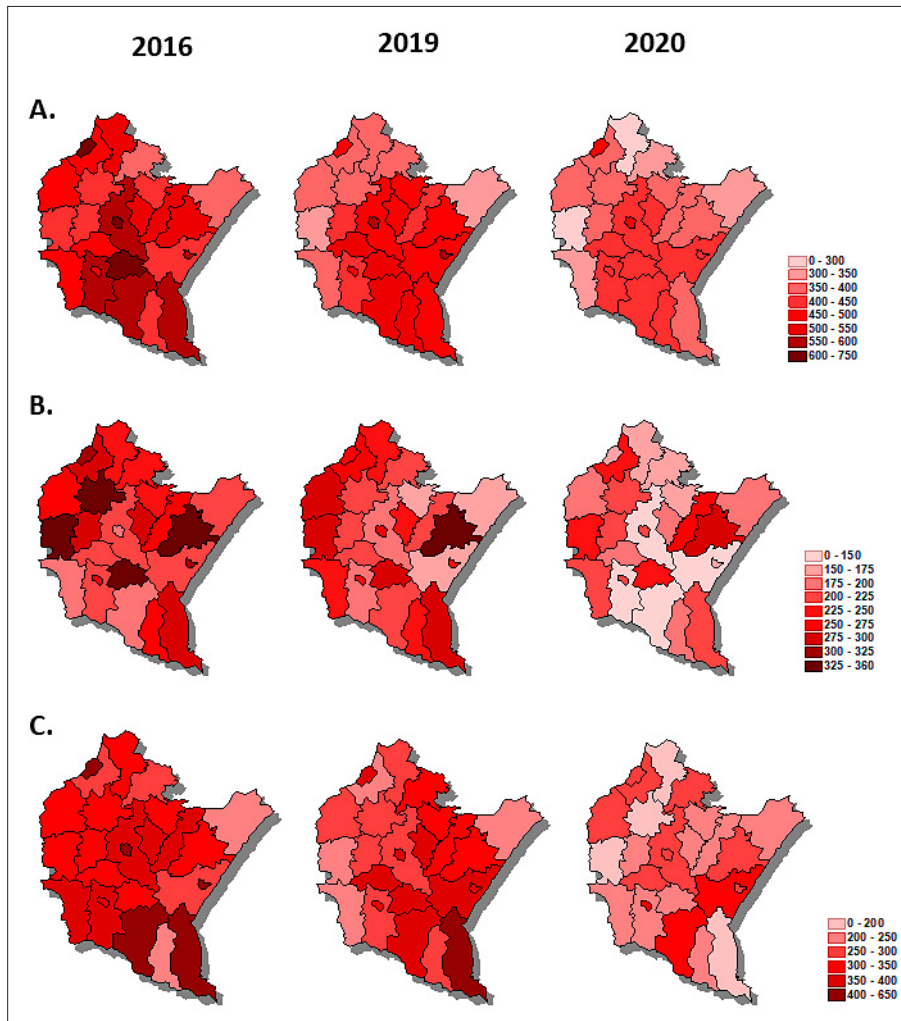
**Subcarpathian Province.** At the beginning of the analysed period at the 2016 time point, the highest values of SMR in all populations of Subcarpathian Province were observed in Brzozów county and the large urban centres of Tarnobrzeg, Przemyśl and Rzeszów. In the following years, the SMR decreased in each county of the Province, remaining at the highest values in the mentioned towns.

The changes found in SMR values due to cancer diseases were characterized by a clear temporal and spatial differentiation. In the period 2016–2019, unencumbered by the COVID-19 pandemic, the SMR values decreased, on average, by -13.2% (95% CI: -20.6% – -2.5%) in most counties of the Subcarpathian Province, with the exception of Lesko, Leżajsk, Nisko, Przemyśl and Strzyżów counties. Meanwhile, in 2020, the SMR values decreased by -14.7% (95% CI: -17.5% – -8.3%) compared to 2019. Such a sharp reduction in the management of cancer diseases in the one-year perspective suggests the limitation of availability of the specialistic oncologic healthcare services.

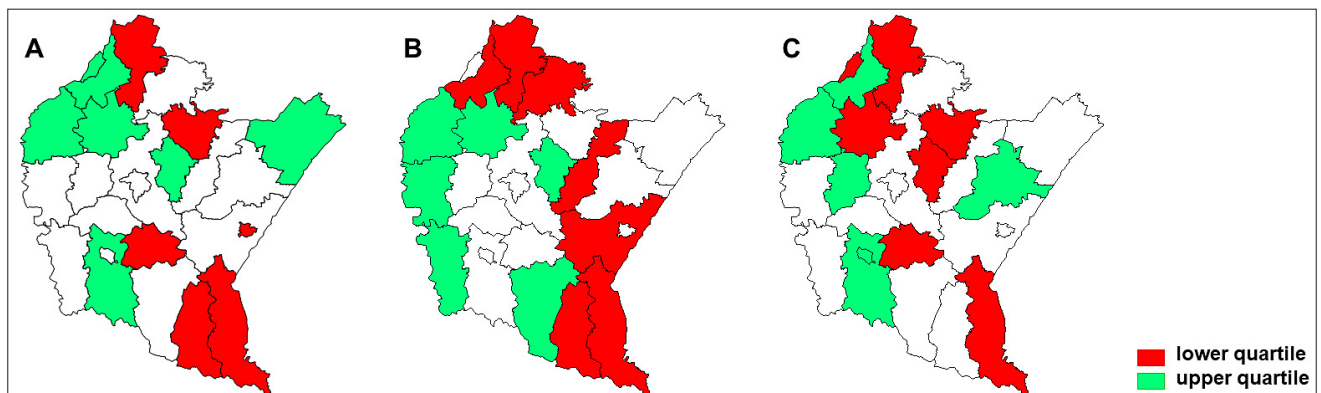
The SMR value determined per 100,000 citizens in the Subcarpathian Province is presented in Figure 2 and the percentage changes of SMR due to neoplastic diseases between 2016, 2019, and 2020 are presented in Table 2 and Figure 3.

The most significant burden for the healthcare system, as well as a serious problem for public health, was constituted by cancer diseases which were the most common. In the period 2015–2020, the most frequently cancers diagnosed among women were: 1) malignant neoplasm of the breast (C50), 2) malignant colorectal neoplasm – CRC (C18-C21), 3) malignant neoplasm of the corpus uteri (C54), 4) other malignant neoplasms of the skin (C44) and 5) malignant neoplasm of ovaries (C56). Meanwhile, in men the most often treated diseases of this type were: 1) malignant neoplasm of





**Figure 2.** SMR per 100,000 citizens of cancer diseases values in the Subcarpathian Province in 2016, 2019, and 2020; A – no gender division; B – women; C – men



**Figure 3.** Changes in SMR per 100,000 citizens of the most frequent cancer diseases in the Subcarpathian Province in 2020, compared to 2019 (A – total group, B – women, C – men)

the prostate (C61), 2) CRC (C18-C21), 3) malignant neoplasm of bronchus and lung (C34), 4) other malignant neoplasms of the skin (C44) and 5) malignant neoplasm of the kidney, excepting renal pelvis (C64).

The SMR values determined per 100,000 citizens for the most frequent cancers diseases managed among females and males in the Subcarpathian Province are presented in Figures 4 and 5.

The highest values of the SMR of cancer diseases in 2016 were noted in the biggest urban areas; cities included in the metropolitan areas and cities of of Upper Silesia, Zagłębie, Częstochowa and Bielsko-Biała. In the Silesian Province, similar to the Subcarpathian Province, the values of SMR decreased in the period 2016–2019 in all counties, with the exception of the town of Piekary Śląskie, on average by -11.5% (95% CI: -18.0% – -9.2%). Subsequently, in 2020, a significant

**Table 2.** Percentage change of the SMR in 2016-2020 in the population of the Subcarpathian Province, and the percentage change of the most frequent cancer diseases diagnosed among women and men

	Total group			Women				Men	
	2020 vs. 2016	2019 vs. 2016	2020 vs. 2019	2020 vs. 2016	2019 vs. 2016	2020 vs. 2019	2020 vs. 2016	2019 vs. 2016	2020 vs. 2019
town of Krosno	-20.6%	-13.2%	-8.5%	-25.9%	-2.5%	-24.0%	-7.4%	-8.0%	0.6%
town of Przemyśl	-25.8%	-2.5%	-23.8%	-26.0%	-13.3%	-14.7%	-34.3%	-16.5%	-21.3%
town of Rzeszów	-34.4%	-20.6%	-17.4%	-32.8%	-17.6%	-18.5%	-44.3%	-31.1%	-19.1%
town of Tarnobrzeg	-32.2%	-30.2%	-2.8%	-19.9%	-2.2%	-18.1%	-58.4%	-42.0%	-28.2%
Bieszczadzki county	-34.9%	-17.8%	-20.8%	-37.0%	-11.5%	-28.8%	-62.9%	-15.4%	-56.2%
Brzozów county	-35.0%	-12.0%	-26.1%	10.1%	25.4%	-12.1%	-27.0%	23.3%	-40.8%
Dębica county	-39.5%	-26.7%	-17.5%	-37.8%	-36.2%	-2.5%	-36.4%	-30.3%	-8.7%
Jarosław county	-23.2%	-9.8%	-14.9%	-33.3%	-14.6%	-21.9%	-19.2%	-15.4%	-4.5%
Jasło county	-33.4%	-23.7%	-12.7%	-35.1%	-31.3%	-5.5%	-40.9%	-33.6%	-11.1%
Kolbuszowa county	-14.2%	-10.2%	-4.5%	-14.0%	-15.6%	1.9%	-38.8%	-14.5%	-28.4%
Krosno county	-24.5%	-22.6%	-2.5%	-35.7%	-12.7%	-26.4%	-37.0%	-33.8%	-4.9%
Lesko county	-5.4%	22.5%	-22.8%	-27.0%	8.6%	-32.8%	12.4%	29.0%	-12.8%
Leżajsk county	-19.6%	6.7%	-24.7%	-27.0%	-8.5%	-20.3%	-35.3%	-3.1%	-33.2%
Lubaczów county	-21.2%	-23.5%	3.1%	-32.7%	-23.4%	-12.0%	-15.5%	-1.1%	-14.6%
Łańcut county	-20.4%	-13.2%	-8.3%	-4.1%	-26.3%	30.1%	-39.2%	-4.9%	-36.1%
Mielec county	-19.4%	-15.9%	-4.2%	-26.3%	-29.9%	5.0%	-6.8%	-4.0%	-3.0%
Nisko county	-9.4%	3.7%	-12.6%	-41.5%	-15.3%	-31.0%	-9.9%	19.1%	-24.4%
Przemyśl county	-6.3%	9.8%	-14.7%	-20.6%	19.8%	-33.7%	11.0%	20.7%	-8.0%
Przeworsk county	-28.3%	-14.0%	-16.6%	-31.1%	-0.8%	-30.5%	-33.4%	-14.2%	-22.4%
Ropczyce-Sędziszów county	-14.4%	-2.1%	-12.5%	-16.3%	-5.4%	-11.5%	-22.0%	-21.9%	-0.1%
Rzeszów county	-21.7%	-13.9%	-9.1%	-20.3%	-13.4%	-7.9%	-26.3%	-20.7%	-7.0%
Sanok county	-25.4%	-12.3%	-15.0%	-16.7%	-11.8%	-5.5%	-25.2%	-17.0%	-9.9%
Stalowa Wola county	-42.2%	-23.1%	-24.9%	-44.7%	-21.6%	-29.4%	-47.5%	-12.2%	-40.2%
Strzyżów county	-14.3%	3.6%	-17.3%	21.7%	48.7%	-18.1%	-22.4%	2.8%	-24.5%
Tarnobrzeg county	-17.1%	-20.2%	3.9%	-46.6%	-18.8%	-34.3%	7.3%	-17.9%	30.6%
Me (Q <sub>1</sub> – Q <sub>3</sub> )	<b>-21.7%</b> (-32.2% – -17.1%)	<b>-13.2%</b> (-20.6% – -2.5%)	<b>-14.7%</b> (-17.5% – -8.3%)	<b>-27.0%</b> (-35.1% – -19.9%)	<b>-13.3%</b> (-18.8% – -2.5%)	<b>-18.1%</b> (-28.8% – -7.9%)	<b>-27.0%</b> (-38.8% – -15.5%)	<b>-14.5%</b> (-20.7% – -3.1%)	<b>-14.6%</b> (-28.2% – -7.0%)

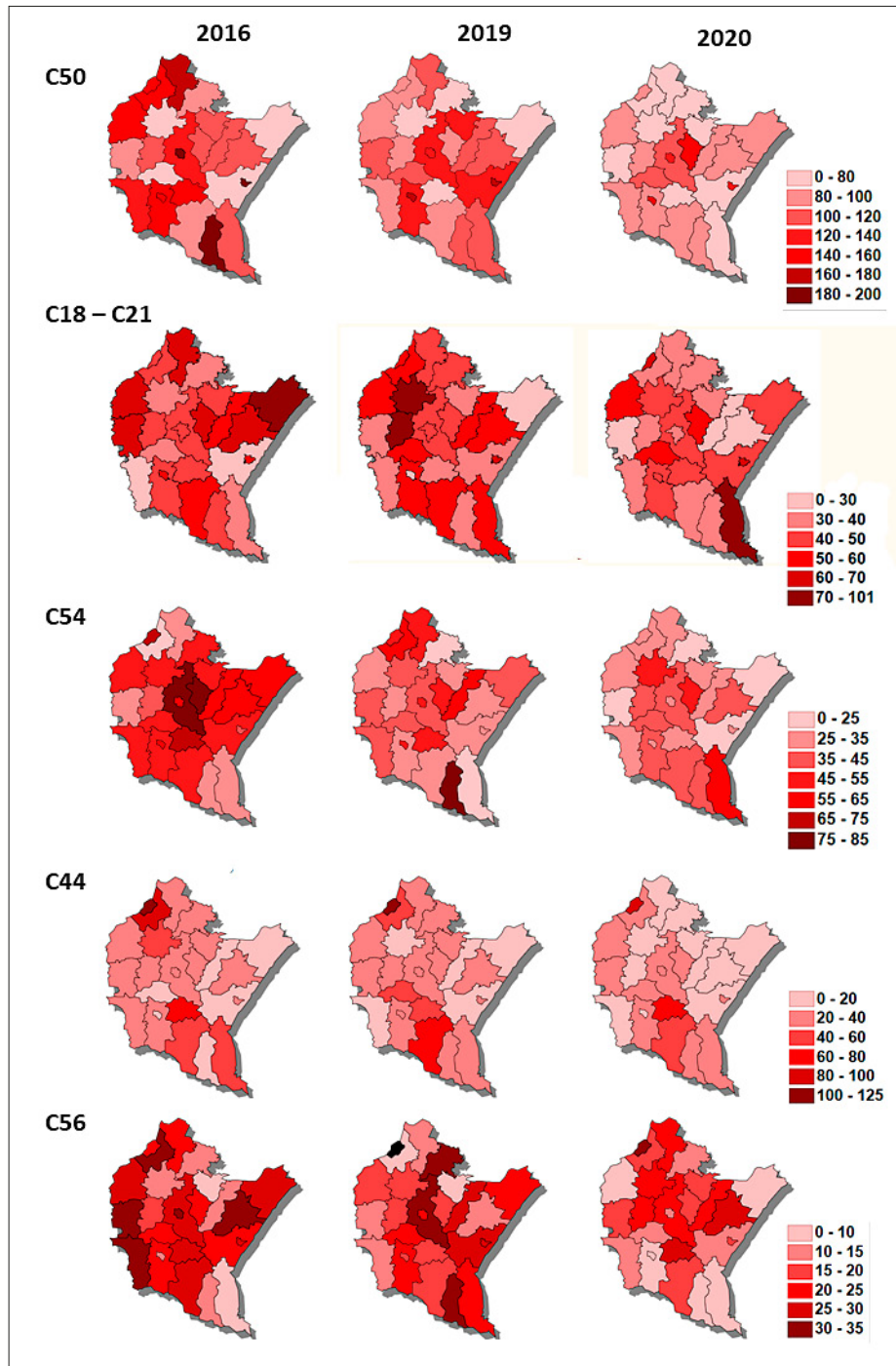
reduction of SMR was observed, compared to 2019, especially in Rybnik, Myszków, Żywiec and Piekary Śląskie, on average by -7,9% (95% CI: -12.6% – -3.2%). It should be noted that in all analyzed periods in the county and city of Gliwice, a stable decreasing trend of SMR values was maintained. The SMR value determined per 100,000 citizens in the Silesian Province is presented in Figure 6, and the percentage changes of SMR due to cancer diseases between 2016, 2019, and 2020, are presented in Table 3 and Figure 7.

The most frequent cancer diseases treated in 2015–2020 in the Silesian Province were similar to those among the Subcarpathian population; among women: 1) malignant neoplasm of the breast (C50), 2) CRC (C18 – C21), 3) malignant neoplasm of the corpus uteri (C54), 4) malignant neoplasm of bronchus and lung (C34) and 5) other malignant neoplasms of the skin (C44). Among men, the most often diagnosed neoplastic diseases did not differ from those in the Subcarpathian Province. The SMR values determined per 100,000 citizens for the most frequent cancer diseases in women and men in the Silesian Province are presented in Figures 8 and 9.

## DISCUSSION

Besides the fact that coronavirus SARS-CoV-2 and affected by it COVID-19 disease has become the most urgent problem for global public health concerning non-communicable diseases, including neoplastic diseases, remains the leading long-term health problem in most European societies. The incidents of cancer diseases diagnosed in Europe constitute a quarter of all cases worldwide. Over a quarter of worldwide cancer incidents concern Europe, although Europeans constitute only 10% of the global population [4]. It should be noted that cancer diseases remain the leading cause of premature deaths in 28 of the 40 European countries, and is the second in the rest of the countries [8, 9]. The social importance, as well as the economic burden of cancer diseases, will increase shortly due to the aging process observed in most EU member states, in combination with an increasing survival rate among patients. Hence, epidemiological studies and screening in areas with an increased oncological burden, both from the social and economic aspects, are essential.

In the current study, 251,373 patients with diagnosed neoplastic disease, in both the Subcarpathian and Silesian Provinces, were enrolled in the analyses. In the study group,



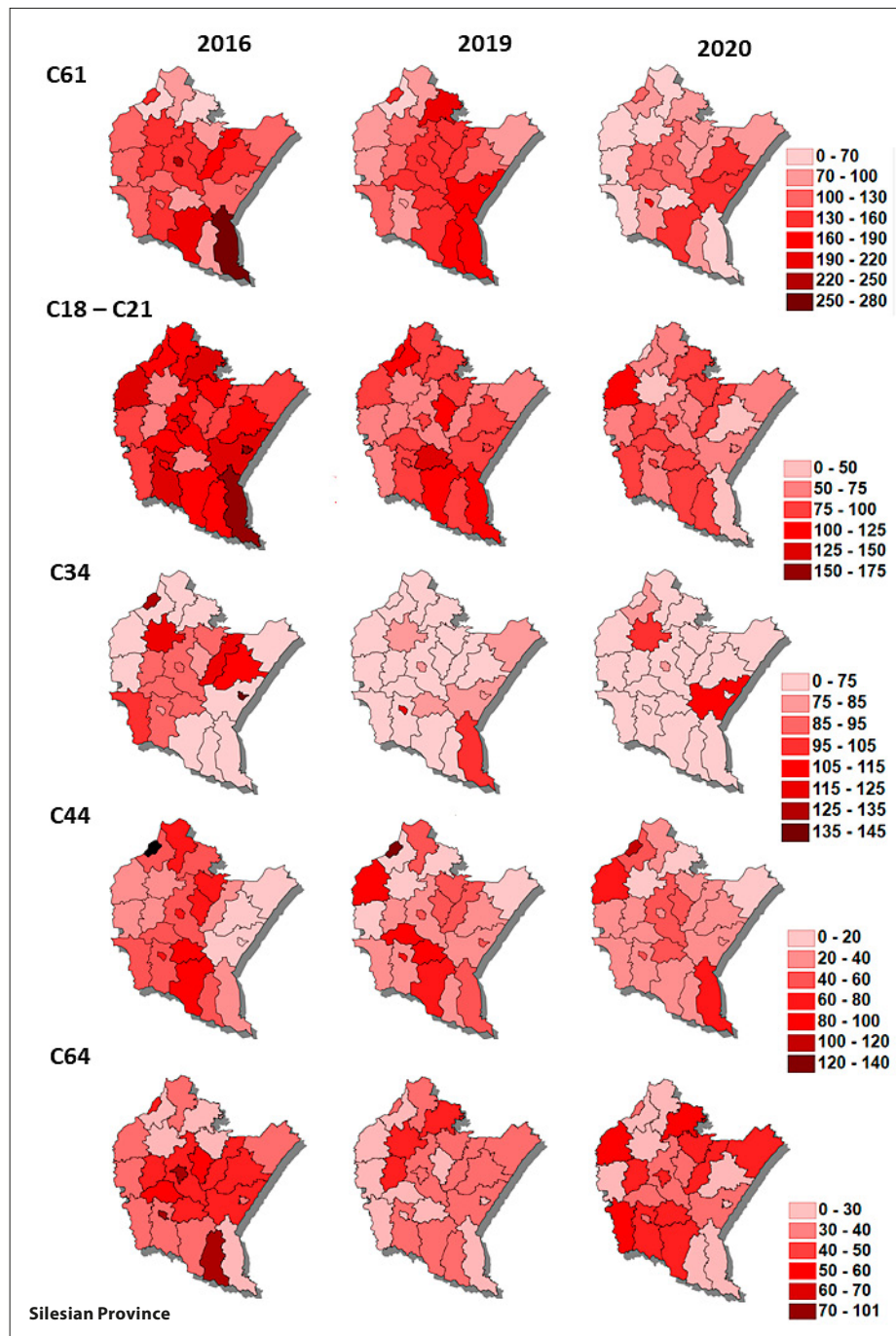
**Figure 4.** SMR per 100,000 citizens of the most frequent cancer diseases in women in the Subcarpathian Province in 2016, 2019, and 2020

men constituted 44.9% of patients and there was a slight difference between Provinces – higher in the Subcarpathian Province. The results obtained differ from the estimates by Dyba et al., according to which 53% of about 4 million new cancer diseases which will be diagnosed in Europe in 2020, will concern men [4]. This observation may be explained by the male profile differences between Poland and Western Europe, and the relationship between the higher education level and health-conducive lifestyle, which is the result of increased health concern and knowledge about risk factors for the development of diseases [7]. In the Subcarpathian Province, only 23.5% of men had tertiary education and

in the Silesian Province – 25.2%. These values are lower in comparison to nationwide data (26.9%), as well as data from the European Union member states (30.4%) [10].

Apart from some gender morbidity differences, the most common cancer diseases diagnosed in the analysed Provinces did not differ from available European data. Both in the Subcarpathian and Silesian Provinces, the most frequent cancer disease diagnosed in women were malignant neoplasm of the breast, CRC, of the corpus uteri, and other malignant neoplasms of the skin. Moreover, in the Silesian Province, malignant neoplasm of the bronchus and lung remains a serious health problem that may be affected by adverse



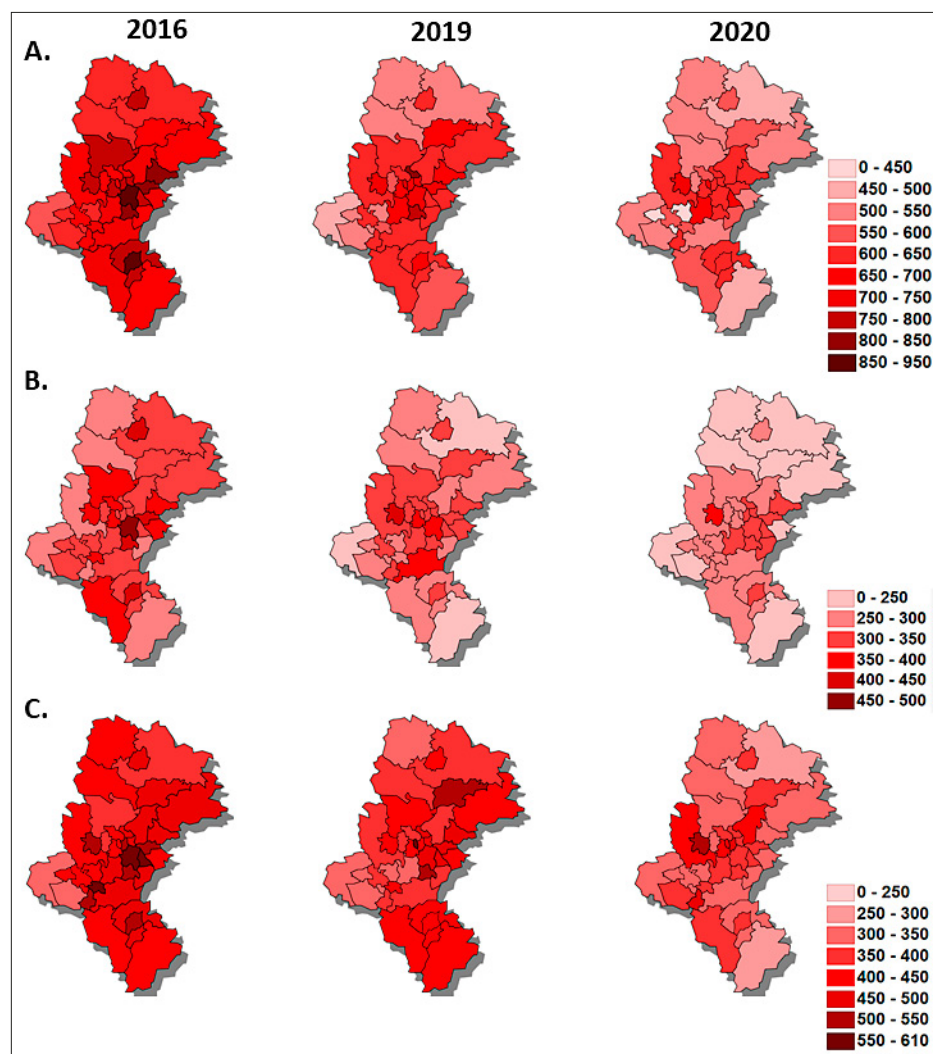


**Figure 5.** SMR per 100,000 citizens of the most frequent cancer diseases among men in the Subcarpathian Province in 2016, 2019, and 2020

environmental conditions, including pollution and poor air quality observed in most urban and suburban areas [11]. The correlation between an exposition of the Silesian inhabitants to air pollution ( $PM_{10}$  fraction and benzo(a)pyrene) and their length of life, as well as an association between the risk of lung cancer and air pollution are well established [12–14]. Additionally, an increased morbidity of malignant neoplasm of ovaries was observed in the Subcarpathian Province.

The highest values of SMR for breast cancer were observed in the biggest urban centres, both in the Subcarpathian and Silesian Provinces. This phenomenon may be explained by the greater number and availability of preventive programmes financed by the local governments of wealthy

towns. According to Augustynowicz et al., in 2009–2014, 1,646 breast cancer prevention programmes financed by municipalities, counties and the authorities of self-governed Provinces were introduced in Poland. Simultaneously, both in the Subcarpathian and Silesian Provinces, there were more secondary than primary prevention programmes [15]. The results obtained in the current study correspond to those obtained by Chakalova et al., who found that the highest age-standardized incidences rates (ASR) values of breast cancer were noted in the biggest urban centres in Bulgaria, with significant spatial diversity between rural and urban areas [16]. Urban domicile is associated with a higher socio-economic status which affects the higher



**Figure 6.** SMR per 100,000 citizens of cancer diseases in the Silesian Province in 2016, 2019, and 2020. (A – no gender division; B – women; C – men)

breast cancer morbidity [17]. Similarly, an increase of ASR from 145.3 per 100,000 in 2001–2003 to 163.9 per 100,000 in 2010–2012 in the inverse of the socio-economic gradient has been described [5]. Hence, some authors underline that the increased number of breast and uterine cancers is connected with the final phase of epidemiological transformation, characterized by the increased burden of non-communicable diseases [18].

It should be noted that the high value of incidents of breast cancer diagnosed in favourable social conditions may be a result of the high availability of healthcare resources, including diagnostic procedures. The relationship between the higher percentage of women performing mammography and the higher education level and socio-economic status is well known [19]. Moreover it should be mentioned that the Polish breast cancer early detection programme introduced in 2006 is relatively new and still ineffective. Moreover, in 2015, the funds dedicated to this programme were reduced which resulted in a decrease of coverage in the population eligible for the examination from 42% – 37% in 2016–2019 [20]. Such a reduction in the funds exacerbates the inequalities in access to diagnostic procedures, especially for individuals of low socio-economic status. Against these facts, the high values of SMR for breast cancer observed in 2016 in Lesko

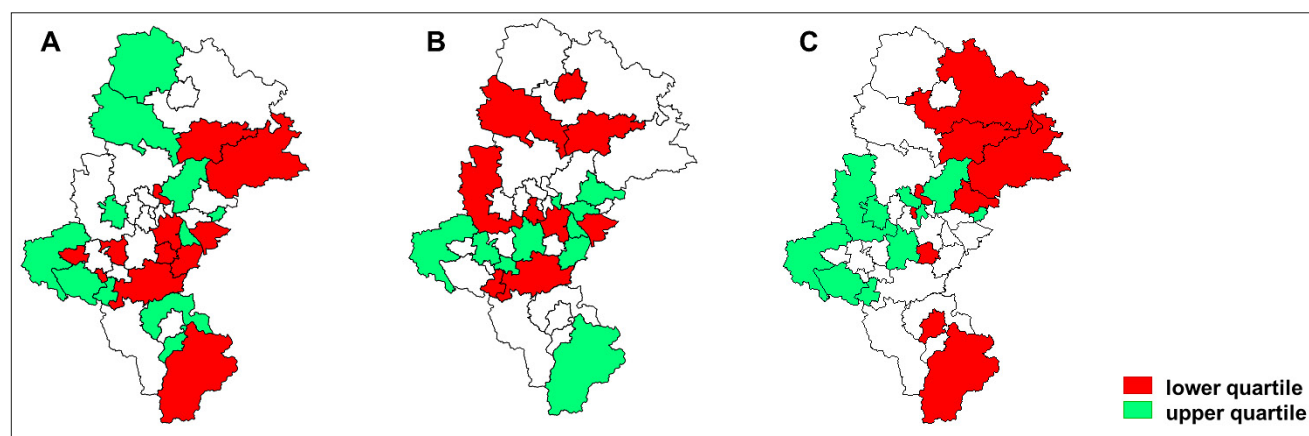
county of the Subcarpathian Province, are worrying and require further investigation.

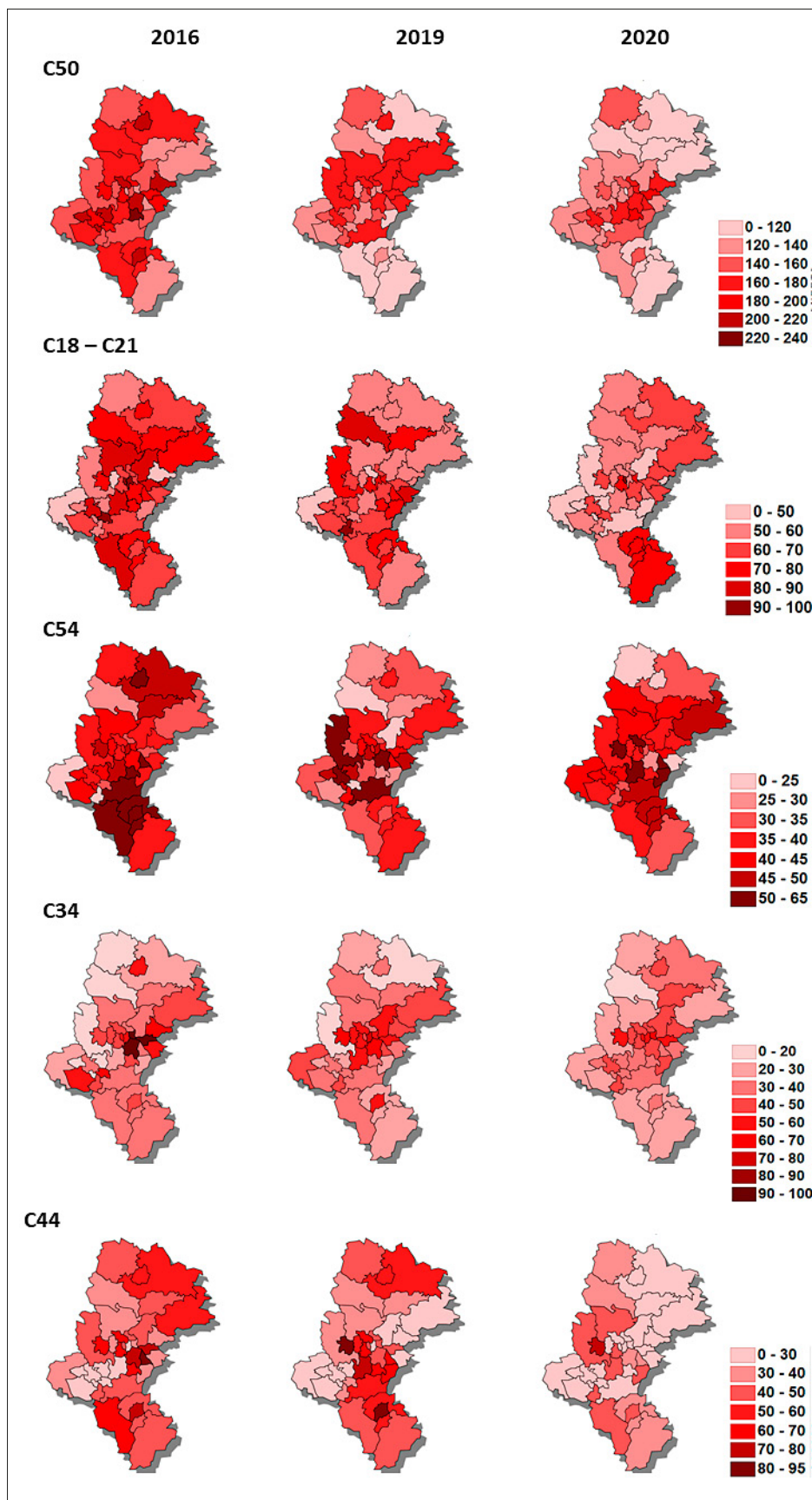
Meanwhile, the most frequent cancer diagnosed among men in the Subcarpathian as well as in the Silesian Province was the malignant neoplasm of the prostate, with the observed values of SMR being similar in both Provinces but with some spatial diversity, especially in the Silesian Province. The highest values of SMR were noted in the biggest urban centres and the neighbouring counties, and the burden of prostate cancer increased in most counties in each of the Provinces. These observations are confirmed by the literature in which the increasing trends of morbidity of prostate cancer were observed in most countries of Eastern and Southern Europe, while the highest SMR values were observed in Western and Northern Europe [1]. A relationship was also established between the increased incidence rate of prostate cancer observed among men living in favourable socio-economic conditions. Generally, the highest incidence rates of prostate cancers and breast cancer observed in favourable socio-economic environments [5] result from the greater health awareness of patients and the availability of diagnostic programmes. The common usage of Prostate Specific Antigen (PSA) for prostate cancer screening results in a certain amount of over-diagnosis and over-treatment [9].



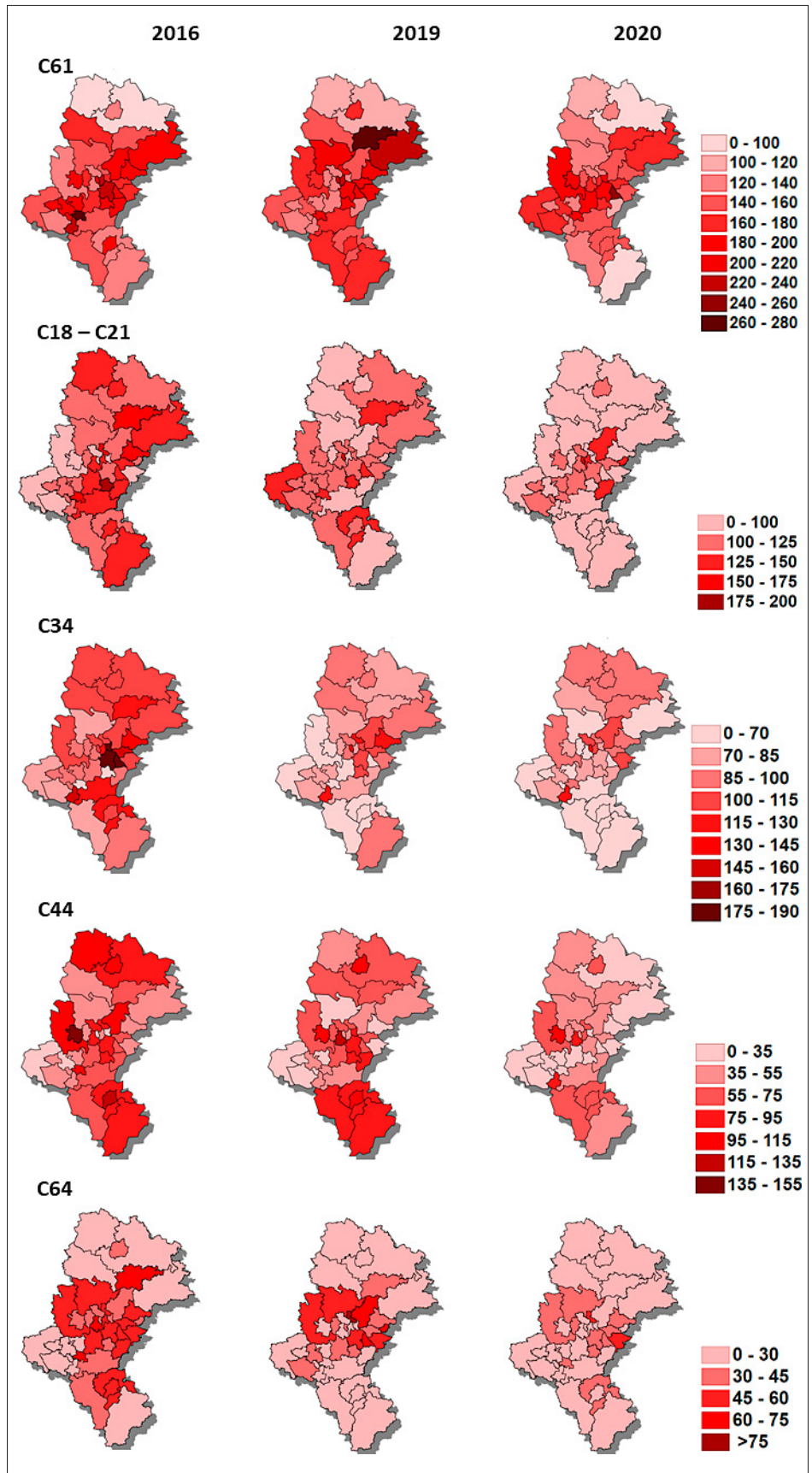
**Table 3.** Percentage change of SMR in 2016-2020 in the population of the Subcarpathian Province, and percentage change of the most frequent cancer diseases diagnosed in women and men

City	Total group				Women			Men	
	2020 vs. 2016	2019 vs. 2016	2020 vs. 2019	2020 vs. 2016	2019 vs. 2016	2020 vs. 2019	2020 vs. 2016	2019 vs. 2016	2020 vs. 2019
Bielsko-Biała	-26.1%	-18.8%	-9.0%	-22.0%	-16.9%	-6.1%	-35.9%	-18.1%	-21.8%
Bytom	-15.7%	-9.1%	-7.4%	-20.8%	-11.4%	-10.6%	-10.4%	-7.8%	-2.9%
Chorzów	-18.4%	-11.0%	-8.3%	-11.3%	-1.2%	-10.2%	-14.6%	-23.7%	12.0%
Częstochowa	-26.8%	-17.7%	-11.1%	-35.9%	-23.7%	-16.0%	-18.0%	-11.9%	-6.9%
Dąbrowa Górnicza	-24.9%	-16.1%	-10.6%	-14.9%	-17.1%	2.7%	-37.9%	-14.4%	-27.4%
Gliwice	-10.0%	-9.4%	-0.7%	-4.5%	-0.2%	-4.3%	-8.6%	-18.9%	12.8%
Jastrzębie-Zdrój	-4.4%	-8.3%	4.2%	1.2%	24.4%	-18.7%	-17.6%	-24.8%	9.5%
Jaworzno	-25.8%	-12.1%	-15.6%	-30.2%	-6.5%	-25.3%	-14.1%	3.7%	-17.2%
Katowice	-29.5%	-19.3%	-12.6%	-33.3%	-21.0%	-15.6%	-33.2%	-19.5%	-17.1%
Mysłowice	-15.0%	-20.5%	6.8%	2.7%	-5.4%	8.6%	-33.8%	-19.4%	-17.8%
Piekary Śląskie	-11.5%	12.2%	-21.2%	-9.6%	-5.5%	-4.3%	-20.5%	41.0%	-43.6%
Ruda Śląska	-16.4%	-9.2%	-8.0%	-18.0%	-3.4%	-15.1%	-10.8%	-4.3%	-6.8%
Rybnik	-18.2%	-10.0%	-9.2%	-8.6%	-8.7%	0.1%	-22.0%	-10.5%	-12.9%
Siemianowice Śląskie	-17.1%	-10.2%	-7.7%	-1.2%	-6.6%	5.8%	-21.5%	-11.5%	-11.4%
Sosnowiec	-22.8%	-15.9%	-8.2%	-24.9%	-25.0%	0.1%	-24.0%	-8.4%	-17.0%
Świętochłowice	-5.7%	-0.5%	-5.2%	-12.3%	-1.4%	-11.0%	7.7%	31.7%	-18.2%
Tychy	-22.4%	-9.7%	-14.1%	-27.1%	-22.3%	-6.1%	-31.8%	-4.4%	-28.7%
Zabrze	-17.3%	-11.2%	-6.9%	-14.5%	0.4%	-14.9%	-15.6%	-8.4%	-7.8%
Żory	-25.8%	-22.4%	-4.4%	-33.0%	-33.2%	0.3%	-33.8%	-24.6%	-12.2%
<b>County</b>									
Będzin	-13.8%	-14.1%	0.4%	-19.5%	-10.2%	-10.3%	-15.0%	-16.7%	2.0%
Bielsko-Biała	-20.9%	-19.7%	-1.5%	-20.6%	-14.6%	-7.1%	-27.1%	-15.7%	-13.6%
Bieruń-Lędzin	-18.6%	-5.5%	-13.8%	14.7%	-4.5%	20.1%	-28.7%	-20.2%	-10.7%
Cieszyn	-21.9%	-15.6%	-7.5%	-31.2%	-29.9%	-1.8%	-14.3%	-4.1%	-10.7%
Częstochowa	-25.1%	-19.6%	-6.9%	-30.9%	-27.7%	-4.4%	-27.0%	-5.0%	-23.1%
Gliwice	-7.7%	-4.0%	-3.9%	-7.1%	14.4%	-18.8%	-0.4%	-10.3%	11.0%
Kłobuk	-20.6%	-18.2%	-3.0%	-5.0%	1.5%	-6.4%	-27.7%	-25.2%	-3.3%
Lubliniec	-11.6%	-11.6%	0.0%	-22.5%	-7.4%	-16.3%	-21.2%	-12.9%	-9.5%
Mikołów	-8.8%	-5.5%	-3.4%	3.3%	0.1%	3.2%	-16.3%	-23.7%	9.8%
Myszków	-18.8%	-2.9%	-16.4%	-22.9%	-0.6%	-22.5%	-28.0%	2.6%	-29.8%
Pszczyna	-28.8%	-18.4%	-12.8%	-11.1%	12.2%	-20.8%	-30.1%	-22.6%	-9.7%
Racibórz	-13.8%	-17.1%	4.0%	-10.1%	-10.1%	0.1%	7.6%	1.5%	6.0%
Rybnik	-56.3%	-13.0%	-49.8%	-15.6%	-6.8%	-9.4%	-24.0%	-20.8%	-4.0%
Tarnowskie Góry	-26.9%	-19.7%	-8.9%	-24.6%	-12.2%	-14.2%	-15.9%	-0.3%	-15.7%
Wodzisław Śląski	-13.4%	-11.3%	-2.4%	-24.8%	-21.4%	-4.3%	9.2%	0.9%	8.3%
Zawiercie	-21.2%	-9.8%	-12.6%	-21.6%	-7.8%	-15.0%	-30.9%	-7.4%	-25.3%
Żywiec	-23.7%	-9.2%	-16.0%	-11.3%	-13.9%	3.0%	-40.4%	-7.4%	-35.6%
<b>Me (Q<sub>1</sub> – Q<sub>3</sub>)</b>	<b>-18.7%</b> <b>(-25.0% – -13.8%)</b>	<b>-11.5%</b> <b>(-18.0% – -9.2%)</b>	<b>-7.9%</b> <b>(-12.6% – -3.2%)</b>	<b>-16.8%</b> <b>(-24.7% – -9.1%)</b>	<b>-7.6%</b> <b>(-17.0% – -1.3%)</b>	<b>-6.8%</b> <b>(-15.1% – 0.1%)</b>	<b>-21.3%</b> <b>(-29.4% – -14.5%)</b>	<b>-11.0%</b> <b>(-19.5% – -4.3%)</b>	<b>-11.0%</b> <b>(-18.0% – -3.1%)</b>

**Figure 7.** Changes in SMR per 100,000 citizens of the most frequent cancer diseases in the Silesian Province in 2020, compared to 2019. (A – total group, B – women, C – men)



**Figure 8.** SMR per 100,000 citizens of the most frequent cancer diseases in women in the Silesian Province in 2016, 2019, and 2020



**Figure 9.** SMR per 100,000 citizens of the most frequent cancer diseases in men in the Silesian Province in 2016, 2019, and 2020



Our result corresponds with data published by the National Cancer Registry of Poland (NCR), although the SMR values noted in our study are slightly higher compared to the incidence reported by NCR database [21].

The second most frequently diagnosed cancer among both females and men in both Provinces was CRC (C18-C21), and in Poland is the third most frequently diagnosed cancer after lung and bronchial cancer. This finding corresponds with the results of the Global Burden Diseases Study, according to which CRC was the fifth leading cause of years of life lost (YLL) in Poland [22]. The SMR values of CRC remain stable in 2016–2019 in both Provinces, apart from socio-economic differences, observations correspond with the literature. Tweed et al. found that the ASR had grown among Scottish women from 61.1 in 2001–2003 to 68.8 per 100,000 in 2010–2012, while at the same time, the ASR observed among men remained stable [5].

Generally, the burden and the epidemic conditions of gastrointestinal cancers in Poland are unfavourable. The share of YLL in CRC has increased in Poland from 34.3% in 2002 to 38.1% in 2011. The percentage of deaths has also increased 36.1% to 40.2% of total cancer deaths, respectively [23]. It should be mentioned that relatively low morbidity rates of CRC are accompanied by high mortality [4], corresponding with low utilization of screening colonoscopy and frequent late diagnosis, with a high frequency of metastatic disease.

The significant burden of lung and bronchial cancer observed among the Silesian population and Subcarpathian men may be explained by the adverse environmental conditions, including air pollution and the prevalence of smoking. The long-standing problem of air pollution and the smog-emitting cities of the Silesian Province is well known. According the WOBASH study, the prevalence of active smokers among men in the Silesian Province was the second nationwide, and in the Subcarpathian Province was higher compared to the national average. The percentages of women active smokers, both in the Silesian and Subcarpathian Provinces, were lower compared to the national average [24].

The results of the current study correspond with previous estimates [4] and reports published by the NCR, although there are some differences in quoted SMR values [25, 26]. In most cases, the SMR values (incidence) published by the NCR are lower than those in the current study, showing cancer management. This difference is caused by the diverse methods of data collection. The reports prepared by NCR were based on the malignant neoplasms notification cards (MZ/N-1a sheet) that should be sent by each physician who has diagnosed a patient with cancer. In practice, the method of preparing and the quality completeness of medical documentation is insufficient. There is a tendency for abbreviations and careless ways of preparing medical documentation. Sometimes, even range documentation does not contain important information, in many cases, there is a lack of information necessary for the confirmation and assessment of the disease progression [27]. Moreover, physicians are overloaded by the paperwork which occupies about a quarter to half their work time [28], which may result in the incompleteness of medical documentation. Similar conclusions are found in a report by the Supreme Audit Office of Poland. Low awareness of the correct medical record-keeping among medical staff may be confirmed by many incidents of incorrectly completed documentation. The leading explanation for negligence in records-keeping

is that it is 'an unpleasant bureaucratic obligation that takes too much time'. Furthermore, the barriers to the flow of information about patients between healthcare providers have been described [29]. These findings allow the conclusion that studies based on registry data from medical personnel may be underestimated and are the most probably known by the NCR, who emphasize that their reports are still underestimated [25, 26].

In the current study, the data was obtained from two Province branches of the NFZ, which is the only State institution which finances healthcare services by funds obtained from compulsory health insurance. Additionally, the Minister of Health finances the highly specialized healthcare services involved in transplant and cardiac surgery. Such data sources, in combination with the healthcare financing model, make it the most reliable and complete source available.

The political and socio-economic transformation that occurred in Poland 30 years ago changed Polish society. The implementation of capitalism caused an increase in wealth and consequently a change in the burden of risk factors. An increased human development index (HDI) describes not only the economic growth but also the ways of influencing the individual pro and anti-health decisions by local policy. The currently obtained results confirmed that from an epidemiological point of view, Poland has joined the high HDI values in developed countries, in which the prostate, breast, colorectal, and lung cancers remain the most frequent cancers [7], constituting the leading problem for public health. Economic growth stimulates progressive improvement in healthcare quality. Unfortunately, access to healthcare resources is not equal. There is a clear relationship between lower socio-economic status and shorter life expectancy and increased risk of development of diseases, compared to people with a higher social status. A low education level is associated with lower incomes and an adverse social environment [30]. Moreover, in the case of some cancer, e.g. breast cancer, there is an association between increased mortality and lower education level, income, economic activity, and socio-economic status [17]. There is also evidence that morbidity and mortality due to some cancers increase with increasing HDI and the Gender Inequality Index (GII); for example, an increase of GII by 0.2 units yields an increase of malignant neoplasms of the cervix and corpus uteri (C53-C54) incidence rate by 24%, and mortality rate over by 40% [18]. These social factors may additionally enhance the health inequations in the field of oncological healthcare.

In the unfavourable conditions, the COVID-19 pandemic caused changes in the functioning of healthcare providers due to the minimalization of the risk of viral transmission, as well as the protection of personal resources. It should be noted that oncological patients require frequent contact with the treating physician because of the need for assessment of the stage of disease progression, and any neglect may induce the worsening of the patient's prognosis [31].

To ensure fast access to appropriate diagnostic procedures and treatment, in 2015 the Fast Oncological Therapy Programme was introduced in Poland. Each patient with a suspicion of cancer receives the so-called DiLO cards (Diagnostics and Oncological Treatment Cart) that shorten the diagnostic path. The DiLO cards may be issued by general practitioners, specialist doctors, and hospitals. However, in March 2020, this programme collapsed, like many others. On 4 March 2020, the first incidence of COVID-19 was diagnosed

in Poland and 10 days later the Polish government introduced the first package of restrictions. In 2020, 12,899,293 incidences of COVID-19 were diagnosed in Poland, with a nationwide incidence rate of 3361.5 per 100,000. Simultaneously, 146,970 incidences of COVID-19 was diagnosed in the Silesian Province which was the second highest regional result nationwide (3260.1 per 100,000). In 2020, in the Subcarpathian Province only 59,180 incidences of COVID-19 were diagnosed, and the incidence rate of 2783.8 per 100,000, which was the second lowest nationwide. According to the National Institute of Public Health NIH – National Research Institute and the Chief Sanitary Inspectorate Report, 102,357 (7.9%) of COVID-19-diagnosed patients required hospital care. The percentages of patients who required inpatient healthcare services, both in the Subcarpathian and Silesian Provinces, were different, compared to the national average (9.6% and 4.3%, respectively). [32].

To ensure appropriate quality and accessibility of healthcare services, the government retained a part of hospital beds only for COVID-19 patients, co-called 'COVID beds'. The number of COVID-19 beds changed depending on the current epidemic situation. According to the Polish Ministry of Health, the majority of hospital beds were allocated for the COVID beds in both Provinces at the turn of November and December of 2020 – 4,105 in the Silesian Province (18.1% of 22,688 available hospital beds) and 2,301 in the Subcarpathian Province (25.4% of 9,045 available hospital beds) [33, 34]. The utilisation of part of the hospital beds for COVID patients most likely caused a reduction in the availability of treatment and diagnostic services for non-COVID patients.

Between March – May 2020, compared to the same period in 2019, a decrease by 33% of the issued DiLO cards was found. Moreover, according to the Maluchnik et al. study, the number of cancers diagnosed in Poland in 2020 decreased by 31%, compared to 2019, and a 25% reduction was also found in diagnostic procedures [35].

In the current study, a significant decrease was found in 2020 in healthcare services in the ranges of oncology, radiotherapy, and general and oncological surgery granted in the Subcarpathian and the Silesian Provinces, compared to 2019. The greater reduction observed in the Subcarpathian Province may be caused by lower basic availability and less developed healthcare resources in this Province (Tab. 1). This relationship is observed especially in the Bieszczadzki, Lesko, Przemyśl and Stalowa Wola counties, most of which are low developed areas with limited access or even without specialized healthcare resources. Health inequalities observed before 2019 were multiplied by the COVID-19 pandemic and targeted the forces and resources of the healthcare system to fight the pandemic. It should be mentioned that access to healthcare services is worse in marginalized communities, and patients suffering from chronic diseases have difficult access to the treatment and diagnostic procedures when the healthcare system is overloaded by fighting the pandemic [36].

In the Silesian Province, the availability of highly specialized healthcare services, including oncological centres, is much greater, therefore the changes in the functioning of medical entities due to the pandemic did not significantly affect the availability of oncological healthcare as in the Subcarpathian Province. The current findings comply with the trend of limitations of services and healthcare system and human resource protection by the reduction of physical

examinations, except for cases when it was necessary [30].

The American Cancer Society, which is one of the most significant oncological scientific societies worldwide, recommended the suspension of screening programmes during the epidemic [37], while other guidelines suggested reductions in elective hospitalizations, temporary cancellations of surgery procedures, and postponement of adjuvant chemotherapy and radiotherapy. On the other hand, only 40% of oncologists have decided on conjunctive therapy in the form of virtual clinics and the remote planning of therapy, although 86% of them knew about such possibilities. Moreover, about half of oncologists did not prefer remote referral for new chemotherapy or immunotherapy [38].

It should be emphasized that the decrease in the incidence of cancer occurrences observed in 2020 in the current study, caused by the reduction of diagnostic procedures in both the Subcarpathian and Silesian Provinces, may have serious and far-reaching consequences. Patients who were not diagnosed appropriately because of pandemic restrictions and limitations in access to specialist healthcare services, will be diagnosed in the future at a more advanced stage of the disease, which will also worsen their prognosis. Moreover, in the coming years, an increase in cancer incidences might be expected because of overlapping of current cases with those who were not diagnosed before the COVID-19 pandemic [35, 39]. Furthermore, the postponement of specialist healthcare services may cause an increase in mortality among patients suffering from chronic diseases.

One of the leading goals of healthcare systems in developed countries is to ensure the availability of healthcare and to meet the current health needs of society [40]. The COVID-19 global pandemic announced by the World Health Organization (WHO) on 11 March 2020 has become a new and serious, unprecedented barrier to healthcare availability, accessibility, and the possibility of efficient use of healthcare resources.

According to global studies collected in the WHO reports, the prophylactic programmes and treatments of chronic diseases have been significantly reduced because of the COVID-19 pandemic [41]. The reduction of breast cancer therapies observed in the current study in 2020, compared to 2019, confirm those observations. Due to pandemic restrictions, most of the national screening programmes, e.g. mobile mammography diagnostic actions have been suspended. Another possible explanation for the reduction of incidence rates may be the patients' fear of the need for hospitalization and the intrahospital COVID-19 infections, [42] but this thesis requires further investigation.

The influence of the pandemic on health inequalities is not limited to viral-related morbidity and mortality, but it also affects long-term health consequences. The lockdown introduced as one of the ways of fighting the pandemic has shaken the social health determinants. The restricted access to healthcare services other than those COVID-related, and an overloaded healthcare system, intensified health inequalities. While fighting the pandemic, the old-established public health problems, such as oncological or cardiovascular diseases, were neglected. A further increased number of oncological incidents should be expected, and the patients will be in more advanced stages of the disease. This will restrict the therapeutic options and make the patient's prognosis worse.

Telemedicine that has been introduced by most healthcare providers to manage the routine control of patients with

chronic diseases will not replace the physical examination and direct contact between patient and physician. Moreover, many people had lived in difficult socio-economic conditions before the pandemic occurred. Those patients, as well as the older ones, were not able to use the telemedicine tools [43] which causes further exacerbation of health inequalities. Society has incurred a health debt, and solving the post-pandemic health problems and inequations will be the next challenge for the healthcare system.

## CONCLUSIONS

Cancers remain one of the leading public health problems, both in the Subcarpathian and Silesian Provinces of Poland. Apart from the environmental and socio-economic differences between the Provinces, there are no other differences in the profile of most frequent neoplastic diseases diagnosed in 2015–2020 in both Provinces.

In 2020, a significant reduction was found in the therapies of cancers in the Subcarpathian and Silesian Provinces, in all probability caused by the limited availability of oncological healthcare services due to the COVID-19 pandemic. An increased burden of cancers should be expected shortly; therefore, regional and nationwide screening programmes should be introduced to enable the diagnosis of oncological diseases at the earliest possible stage.

**Limitations.** The study has some limitations which be should be mentioned. First of all, data was obtained from two provincial branches of the National Health Fund which concerned only the healthcare services financed by those branches; therefore, no information was obtained about the patients who received healthcare services outside the Subcarpathian and Silesian Provinces. Secondly, the incidence rates were determined based on the first oncological healthcare service, which meant it was not possible to identify cases of relapsing diseases diagnosed primarily before 2015.

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