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The epidemiology of the testicular cancer in Poland in 2015–2021

Epidemiologia raka jąder w Polsce w latach 2015–2021

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Abstract

Introduction and objective. Testicular cancer is a rare cancer constituting approximately 1% of all cancers diagnosed in men worldwide. Simultaneously the burden of the testicular cancer increased in last decades, becoming the most frequent cancer diagnosed among adolescents and young males aged 14 – 44 years of live. Our study was aimed to present the epidemiology and assess the impact of COVID-19 pandemic on the testicular cancer morbidity in Poland.

Material and methods. The secondary epidemiological data obtained from the National Health Fund of Poland regarding males aged over 20 years of life diagnosed with the testicular cancer who have obtained healthcare services in at least one of the over 250 specialized healthcare services provided to cancer patients were analysed. The incidence rate per 100,000 males standardized to the European Standard Population 2013 (SIR) was calculated divided into subregions, according to patients' domicile.

Results. In 2015–2021, the average national testicular cancer incidence rate remained stable, but in 2021 an increase of almost 10% compared to 2020 was noted. Furthermore, an epidemiological analysis conducted at the subregional level pointed out an increase in testicular cancer incidence in 52 of the 73 subregions, with spatial differantiation. The largest increases in incidence were observed in the Żyrardów, Tychy, and Tricity subregions, with differences between the subregions with the lowest and highest incidence.

Conclusions. The incidence of testicular cancer in Poland in 2015 – 2021 increased despite the pandemic restrictions and limited availability of in-patient healthcare services. The spatial differentiation of incidence's annual percent change was also demonstrated identifying areas where health promotion and health education activities should be intensified.

Key words

Poland, epidemiology, testicular cancer, COVID-19

Streszczenie

Wprowadzenie i cel pracy. Rak jąder jest rzadko występującym nowotworem, stanowiącym ok. 1% wszystkich nowotworów diagnozowanych u mężczyzn na świecie. Jednocześnie w ostatnich dekadach zaobserwowano wzrost zachorowalności na raka jądra, który obecnie jest najczęściej diagnozowanym nowotworem wśród nastolatków i młodych mężczyzn w wieku 14–44 lat. Celem pracy było przedstawienie epidemiologii i ocena wpływu pandemii COVID-19 na zachorowalność na raka jądra w Polsce.

Materiał i metody. Materiał badawczy stanowiły wtórne dane epidemiologiczne uzyskane z NFZ-u dotyczące mężczyzn powyżej 20. r.ż., u których rozpoznano raka jąder, i którzy uzyskali świadczenia zdrowotne w co najmniej jednym z ponad 250 specjalistycznych ośrodków zdrowia udzielających pomocy pacjentom onkologicznym. Obliczono współczynnik zapadalności na 100 tys. mężczyzn, standaryzowany w odniesieniu do Europejskiej Populacji Standardowej 2013 (SIR), z podziałem na podregiony według miejsca zamieszkania pacjentów.

Wyniki. W latach 2015–2021 średnia wartość SIR raka jąder w skali kraju utrzymywała się na podobnym poziomie, jednak w roku 2021 zaobserwowano wzrost zapadalności o niemal 10% w stosunku do roku 2020. Ponadto analiza epidemiologiczna na poziomie podregionów wykazała wzrost zapadalności na raka jąder w 52 z 73 podregionów, z wyraźnym zróżnicowaniem przestrzennym; największy wzrost odnotowano w podregionach żyrardowskim, tyskim i trójmiejskim, stwierdzając duże różnice między podregionami o najniższej i najwyższej zapadalności.

Wnioski. W latach 2015–2021 zapadalność na raka jąder w Polsce zwiększyła się pomimo wprowadzonych obostrzeń pandemicznych i ograniczonej dostępności stacjonarnych świadczeń opieki zdrowotnej. Wykazano również zróżnicowanie przestrzenne zachorowań, wskazując obszary, gdzie należy zintensyfikować działania z zakresu promocji zdrowia i edukacji zdrowotnej.

Słowa kluczowe

Polska, epidemiologia, COVID-19, rak jąder

INTRODUCTION

Testicular cancer is a rare cancer constituting approximately 1% of all cancers diagnosed in men and 5% of urological cancers worldwide [1–3]. Nevertheless, it remains the most

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frequent cancer diagnosed among adolescents and young males aged between 14–44 years of live [4–5]. In recent decades, a significant increase of the worldwide testicular cancer burden has been noted, and even a three- or four-fold increase of morbidity has been observed in several European countries with high-quality cancer registries [6–7]. The incidence of testicular cancer differs significantly between European countries; the lowest load is observed in Spain being 13 per 100,000 and the highest, over 15 per 100,000 in Denmark and Switzerland [8]. Moreover, according to estimates, the incidence of testicular cancer will increase by 13% in Western Europe, by 21% in Northern Europe, and even by 32% in Eastern Europe by the 2035 [9].

A significant disparity between European countries, both in the load of testicular cancer as well as the healthcare resources, are noticeable. Moreover, the COVID-19 pandemic caused by a new coronavirus SARS-CoV2 that occurred in December 2019 in the Wuhan in the Hubei province of China [10], involved almost all resources of the worldwide healthcare systems, including Poland. This resulted in a reduction of the registered incidence of almost all cancers in 2020, which was directly related to the delay in diagnosis and implementation of appropriate treatment [11–13].

The aim of the study was to present the epidemiology and assess the impact of COVID-19 pandemic on the testicular cancer incidence, what which is mandatory for the development of public health strategies and effective allocation of the healthcare resources [14].

MATERIALS AND METHOD

Materials

In our study we have analysed the pre-processed, secondary epidemiological data obtained from the National Health Fund of Poland, which is the only one entity responsible for the contracting and accounting of healthcare services financed from public funds in Poland. Therefore, the NFZ may be perceived as the most reliable and comprehensive data source. We have analysed data regarding males aged over 20 years of life and diagnosed with the testicular cancer (the C62 code according the ICD-10 classification) who had received healthcare services in at least one of the over 250 specialized healthcare services provided to cancer patients such as: nuclear medicine, brachytherapy, isotope therapy, services of the clinical oncology, chemotherapy, oncological surgery and services, and cancer drug programs programmes settled by the National Health Fund of Poland.

The limitation of the study participants to the group of those aged over 20 years life was related to the need to use fractions designated for five-year groups according to the European Standardized Population and it is a certain limitation of the study.

Methodology

The epidemiological analysis was performed according to 73 subregions (NUTS-3 units introduced in Poland on 26 November 2005), according to patients' domicile at the time of cancer diagnosis (Fig. 1).

The time-point of the primary obtaining of one enrollment ranges of healthcare services was considered as the time of cancer diagnosis. Unlike the Polish National Cancer Registry which bases its annual rapports on the MZ/N-1a form

Figure 1. The Division of Poland into subregions (NUTS-3 units)

completed by the physician who has diagnosed the cancer, the current study is based on the data from the medical treatment billing process by of the NFZ.

For each of 73 subregions, the incidence rate was calculated per 100,000 males, standardized to the European Standard Population 2013 (ESP 2013), using the formula:

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

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.

Data on the state of population in each of the subregions was obtained from the Statistics Poland database [15].

The Standardized Incidence Ratio (SIR) at the three time points was analysed: the years of 2015 and 2019 – unaffected by the COVID-19, and the 2020 when the pandemic has spread and the pandemic restrictions were introduced. Selection of the time points allowed the assessment of both the baseline burden of testicular cancer as well as and the impact of the COVID-19 pandemic, including the involvement of the healthcare system in combating the pandemic and the restrictions introduced by the Polish government, and their effect on the incidence of testicular cancer.

To assess the average annual change of SIR in the 2015 – 2021 period, the Annual Percentage Change (APC) with the 95% Confidence Interval was calculated for each of Polish subregions, using the formulas:

$$APC = 100 \cdot (e^b - 1)$$

where:
e – Euler's number (≅2.718);
b – linear regression coefficient for the ln(rates) ~ calendar year model,

and

$$95\%CI = \left(e^{\left(b \pm (t_{value} \cdot SE)\right)} - 1\right) \cdot 100$$

where:
t_{value} – an inverse of the t distribution function evaluated at 1–p/2 and with n–2 degrees of freedom;
SE – standard error.

The Assessment of the statistical significance of APC was equivalent to the statistical evaluation of the linear regression model. Statistical significance was set at a *p*-value below 0.05. Two-tailed tests were used. Statistical analyses were performed by the *Statistica* v. 13.3 software (TIBCO Software Inc., Palo Alto, CA, USA).

Ethical approval. According to the decision of the Bioethical Committee of the Medical Univeristy of Silesia in Katowice (No. PCN/CBN/0052/KB/108/22), due to the retrospective character of the study, permission of the Committee was not required. All methods used in the study were conducted according to relevant guidelines and regulations, and respected the confidentiality of biomedical data.

RESULTS

During 2015–2021, an increase of incidence of testicular cancer was observed in 52 of the 73 Polish subregions, and the most significant enhancement of the SIR was noted in the subregions of Żyrardów, Tychy and Tricity (APC = 13.18; p<0.05, 12.39; p<0.05, 9.64; p<0.05, respectively) (Fig. 2B). Simultaneously, the differences were observed between subregions with the least and the highest incidence (Tab. 1).

Throughout the 2015–2021 period, the national average of the SIR did not differ much, but a changes in subregions were noted (Fig. 2). However, an increase in incidence of almost 10% was observed in 2021 compared to 2020. The greatest burden of testicular cancer in 2020 was observed in the subregions of Leszno, Słupsk, and the cities of Warsaw and Poznań (Fig. 2A). Overall, in the 2015–2021 in the provinces of Lower Silesia, Lubusz and Kuyavian-Pomerania, as well as some subregions of Białystok, Ostrołęka and Przemyśl, the most noticeable reduction in the incidence of testicular cancer was noted (Fig. 2B, Tab. 2).

DISCUSSION

Testicular cancer remains the most frequent cancer diagnosed among young males, and the epidemiological analyses shows that it will be diagnosed even in 0.5% of man among theirs live [1, 16]. Simultaneously, Most of cases are diagnosed in the first stage, and metastases occurs in 30% – 50% of patients [3].

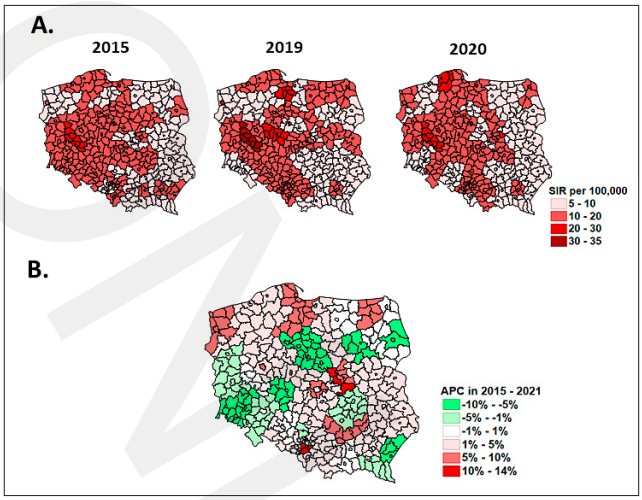

Figure 2. Epidemic situation of the testicular cancer in Poland: **A** – SIR values in 2015, 2019, and 2020 in each of the subregions; **B** – the APC in 2015–2021 period in each of the subregions

The epidemiology of the testicular cancer is characterized by the difference between the morbidity and mortality. Although the incidence is increasing worldwide, especially in high developed countries, mortality rates have decreased, particularly since the 1980s, which is related to the availability of modern multidisciplinary healthcare [14]. Overall, in most countries of Western Europe as well as the and the United States, the mortality rate for testicular cancer has decreased by nearly 70% since the 1970s. However, in Eastern and Central European countries, a decline in incidence has been observed only since the late 1980s. This might be a consequence of the limitations and subsequent availability of modern diagnostic techniques related to the political transformation that took place in these countries at the turn of the 1980s and 1990s [17].

In our study we have analysed the incidence of the testicular cancer among males aged over 20 years of life that is a certain limitation of the study and was directly related to the need for standardization of incidence rate. Although testicular cancer can be diagnosed at any age, the highest incidence is reported among men aged 25–43 [1, 14], therefore the results obtained allow for a comprehensive assessment of the epidemiology of testicular cancer among young men in Poland.

A steady increase was found in the SIR of testicular cancer in 2015–2021, and later in 2020 and 2021, when most of the resources of the healthcare system were involved in combatting the COVID-19 pandemic and the implemented restrictions limited the availability of in-patient healthcare services for a non-COVID reasons. These findings differ from the results concerning both the most frequent and gynaecological cancers diagnosed in Poland, indicating a decline of in incidence in 2020 compared to 2019 [12–13]. This fact may be related with easily observable symptoms of

Table 1. The Nationwide average of SIR with the lowest and highest values across the country Poland

	2015	2016	2017	2018	2019	2020	2021
National average (95% CI)	11.8 (10.5 – 13.1)	12.5 (11.1 – 13.9)	12.4 (11.0 – 13.7)	12.3 (11.0 – 13.7)	12.1 (10.7 – 13.5)	12.2 (10.9 – 13.6)	13.4 (11.8 – 14.9)
Min.	4.3	5.9	3.3	2.6	5.0	5.4	5.1
Max.	25.9	24.5	27.8	27.4	33.8	24.9	27.6

Table 2. The Annual Percent Change with the 95% Confidence Interval of the SIR of testicular cancer in Polish subregions in 2015–2021

Subregion	APC (95% CI)	Subregion	APC (95% CI)
BIAŁA PODLASKA	1.74 (-7.89–12.38)	OŚWIĘCIM	2.95 (-13.04–21.87)
BIAŁYSTOK	-6.16 (-16.87–5.93)	PIŁA	2.11 (-11.32–17.58)
BIELSKO – BIAŁA	1.09 (-6.31–9.08)	PIOTRKÓW TRYBUNALSKI	2 (-8.47–13.67)
BYDGOSZCZ & TORUŃ	-6.74 (-10.3 – -3.03) **	PŁOCK	-9.62 (-16.78 – -1.85) *
BYTOM	-2.82 (-15.38–11.6)	CITY OF POZNAŃ	6.41 (-1.76–15.27)
CHEŁM & ZAMOŚĆ	2.92 (-7.77–14.85)	POZNAŃ (RURAL)	1.89 (-6.59–11.14)
CHOJNICE	1.8 (-14.67–21.45)	PRZEMYŚL	-8.84 (-18.23–1.62)
CIECHANÓW	3.62 (-7.57–16.16)	PUŁAWY	3.13 (-4.37–11.22)
CZĘSTOCHOWA	2.4 (-7.84–13.78)	RADOM	-2.21 (-10.56–6.92)
ELBLĄG	2.65 (-5.38–11.37)	RYBNIK	3.1 (-6.53–13.71)
EŁK	7.93 (-4.36–21.8)	RZESZÓW	1.08 (-3.66–6.05)
GDAŃSK	6.09 (0.32–12.19)	SANDOMIERZ & JĘDRZEJÓW	7.69 (-5.9–23.23)
GLIWICE	2.25 (-4.37–9.33)	SIEDLCE	1.42 (-10.68–15.16)
GORZÓW WIELKOPOLSKI	-2.94 (-16.5–12.82)	SIERADZ	4.4 (-3.45–12.87)
GRUDZIĄDZ	-9.37 (-24.26–8.46)	SKIERNIEWICE	4.5 (-15.98–29.96)
INOWROCŁAW	2.82 (-5.03–11.32)	SŁUPSK	1.99 (-5.04–9.54)
JELENIA GÓRA	-6.96 (-13.17 – -0.29)	SOSNOWIEC	2.26 (-3.5–8.36)
KALISZ	-7.67 (-11.15 – -4.06) **	STAROGARD GDAŃSKI	6.02 (-6.89–20.72)
KATOWICE	-1.73 (-7.77–4.71)	SUWAŁKI	0.6 (-12.66–15.87)
KIELCE	-2.09 (-12.35–9.36)	CITY OF SZCZECIN	-0.63 (-9.8–9.48)
KONIN	4.41 (-1.35–10.5)	SZCZECIN (RURAL)	4.53 (-7.06–17.57)
KOSZALIN	2.13 (-9.09–14.74)	SZCZECINEK & PYRZYCE	5.67 (-2.31–14.3)
CRACOW (RURAL)	3.46 (-4.03–11.53)	ŚWIECKO	5.87 (-10.79–25.64)
CITY OF CRACOW	2.45 (-3.51–8.79)	TARNOBRZEG	2.45 (-7.19–13.08)
KROSNO	-2.2 (-13.15–10.14)	TARNÓW	-0.22 (-12.4–13.66)
LEGNICA & GŁOGÓW	-5.28 (-18.74–10.42)	TRICITY	9.64 (2.16–17.67) *
LESZNO	0.7 (-6.27–8.18)	TYCHY	12.39 (4.9–20.4) *
LUBLIN	4.06 (-0.44–8.76)	WAŁBRZYCH	-1.86 (-12.89–10.56)
ŁOMŻA	-0.63 (-12.78–13.21)	WARSAW	4.63 (-0.61–10.14)
ŁÓDŹ (RURAL)	5.36 (-2.02–13.29)	WARSAW EAST	1.24 (-8.49–12.01)
CITY OF ŁÓDŹ	2.1 (-7.23–12.37)	WARSAW WEST	5.08 (-5.93–17.39)
NOWY SĄCZ	-0.53 (-9.7–9.57)	WŁOCŁAWEK	-7.77 (-16.99–2.47)
NOWY TARG	2.06 (-19.89–30.04)	CITY OF WROCŁAW	0.66 (-6.7–8.6)
NYSA	1.91 (-12.3–18.43)	WROCŁAW (RURAL)	-4.04 (-10.53–2.91)
OLSZTYN	-0.19 (-12.64–14.04)	ZIELONA GÓRA	-3.47 (-8.37–1.7)
OPOLE	0.5 (-7.43–9.12)	ŻYRARDÓW	13.18 (4.26–22.86) *
OSTROŁĘKA	-5.66 (-14.47–4.06)		

p < 0.05; ** p < 0.001; *** p < 0.001

the testicular cancer, such as enlargement of the testicles or the appearance of nodules, thickenings or a feeling of heaviness in the testicle that prompted an urgent medical consultation.

Concurrently, an increase in the survival rate of patients with testicular cancer has been observed in most developed countries, despite the increasing incidence of the cancer, is a consequence of the availability of modern and effective therapies and the early diagnosis. Unfortunately, in some Central European countries (e.g. Slovakia) the delays of in diagnosis and the implementation of appropriate treatment has been observed, especially among young men, indicating that this group has insufficient knowledge about the possibility of developing testicular cancer [17].

The results obtained in the current study also show a clear national spatial differentiation of the burden of the testicular cancer, and with the most noticeable increase of the incidence was noted in the subregions of Żyrardów, Tychy and Tricity, which are industrialized and highly-developed communities. These results partially correspond with the findings of Cayuela et al., which highlight that both environmental and industrial factors that may increase the burden of testicular cancer [14]. Meanwhile, a reduction in incidence was found in the subregions of Płock, Kalisz, and Bydgoszcz, & and Toruń, and as well as areas of the Subcarpathian, Lubusz and Lower Silesian voivodeships provinces. These areas differ both in environmental, urban and social factors, but with the exception of the city of Plock, most of them have relatively favourable environmental conditions.

Moreover, the variation between the lowest and highest SIR values in subsequent years correspond to a large regional disparity of the incidence of testicular cancer, ranging from 2.8–7.9 per 100,000, as observed in France. These findings confirm the spatial differentiation of the testicular cancer incidence among European countries where clear differences are noticeable even between the neightboring countries, such as Denmark and Finland. Nevertheless, the results of the current study correspond with Cayuela et al. findings concerning the epidemiology of testicular cancer in Spain, where the presence of clear spatial differentiation of incidence despite the lack of significant nationwide differences was highlighted [14, 18]. An unequal access to healthcare resources, as well as an economic factors and geographic barriers observed also in Brazil and many other countries, were indicated as a possible explanation [19–21]. However, the mechanism linking testicular cancer with the socio-economic status remains unclear and requires further investigation [9].

Over the past 50 years, for reasons that are not fully understood, the incidence of testicular cancer among young men has increased worldwide, with the risk factors including age, family or personal history, and cryptorchidism, as well as factors related to race and ethnicity [22].

Currently, because of availability of combination therapies and cisplatin-based chemotherapy [23], testicular cancer is one of the cancers with the best prognosis, with the five-year survival rate reaching 95.3%. Some Eastern European countries, however, have lower survival rates – below 90% [19, 24] and countries like: Bulgaria, Czech Republic, Hungary and Poland have mortality rates exceeding 1 per 100,000 [17].

Up to half of the patients with testicular cancer had abnormalities detected in their semen before any treatment was introduced commenced, that additionally negatively affected their reproductive health [25]. Current recommendations do not include population screening for testicular cancer due to its unclear and incompletely described ethology [19], so therefore identifying areas with an increased burden of testicular cancer, where health promotion and patient awareness actions should be implemented, is the key to changing this unfavourable incidence trend.

A critical evaluation of the data source is equally important. The annual reports published by the Polish National Cancer Registry (NCR) are the main data source of the cancer epidemiology in Poland. The time trends of the SIR observed in our study the presented study correspond to the data published in the database, although the values of the incidence rate are slightly higher [26]. These differences are most likely due to the methodology adopted. The NCR reports are based on the MZ/N-1a form filled by the medical doctor who have physician who diagnosed the cancer. Meanwhile, in our study In the presented study, the secondary epidemiological data received from the NFZ after settling the healthcare services provided by medical entities, was used. The NFZ is the only one stockholder entity in Poland responsible for the contracting as well as and settlement of the healthcare services financed from the public funds. So, the NFZ data can be considered as equally complete and reliable as the NCR. Nevertheless, it should be emphasized that these data depend on the quality of the medical documentation directly related to the treatment process. Due to the administrative and billing nature, the NFZ data does not contain certain important information, such as clinical staging. Unfortunately, the quality and completeness of medical documentation might by low and even an extensive documentation might have a lack substantial information [27]. The problem of maintaining accurate medical documentation was highlighted in a report of the Polish Supreme Audit Office. Some healthcare providers maintained medical records in violation of applicable requirements and the irregularities identified concerned both formal issues and a lack of due diligence in documenting the diagnosis and treatment process. However, this problem was reduced by the introduction of an electronic medical records system [28].

Limitations

The study has some limitations resulting from the principles of the organization and settlement of health services. Between the diagnosis of testicular cancer by the medical doctor a physician during examination and referral of the patient for further diagnostics services and oncological therapy granted in one of the scopes included in our analyses there is a 'time window' causing a slight incidence ratios shift in time. Nevertheless, we trust that it is to be hoped that this does not strongly affect the comprehensiveness and reliability of our the results obtained. Another limitation was that the study was retrospective, confirmatory in nature, and was pre-registered; therefore, no false discovery rate adjustment was applied.

Finally, an important limitation of the study was that it concerned only males over the age of 20, so the results therefore do not describe take into account the incidence observed among teenagers over the age of 15, years of life and the analysis stratified by age were was not possible. Nevertheless, the peak in the incidence of testicular cancer is occurs between the ages of 20–39 years, of age, that is as confirmed by the NCR data as well [26. The obtained results therefore well describe the epidemiology of testicular cancer among young adult men.

CONCLUSIONS

The incidence of testicular cancer in Poland between 2015–2021 increased despite the pandemic restrictions and limited availability of in-patient healthcare services. The spatial differentiation of the annual percent change in incidence was also demonstrated, identifying areas where health promotion and health education activities should be intensified.

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