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Cancer Incidence and Mortality in the Czech Republic

Incidence a mortalita nádorových onemocnění v České republice

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Summary

Background: The Czech Republic ranks among the countries with the highest cancer burden in Europe as well as worldwide. The purpose of this study is to summarize long-term trends in the cancer burden and to provide up-to-date estimates of incidence and mortality rates after 2011. ***Data and Methods:*** The Czech National Cancer Registry (CNCR) was instituted in 1977 and contains information collected over a 34-year period of standardized registration covering 100% of cancer diagnoses within the entire Czech population. The CNCR analysis is supported by demographic data and by the Death Records Database. An overview of the epidemiology of malignant tumors in the Czech population is available on-line at www.svod.cz. ***Results:*** All neoplasms, including non-melanoma skin cancer, reached a crude incidence rate of almost 802 cases per 100,000 men and 681 cases per 100,000 women in 2011. The annual mortality rate exceeded 258 deaths per 100,000 individuals; in other words, more than 27,000 individuals die of cancer each year. The overall incidence of malignancies has increased with a growth index of +27.6% during the last decade (2001–2011), while the mortality rate has been stabilized over the time span (growth index in 2001–2011: –5.0%). Consequently, the prevalence has significantly increased in the observed period and exceeded 475,000 cases in 2011. In addition to demographic aging of the Czech population, the cancer burden has also increased due to the growing incidence of multiple primary tumors (recently more than 15% of the total incidence). The most frequent diagnoses include colorectal cancer, lung cancer, breast cancer, and prostate cancer. Although some neoplasms are increasingly diagnosed at an early stage (e. g. the proportion of stage I or II was 75.3% for female breast cancer and 84.2% for skin melanoma), the numbers of early diagnosed cases are generally insufficient, even in the case of highly prevalent cancers such as colorectal carcinoma (only 46.1% of incident cases are diagnosed at stage I or II, according to recent data). ***Conclusion:*** Population-based data on malignant tumors are available in the Czech Republic. The data survey can help us define national cancer management priorities. The current priority is to achieve a sustained reduction of cases diagnosed at an advanced stage and reduction of the significant regional differences in diagnostic efficiency.

Key words

epidemiology – incidence – mortality – Czech Republic – neoplasms, multiple primary – staging – Czech National Cancer Registry

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Souhrn

Východiska: ČR patří mezi onkologicky nejzatíženější státy v evropském i celosvětovém měřítku. Cílem této studie je shrnout dlouhodobé trendy v epidemiologii nádorů, včetně nových odhadů incidence a mortality za rok 2011. ***Data a metody:*** Národní onkologický registr ČR (NOR) byl založen v roce 1977 a zpřístupňuje informace o epidemiologii nádorů za 34 let při 100% pokrytí onkologických diagnóz a české populace. Analýza epidemiologie nádorů se dále opírá o demografická data a o data registru zemřelých ČR. Epidemiologická data jsou dostupná on-line na portálu www.svod.cz. ***Výsledky:*** Hrubá incidence zhoubných nádorů (včetně nemelanomových nádorů kůže) dosáhla v roce 2011 hodnoty 802 případů na 100 000 mužů a 681 případů na 100 000 žen. Roční hrubá mortalita přesáhla 258 úmrtí na 100 000 obyvatel; každoročně umírá z příčiny zhoubného nádoru více než 27 000 osob. Celková incidence nádorových onemocnění setrvale roste, růstový index dosáhl za období 2001–2011 hodnoty +27,6 %. Naopak mortalita je ve stejném období stabilizována (růstový index –5,0 %). Důsledkem rostoucí incidence a stabilizované mortality je růst prevalence, která v roce 2011 přesáhla 475 000 osob. K růstu populační zátěže přispívá kromě demografického stárnutí populace také rostoucí incidence vícečetných primárních nádorů u téhož pacienta (v recentním období více než 15 % z celkové incidence). Mezi nejčastější malignity české populace patří nádory kolorekta, prsu u žen, plic a prostaty. Ačkoliv je řada onkologických diagnóz stále častěji odhalována v méně pokročilých stadiích (např. stadium I + II u nádorů prsu: 75,3 %, u maligního melanomu: 84,2 %), celkově je včasná diagnostika zhoubných nádorů v ČR nedostatečná. To se týká i velmi častých typů nádorových onemocnění, jako je kolorektální karcinom (pouze 46,1 % nově diagnostikovaných pacientů je zachyceno ve stadiu I + II). ***Závěr:*** ČR je vybavena kvalitním a funkčním zázemím pro sběr a analýzu onkologických populačních dat. Dostupná data napomáhají definovat priority organizace onkologické péče, kterými jsou jednoznačně posílení záchytu časných stadií onkologických onemocnění a redukce existujících rozdílů mezi regiony ČR.

Klíčová slova

epidemiologie – incidence – mortalita – Česká republika – nádory mnohočetné primární – stadium – Národní onkologický registr

Introduction

Cancer epidemiology is of ever growing importance due to the high incidence rates of malignant tumors [1,2]. In recent years, several comprehensive worldwide and European studies on cancer incidence and prevalence have been published [1–5]. These reports provide unambiguous data-based evidence of a rapid increase of cancer incidence in most European countries. According to Ferlay et al [1] there were 3.45 million newly diagnosed cancer cases (excluding non-melanoma skin cancer) and 1.75 million deaths from cancer in Europe in 2012. Therefore, cancer is an important public health issue in Europe, with measures aiming to diminish the continuous growth of this burden being only partially effective. The Czech Republic is no exception in this respect; quite the opposite: the Czech population ranks among those with the highest burden worldwide [6].

The current role of cancer epidemiology is not purely descriptive. Knowledge regarding age- or stage-specific trends is necessary to evaluate the effectiveness of diagnostic procedures, identify weak points in the management of cancer care, or analyze associations related to therapeutic outcomes [7]. For obvious reasons, survival occupies a dominant position among all health care end-points of population-based cancer registries. A new edition of the international population-based survival study EUROCARE-5 was published recently [8]. A significant improvement in attained survival rates has been reported for most European countries. In particular, the 5-year relative survival reported for cancer patients in the Czech Republic has improved considerably and is now substantially higher than the survival reported for the entire Eastern European region. These promising results have recently been confirmed in a detailed study on time trends in stage-specific survival in the Czech Republic [9].

Nevertheless, evident regional differences still persist, mostly associated with late diagnosis of advanced disease stage and with more or less specific care disparities. Based on current epidemiologic trends, it seems that promising novel research technologies and the practice of personalized medicine have not yet been effectively and widely translated into cancer control. Epidemiologic data thus represent a strategic contribution to the management of this field [10].

Reliable epidemiologic analyses that would be useful for controlling and planning cancer prevention, diagnostics, and therapy require extensive population-based data covering all the relevant parameters. In particular, records identifying morphology and clinical stage of tumors are of utmost importance. Such clinical registries allow for monitoring of early detection of cancer, which is currently a major area of interest in Europe [11], and is closely related to cancer patients' survival. Population-based cancer registries constitute an indispensable component of the functional information systems of organized screening programs, along with specialized cancer screening registries [12]. It is essential that these data be used in order to provide necessary monitoring and evaluation of cancer screening programs according to European guidelines [13–15]. An organized approach to secondary prevention is needed to maintain a favorable balance between the benefits and dangers of the screening programs that aim to decrease cancer mortality in the future.

However, not all national cancer registries can provide such complex information, and therefore many epidemiologic analyses covering large geographic areas cannot address the health care topics adequately. In addition, international epidemiologic surveys often suffer from partially inconsistent data from participating countries or

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Tab. 1. Demographic and cancer-related characteristics of the Czech population.

Parameter	Males	Females	Total
population size	5,158,210	5,347,235	10,505,445
fertility rate	–	–	1.427
age (2011)			
mean/median (years)	39.6/38.5	42.5/41.5	41.1/40.5
25–75th percentile (years)	23.5–56.5	24.5–60.5	24.5–58.5
> 50 years (in %)	32.4%	38.2%	35.3%
life expectancy at birth (years)	74.7	80.7	–
annual overall mortality	54,141	52,707	106,848
causes of death (%)			
diseases of the circulatory system (I00–I99)	44.6%	54.3%	49.3%
neoplasms (C00–D48)	28.0%	23.4%	25.8%
injury, poisoning and certain other consequences of external causes (S00–T98)	7.7%	3.5%	5.6%
diseases of the respiratory system (J00–J99)	6.0%	4.6%	5.3%
diseases of the digestive system (K00–K93)	4.7%	3.7%	4.2%
endocrine, nutritional and metabolic diseases (E00–E90)	2.2%	3.0%	2.6%
other causes	6.8%	7.4%	7.1%

from temporary interruption, as was the case with the Europe Against Cancer Programme of the European Commission [16]. Separate processing of national databases enabling extraction of clinically relevant information is, therefore, still of great value. That is why this overview of recent cancer epidemiology in the Czech Republic has been prepared. The article presents data on cancer incidence and mortality in the Czech population, drawing on more than 30 years' experience with nationwide cancer data collection. Up-to-date estimates of incidence and mortality rates after 2011 are presented in the context of long-term trends. In addition to a general descriptive approach, detailed stage-specific trends and regional differences are discussed as well.

Data sources and methods

Demographic data

As a standard part of population monitoring, the Czech Statistical Office administrates data on the demographic structure of the Czech population and publishes these data on its website [17,18]. This fully consolidated data source describes the main demographic characteristics of the Czech population, such as the total population, the age structure, life expectancy, as well as predictions of demographic parameters up to 2065. The basic demographic characteristics of the Czech population are summarized in Tab. 1.

Czech National Cancer Registry (CNCR)

The CNCR was launched in 1976 and instituted as a national database covering 100% of cancer diagnoses within the entire Czech population. The most recent validated outcomes are from 2011, and the CNCR database contains more than 1.9 million records. The registration of malignant neoplasms is stipulated by the legislation and is obligatory. The CNCR is a part of the National Health Information System (NHIS) and is administered by the Institute of Health Information and Statistics of the Czech Republic [19]. The CNCR is accepted as a key database component of the Czech National Cancer Control Program, designated to report regular and timely estimates of the cancer burden in the Czech population. For this purpose, automated analytic tools with final outputs were developed. The CNCR is equipped with an information system which, among other things, provides a freely accessible analytical web portal (www.svod.cz) [20].

Incidence data and associated attributes

The CNCR contains personal data of patients, data describing malignant tumors, and diagnostic details (including morphology classification and stage), data on patients' treatment, as well as data on post-treatment follow-up. The registration of a new case begins with the initial cancer diagnosis, morphological verification and staging. Subsequently, basic records on primary therapy (modalities used), therapeutic strategy, follow-up data and/or deaths are transferred into the registration forms. The forms are directly linked to the database on the basis of the standardized data model and data processing rules [21]. Malignant

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Tab. 2. Causes of death in the Czech Republic in 2011 according to age.

	0–14 yrs n = 470	15–29 yrs n = 967	30–49 yrs n = 4,530	50–64 yrs n = 18,535	65–74 yrs n = 21,781	75+ yrs n = 60,565	Total n = 106,848
neoplasms (C00–D48)	31 (6.6%)	97 (10.0%)	1,148 (25.3%)	7,275 (39.3%)	8,185 (37.6%)	10,803 (17.8%)	27,539 (25.8%)
diseases of the circulatory system (I00–I99)	15 (3.2%)	70 (7.2%)	850 (18.8%)	5,788 (31.2%)	8,927 (41.0%)	37,075 (61.2%)	52,725 (49.3%)
injury, poisoning and certain other consequences of external causes (S00–T98)	70 (14.9%)	617 (63.8%)	1,330 (29.4%)	1,518 (8.2%)	695 (3.2%)	1,743 (2.9%)	5,973 (5.6%)
diseases of the respiratory system (J00–J99)	18 (3.8%)	35 (3.6%)	156 (3.4%)	939 (5.1%)	1,141 (5.2%)	3,401 (5.6%)	5,690 (5.3%)
diseases of the digestive system (K00–K93)	8 (1.7%)	19 (2.0%)	485 (10.7%)	1,459 (7.9%)	910 (4.2%)	1,650 (2.7%)	4,531 (4.2%)
endocrine, nutritional and metabolic diseases (E00–E90)	10 (2.1%)	17 (1.8%)	79 (1.7%)	353 (1.9%)	651 (3.0%)	1,684 (2.8%)	2,794 (2.6%)
diseases of the nervous system (G00–G99)	34 (7.2%)	59 (6.1%)	136 (3.0%)	280 (1.5%)	399 (1.8%)	1,224 (2.0%)	2,132 (2.0%)
diseases of the genitourinary system (N00–N99)	2 (0.4%)	1 (0.1%)	22 (0.5%)	139 (0.7%)	206 (0.9%)	846 (1.4%)	1,216 (1.1%)
other diseases, disorders and conditions	282 (60.0%)	52 (5.4%)	324 (7.2%)	784 (4.2%)	667 (3.1%)	2,139 (3.5%)	4,248 (4.0%)

neoplasms are recorded according to the International statistical classification of diseases and related health problems, currently the 10th revision (ICD-10) [22], and International Classification of Diseases for Oncology (ICD-O, currently 3rd revision) [23].

Tumors are staged on the basis of TNM classification systems, currently 7th edition [24]. For the purposes of this article, all cases recorded in the CNCR, including DCO (death certificate only) records, were calculated as incident cases. Identification of multiple cancers in the same person was accurately controlled in the CNCR database, based on strict recognition of the patient's individual code, the diagnosis date and diagnostic typology of multiple cancers.

Mortality data

The Czech legislation requires that all deaths in the Czech Republic be registered in the Death Records Database, a civil registration system [18]. For this purpose, standardized Death Certificates (internationally recommended by WHO [25]) are designed to collect precise data on the cause of death in each individual, and are typically written up and verified by a general practitioner. The causes of death are classified according to ICD-10, which provides standardized nomenclature in this field [22]. This system ensures comparability of official Czech mortality data with common international reporting. The coding of the underlying cause of death can be controlled against an independently and promptly completed CNCR. The CNCR serves as another source of mortality data in the Czech Republic. Here, the individual records on the cause of death according to the Death Certificate are directly linked to diagnostic records on decedents in the cancer registry, which can be used to code cause-specific mortality with respect to different cancer diagnoses. The death of a given person from a malignant tumor is indexed with respect to the main cancer diagnosis together with the immediate or the primary cause of death. The system therefore allows the data managers to code distinct cancer entities, and the records on causes of death are finally kept separately in two information systems. The system makes it possible to check the correctness of CNCR data retrospectively and to verify the validity of mortality data on cancer patients according to the internationally accepted rules [26,27].

Data analysis

Basic epidemiologic measures such as the crude incidence and mortality rates, age-standardized rates and lifetime cumulative cancer rates were calculated according to the standardized statistical methodology [28,29]. Cumulative risk is expressed as the probability that an individual will develop the given cancer type during the age span 0–74 years, in the absence of other competing causes of death. Annual incidence and mortality rates per 100,000 individuals (crude incidence) were calculated by gender and related to the Czech population structure in 2011. Age-standardized rates adjusted for the World and European population were calculated using age standards according to Waterhouse et al [30].

Results

The Czech Republic is one of the countries with the highest cancer

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Tab. 3. Cancer epidemiology in the Czech Republic (all cancers including skin neoplasms C00–C97, data from 2011).

Parameter	Males	Females	Total
overall incidence			
absolute number	41,349	36,424	77,773
rate per 100,000	801.6	681.2	740.3
incidence – ranking of Czech Republic worldwide (ASR(W), estimate from 2012)[1]	10th	16th	14th
lifetime cumulative risk of cancer (age 0–74 years)[1]	34.2	25.3	29.3
overall mortality[2]			
absolute number	15,008	12,163	27,171
cases per 100,000 population	291.0	227.5	258.6
mortality – ranking of Czech Republic worldwide (ASR(W), estimate from 2012)[1]	24th	46th	30th
mortality/incidence ratio[2]	0.36	0.33	0.35
prevalence			
absolute number	206,969	268,493	475,462
cases per 100,000 population	4,012	5,021	4,526
growth index (2001–2011)			
incidence	32.0%	22.8%	27.6%
mortality[2]	–4.7%	–5.6%	–5.0%
prevalence	62.4%	50.0%	55.0%

[1] All cancers excluding non-melanoma skin cancer (C00–C97) in age 0–74. Adapted from Ferlay et al [2].
[2] Mortality statistics – Czech Statistical Office

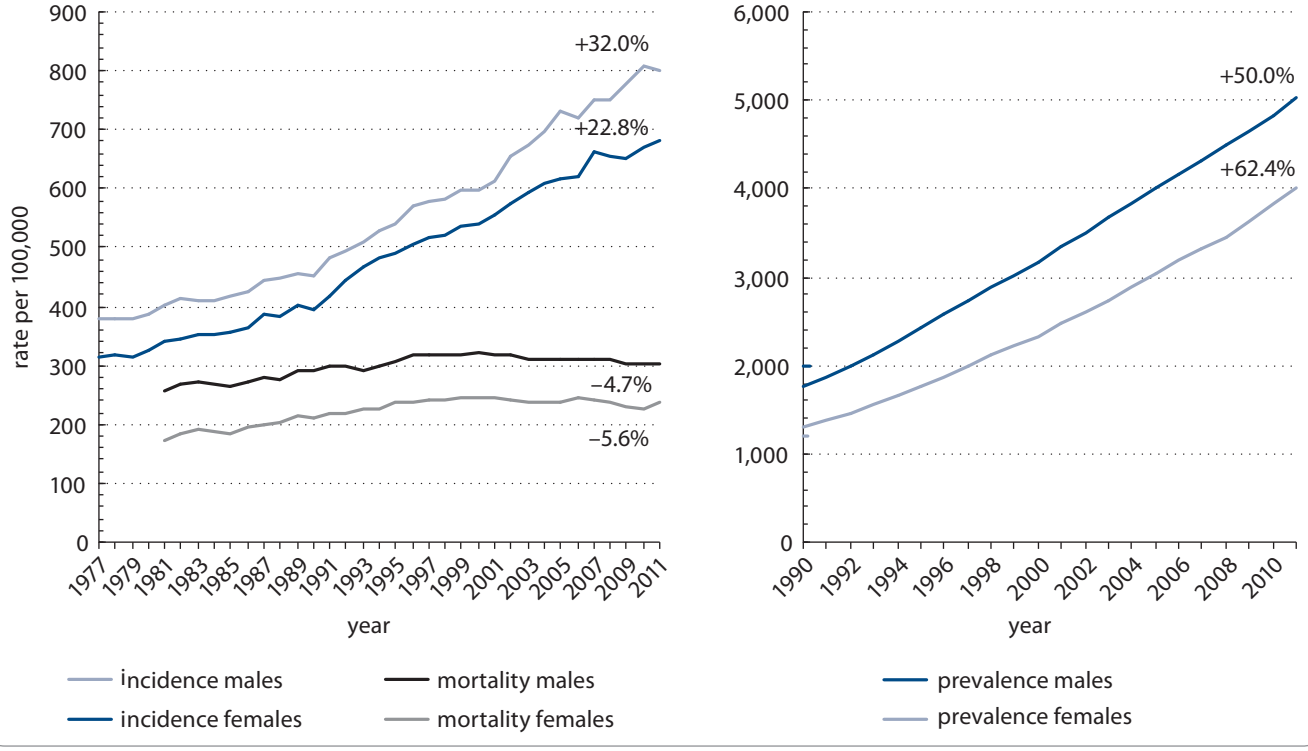

Fig. 1. Overall incidence, mortality and prevalence of all cancer diagnoses (C00–C97) in time trend (Czech National Cancer Registry, 1977–2011). % – growth index (2001–2011)

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Tab. 4. Trends in incidence rates of malignant tumors excluding non-melanoma skin cancer (C00–C97 excluding C44) in the Czech Republic.

	Males		Females		Whole population	
	number of neoplasms	rate per 100,000 males	number of neoplasms	rate per 100,000 females	number of neoplasms	rate per 100,000 persons
1980	16,750	333.9	14,538	273.3	31,288	302.7
1990	19,309	383.4	17,653	331.4	36,962	356.6
2000	23,762	475.3	22,545	427.5	46,307	450.8
2005	27,856	556.8	24,368	464.3	52,224	509.4
2011	30,621	593.6	26,473	495.1	57,094	543.5
growth index: 1980–1990		17.0%		23.1%		19.8%
growth index: 1990–2000		23.9%		28.7%		26.2%
growth index: 2000–2011		24.9%		14.9%		20.1%

burden, and mortality from cancer contributes 25.8% to the overall population mortality (Tab. 1). The highest relative proportion of cancer mortality in relation to other competing causes of death was observed in the age group 50–64 years (39.3%, Tab. 2). The male population ranks 10th worldwide in respect of cancer incidence and 24th in respect of cancer mortality. The female population ranks 16th in respect of the worldwide incidence statistics and 46th in respect of mortality (Tab. 3). In 2011, 77,773 newly diagnosed cases (740.3 per 100,000 individuals) of all cancers including skin neoplasms (C00–C97) were diagnosed. In total, 27,171 cancer deaths were registered in 2011 (258.6 per 100,000 individuals) (Tab. 3). The crude incidence rate has continuously increased with the growth index +27.6% in the last decade (2001–2011), while the crude mortality rate stabilized in late 1990s and recently even started to decrease with the growth index –5.0% over the time period 2001–2011 (Fig. 1, Tab. 3, 4). Growing incidence and stabilized mortality necessarily result in increased prevalence, which exceeded 475,000 of cases in 2011 (Tab. 3).

The age-standardized incidence and mortality rates (World and European age standard) as well as crude incidence and mortality rates for all main cancer diagnostic groups according to gender are presented in Tab. 5 and 6. The cancer types most common in the male population (absolute number in 2011) include prostate cancer (6,965), followed by colorectal cancer (4,755) and lung cancer (4,482). In women, breast

Tab. 5. Incidence and mortality of malignant neoplasms in the Czech Republic according to diagnosis – male population in 2011.

Diagnosis		Number of cases		Age-standardized rate		Lifetime cumulative risk (0–74 years)
		absolute	per 100,000 males	ASR(W)	ASR(E)	
oral cavity and pharynx (C00–C14)	incidence	1,059	20.5	12.7	17.7	1.44
	mortality	556	10.8	6.6	9.2	
	prevalence	5,227	101.3			
oesophagus (C15)	incidence	440	8.5	5.0	7.1	0.69
	mortality	388	7.5	4.3	6.3	
	prevalence	760	14.7			
stomach (C16)	incidence	900	17.4	9.6	14.6	1.21
	mortality	632	12.3	6.7	10.3	
	prevalence	2,790	54.1			

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Tab. 5 – continue. Incidence and mortality of malignant neoplasms in the Czech Republic according to diagnosis – male population in 2011.

Diagnosis		Number of cases		Age-standardized rate		Lifetime cumulative risk (0–74 years)
		absolute	per 100,000 males	ASR(W)	ASR(E)	
colorectal cancer (C18–C21)	incidence	4,755	92.2	51.2	76.6	6.26
	mortality	2,122	41.1	21.7	34.2	
	prevalence	28,786	558.1			
liver (C22)	incidence	590	11.4	6.5	9.6	0.84
	mortality	490	9.5	5.2	7.9	
	prevalence	521	10.1			
gallbladder and billiary tract (C23–C24)	incidence	351	6.8	3.6	5.7	0.42
	mortality	279	5.4	2.8	4.5	
	prevalence	549	10.6			
pancreas (C25)	incidence	1,111	21.5	12.1	18.0	1.42
	mortality	1,037	20.1	11.1	16.9	
	prevalence	973	18.9			
larynx (C32)	incidence	456	8.8	5.3	7.5	0.71
	mortality	238	4.6	2.7	3.9	
	prevalence	3,548	68.8			
trachea, bronchus and lung (C33–C34)	incidence	4,482	86.9	48.2	71.6	6.62
	mortality	3,911	75.8	41.6	62.2	
	prevalence	7,474	144.9			
melanoma of skin (C43)	incidence	1,086	21.1	12.6	18.0	1.34
	mortality	201	3.9	2.2	3.3	
	prevalence	9,743	188.9			
non-melanoma skin (C44)	incidence	10,728	208.0	109.8	174.3	7.45
	mortality	84	1.6	0.8	1.4	
	prevalence	68,385	1,326			
soft tissue (C47, C49)	incidence	160	3.1	2.2	2.8	0.19
	mortality	57	1.1	0.8	1.0	
	prevalence	1,376	26.7			
prostate (C61)	incidence	6,965	135.0	74.0	110.6	8.67
	mortality	1,314	25.5	12.7	21.7	
	prevalence	39,866	772.9			
testis (C62)	incidence	467	9.1	7.6	8.3	0.60
	mortality	38	0.7	0.6	0.7	
	prevalence	8,617	167.1			
kidney (C64)	incidence	1,940	37.6	22.3	31.9	2.59
	mortality	647	12.5	6.8	10.5	
	prevalence	12,621	244.7			
bladder (C67)	incidence	1,608	31.2	16.8	25.9	2.11
	mortality	507	9.8	5.1	8.2	
	prevalence	12,689	246.0			

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Tab. 5 – continue. Incidence and mortality of malignant neoplasms in the Czech Republic according to diagnosis – male population in 2011.

Diagnosis		Number of cases		Age-standardized rate		Lifetime cumulative risk (0–74 years)
		absolute	per 100,000 males	ASR(W)	ASR(E)	
brain, nervous system (C70–72)	incidence	439	8.5	6.2	7.6	0.65
	mortality	389	7.5	5.0	6.6	
	prevalence	1,705	33.1			
thyroid (C73)	incidence	215	4.2	2.8	3.7	0.30
	mortality	36	0.7	0.4	0.6	
	prevalence	1,994	38.7			
Hodgkin lymphoma (C81)	incidence	152	2.9	2.5	2.7	0.20
	mortality	30	0.6	0.3	0.5	
	prevalence	2,620	50.8			
non-Hodgkin lymphoma (C82–C85, C96)	incidence	723	14.0	8.7	12.1	0.90
	mortality	317	6.1	3.3	5.2	
	prevalence	4,877	94.5			
multiple myeloma (C90)	incidence	245	4.7	2.7	3.9	0.34
	mortality	161	3.1	1.7	2.6	
	prevalence	982	19.0			
leukaemia (C91–C95)	incidence	721	14.0	8.8	12.1	0.98
	mortality	461	8.9	4.9	7.5	
	prevalence	4,056	78.6			
all malignant but skin (C00–C97 but C44)	incidence	30,621	593.6	341.3	496.8	31.28
	mortality	14,924	289.3	158.5	242.0	
	prevalence	148,717	2,883.1			
all malignant	incidence	41,349	801.6	451.1	671.0	34.96
	mortality	15,008	291.0	159.3	243.4	
	prevalence	206,969	4,012.4			

Mortality statistics: Czech Statistical Office. Lifetime cumulative risk (0–74 years) estimated from period 2007–2011.

cancer is most frequently diagnosed (malignant tumor) (6,620 incident cases in 2011), followed by colorectal cancer (3,421), lung cancer (2,033), and uterine cancer (1,990). The highest lifetime cumulative risk (0–74 years) was observed for prostate cancer (men: 8.67), breast cancer (women: 7.19), lung cancer (men: 6.62), and colorectal cancer (men: 6.26).

In addition to demographic aging of the Czech population, the cancer burden has also increased as a consequence of the growing incidence of multiple primary tumors. The data in Tab. 7 document a significantly growing contribution of patients with multiple primary malignancies (both synchronous and metachronous) to the overall incidence. In most prevalent cancers, the rate of multiple malignancies in the same patient represents over 15% of the overall incidence (2008–2011).

The CNCR database offers accurate stratification of newly diagnosed cases according to clinical stage (Fig. 2). It is evident that early detection of the disease is low, particularly for liver, lung, and pancreatic cancer (Tab. 8). A relatively low proportion of early detected cases can also be observed in highly prevalent neoplasms, such as colorectal cancer (stage I or II: 46.1%). Furthermore, in all the above-mentioned diagnoses there is no sign that this situation has improved at all over the 1998–2011 period (Fig. 2). On the other hand, the present survey also revealed several highly prevalent cancers with a continuous increase of early diagnosed cases, including female breast cancer, testicular, prostate, and bladder cancer. For all these diagnoses, the proportion of patients diagnosed in stage I or II has recently exceeded 65% of incident cases (Tab. 8, Fig. 2).

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Tab. 6. Incidence and mortality of malignant neoplasms in the Czech Republic according to diagnosis – female population in 2011.

Diagnosis		Number of cases		Age-standardized rate		Lifetime cumulative risk (0–74 years)
		absolute	per 100,000 females	ASR(W)	ASR(E)	
oral cavity and pharynx (C00–C14)	incidence	408	7.6	4.0	5.6	0.43
	mortality	142	2.7	1.4	1.9	
	prevalence	2,645	49.5			
oesophagus (C15)	incidence	91	1.7	0.8	1.1	0.11
	mortality	85	1.6	0.8	1.1	
	prevalence	161	3.0			
stomach (C16)	incidence	648	12.1	5.2	7.8	0.61
	mortality	460	8.6	3.5	5.3	
	prevalence	2,321	43.4			
colorectal cancer (C18–C21)	incidence	3,421	64.0	28.3	41.8	3.19
	mortality	1,565	29.3	11.1	17.3	
	prevalence	23,047	431.0			
liver (C22)	incidence	326	6.1	2.4	3.6	0.28
	mortality	276	5.2	2.0	3.1	
	prevalence	297	5.6			
gallbladder and billiary tract (C23–C24)	incidence	550	10.3	3.9	6.2	0.52
	mortality	477	8.9	3.5	5.5	
	prevalence	990	18.5			
pancreas (C25)	incidence	1,073	20.1	8.2	12.5	0.93
	mortality	996	18.6	7.5	11.5	
	prevalence	937	17.5			
larynx (C32)	incidence	70	1.3	0.7	0.9	0.08
	mortality	26	0.5	0.2	0.3	
	prevalence	516	9.6			
trachea, bronchus and lung (C33–C34)	incidence	2,033	38.0	17.6	25.6	2.15
	mortality	1,679	31.4	14.0	20.6	
	prevalence	3,684	68.9			
melanoma of skin (C43)	incidence	958	17.9	10.3	13.8	1.10
	mortality	164	3.1	1.3	2.0	
	prevalence	12,146	227.1			
non-melanoma skin (C44)	incidence	9,951	186.1	79.0	118.3	6.17
	mortality	45	0.8	0.3	0.5	
	prevalence	79,382	1,484.5			
soft tissue (C47, C49)	incidence	133	2.5	1.9	2.1	0.15
	mortality	50	0.9	0.5	0.7	
	prevalence	1,331	24.9			
female breast (C50)	incidence	6,620	123.8	67.4	92.9	7.19
	mortality	1,725	32.3	13.9	20.8	
	prevalence	67,261	1,257.9			

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Tab. 6 – continue. Incidence and mortality of malignant neoplasms in the Czech Republic according to diagnosis – female population in 2011.

Diagnosis		Number of cases		Age-standardized rate		Lifetime cumulative risk (0–74 years)
		absolute	per 100,000 females	ASR(W)	ASR(E)	
uterine cervix (C53)	incidence	1,023	19.1	13.0	16.3	1.29
	mortality	315	5.9	3.2	4.4	
	prevalence	17,398	325.4			
uterus (C54–C55)	incidence	1,990	37.2	18.7	26.7	2.27
	mortality	432	8.1	3.3	5.0	
	prevalence	24,576	459.6			
ovary (C56)	incidence	1,080	20.2	11.0	15.2	1.31
	mortality	678	12.7	5.9	8.5	
	prevalence	8,917	166.8			
kidney (C64)	incidence	1,065	19.9	9.4	13.5	1.16
	mortality	398	7.4	2.8	4.4	
	prevalence	8,307	155.4			
bladder (C67)	incidence	543	10.2	4.4	6.6	0.59
	mortality	192	3.6	1.2	2.0	
	prevalence	4,921	92.0			
brain, nervous system (C70–72)	incidence	418	7.8	5.1	6.2	0.49
	mortality	352	6.6	3.6	4.8	
	prevalence	1,553	29.0			
thyroid (C73)	incidence	791	14.8	10.4	12.8	1.00
	mortality	40	0.7	0.2	0.4	
	prevalence	9,127	170.7			
Hodgkin lymphoma (C81)	incidence	132	2.5	2.3	2.3	0.15
	mortality	17	0.3	0.2	0.2	
	prevalence	2,565	48.0			
non-Hodgkin lymphoma (C82–C85, C96)	incidence	700	13.1	6.6	9.2	0.72
	mortality	276	5.2	2.0	3.0	
	prevalence	4,897	91.6			
multiple myeloma (C90)	incidence	238	4.5	2.0	2.9	0.25
	mortality	190	3.6	1.3	2.1	
	prevalence	977	18.3			
leukaemia (C91–C95)	incidence	568	10.6	5.3	7.2	0.58
	mortality	392	7.3	3.0	4.5	
	prevalence	3,267	61.1			
all malignant but skin (C00–C97 but C44)	incidence	26,473	495.1	252.3	352.6	22.73
	mortality	12,118	226.6	95.0	142.8	
	prevalence	198,763	3,717.1			
all malignant	incidence	36,424	681.2	331.3	470.9	26.61
	mortality	12,163	227.5	95.3	143.3	
	prevalence	268,493	5,021.2			

Mortality statistics: Czech Statistical Office. Lifetime cumulative risk (0–74 years) estimated from the period 2007–2011.

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Tab. 7. Trend in incidence of multiple primary cancers diagnosed in period 1977–2011 (documented on records of selected most frequent cancer diagnoses).

Diagnosis	Given type of cancer diagnosed as primary tumor and as subsequent multiple tumor in a patient	Period 1977–1987	Period 1988–1997	Period 1998–2007	Period 2008–2011
		annual absolute number (% new cases)			
colon and rectum (C18–C20)	primary tumors	4,236 (95.5%)	5,694 (91.5%)	6,706 (86.4%)	6,714 (82.4%)
	subsequent multiple tumors developed in already diagnosed cancer patients	199 (4.5%)	527 (8.5%)	1,056 (13.6%)	1,433 (17.6%)
pancreas (C25)	primary tumors	1,094 (96.2%)	1,351 (92.7%)	1,501 (87.3%)	1,711 (83.2%)
	subsequent multiple tumors developed in already diagnosed cancer patients	43 (3.8%)	107 (7.3%)	218 (12.7%)	346 (16.8%)
lung (C34)	primary tumors	5,375 (96.6%)	5,441 (93.1%)	5,413 (87.7%)	5,462 (83.4%)
	subsequent multiple tumors developed in already diagnosed cancer patients	192 (3.4%)	403 (6.9%)	760 (12.3%)	1,089 (16.6%)
female breast (C50)	primary tumors	2,900 (95.6%)	3,756 (91.8%)	4,922 (88.3%)	5,479 (85.2%)
	subsequent multiple tumors developed in already diagnosed cancer patients	133 (4.4%)	336 (8.2%)	652 (11.7%)	955 (14.8%)
uterine cervix (C53)	primary tumors	1,089 (98.3%)	1,099 (96.6%)	997 (94.3%)	937 (92.1%)
	subsequent multiple tumors developed in already diagnosed cancer patients	19 (1.7%)	39 (3.4%)	60 (5.7%)	80 (7.9%)
corpus uteri (C54)	primary tumors	1,218 (97.2%)	1,399 (94.0%)	1,531 (89.9%)	1,660 (88.5%)
	subsequent multiple tumors developed in already diagnosed cancer patients	35 (2.8%)	89 (6.0%)	172 (10.1%)	217 (11.5%)
ovary (C56)	primary tumors	846 (95.4%)	966 (92.0%)	1,020 (87.7%)	941 (83.8%)
	subsequent multiple tumors developed in already diagnosed cancer patients	41 (4.6%)	84 (8.0%)	143 (12.3%)	183 (16.2%)
prostate (C61)	primary tumors	1,256 (94.6%)	1,842 (90.4%)	3,335 (85.8%)	5,462 (85.7%)
	subsequent multiple tumors developed in already diagnosed cancer patients	72 (5.4%)	195 (9.6%)	551 (14.2%)	911 (14.3%)
kidney (C64)	primary tumors	869 (94.6%)	1,692 (90.8%)	2,196 (85.3%)	2,354 (80.5%)
	subsequent multiple tumors developed in already diagnosed cancer patients	50 (5.4%)	172 (9.2%)	377 (14.7%)	570 (19.5%)
bladder (C67)	primary tumors	976 (95.3%)	1,402 (90.8%)	1,796 (85.0%)	1,776 (80.7%)
	subsequent multiple tumors developed in already diagnosed cancer patients	48 (4.7%)	143 (9.2%)	317 (15.0%)	424 (19.3%)

Problems with access to early diagnosis were observed in a regional survey presented in Tab. 9. Significant regional heterogeneity in early detection rate was found for nearly all listed diagnoses, including the most prevalent colorectal cancer (inter-regional range in proportion to early diagnosed cases: 42.0–52.3%), prostate cancer (56.8––78.9%), or bladder cancer (65.1–88.7%). It should be mentioned that even the overall cancer burden significantly varies between different regions of the Czech Republic. Crude incidence for different regions estimated for the period 2007–2011 ranged from 499.8 to 637.1, and crude mortality ranged from 237.4 to 281.6 (Tab. 9). Such heterogeneity cannot be explained solely by the fact that the population structure of the regions differs. In selected cancer types, the regional distribution of age-standardized incidence rather indicates the potential influence of some external, most probably environmental factors (Fig. 3).

Discussion

The cancer burden in the Czech population ranks among the highest worldwide and is growing continuously [4,6]. During the 1990s and 2000s, the incidence of all major cancers in the Czech population was constantly increasing [20] and the growth dynamic was consistent with recently published international

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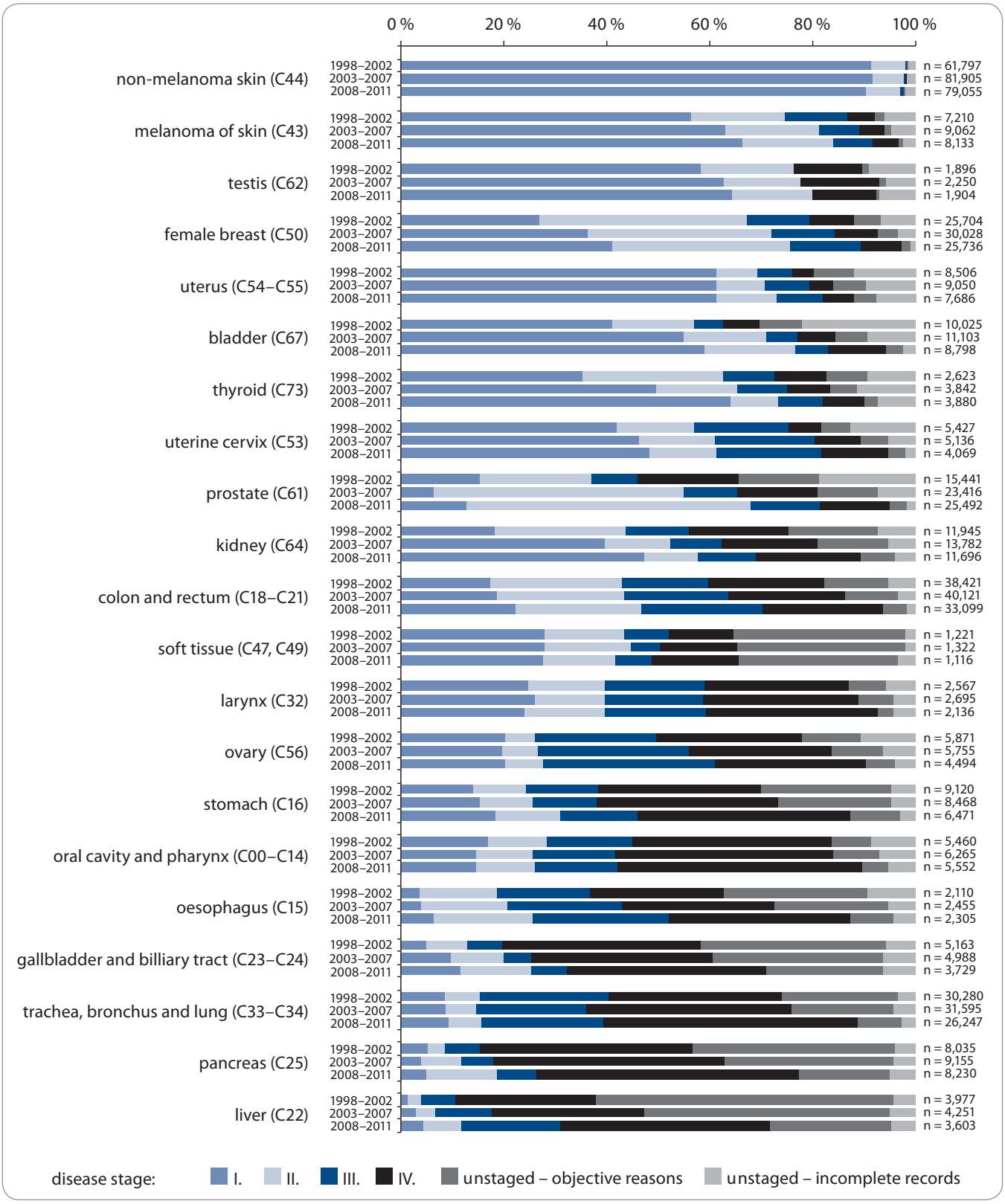

Fig. 2. Proportion of clinical stages in malignant disorders (sorted by proportion of stage I + II; Czech National Cancer Registry, 1998–2011).

data [1–5]. Furthermore, the relative profile of most prevalent cancer types (breast cancer in women, prostate cancer in men, colorectal and lung cancer in both genders) corresponds to the outcomes of recent European epidemiology summaries [1]. Lung cancer is the most frequent cause of death from cancer in both males and

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females, with annual death rates of 3,911 and 1,679, respectively.

The growing cancer burden trend can generally be attributed to widely known risk factors, such as apparent demographic aging of the Czech population, life style factors or, more specifically, to changes in reproductive behavior (e. g. for female breast cancer) [31].

Continuous cancer incidence growth can also be expected in the foreseeable future due to the demographic structure and aging of the Czech population. In 1999, the average age was 36.8 years for men and 40.0 years for women. Within 12 years, these values have shifted to 39.6 years for men and 42.5 years for women (data from 2011). During the period 1999–2011, the proportion of inhabitants aged over 50 years increased by 4.6%.

The increasing incidence was also noted for preventable cancers, particularly colorectal carcinoma. The incidence of colorectal cancer in the Czech male population ranks 4th highest in the world [2]. The growing incidence of colorectal cancer (growth index 2001–2011: 6.0%) was accompanied by a relatively low rate of early detection of the disease (only 46.1% of incident cases in stage I or II). Furthermore, the relative rate of early detected cases varied greatly among regions (42.0–52.3%), which indicates certain disparities in cancer control. These findings should guide further development of the Czech colorectal screening program [32,33].

Based on the results of various international trials, a decrease in colorectal cancer mortality by more than 30% due to organized screening based on annual faecal occult blood test (FOBT) can be expected [34,35]. However, recent Czech data indicate only 25.8% coverage of the target adult population by FOBT screening, which is insufficient to trigger substantial population changes. Therefore, a population-based program including invitation of the target population to cancer screening was initiated in January 2014 [33].

The recent situation of the epidemiology of breast cancer in the Czech female population is better compared to that of colorectal cancer. Although the incidence of breast carcinoma is significantly increasing (growth index 2001–2011: 22.9%), it is accompanied by a continuous increase in cases diagnosed at an early stage (according to recent data, 75.3% of cases are diagnosed in stage I or II). These positive changes are due to the increasing impact of the Czech national breast cancers screening program [36] which has already reached more than 50% coverage of the target female population (aged 45–69 years). Similarly, as a consequence of the widely used PSA test, we can see a growing incidence of early detected prostate cancer (Tab. 8, Fig. 2), although no organized screening for this type of cancer exists in the Czech Republic.

On the other hand, cervical cancer is one of the few cancer diagnoses with a decreasing incidence (Tab. 8). This is probably associated with cervical cancer screening, the third organized cancer screening program recommended for implementation in the EU [11]. Cervical cancer prevention through cytology examinations has been running in the Czech Republic for many years. An organized screening program, including accreditation of cytology laboratories and data monitoring through the cervical cancer screening registry, was initiated in the Czech Republic in 2008 [37].

The cancer burden in the Czech Republic has also been increasing due to a growing incidence of multiple primary malignancies diagnosed in the same patient. Although the registration of multiple tumors is considered by many authors as rather a complicated issue [38], the Czech cancer registry provides reliable data on multiple synchronous or metachronous malignancies. The CNCR database makes it possible to identify a specific patient; therefore, malignancies occurring in the same person can be identified accurately, whether in the same or another location. The chronological order of multiple malignancies can be assessed as well. Table 7 summarizes the overall data, demonstrating that multiple malignancies are relatively common, although the rate differs markedly for various types of first tumors. If non-melanoma skin cancers (C44) and malignant neoplasms of uncertain behavior (D37–D48) are not considered, the relative frequency of recurring malignancies ranges from 14% to 16%, the overwhelming majority (89%) of recurring malignancies belonging to a different diagnostic group than the first tumor. Second malignancy belonging to the same diagnostic group was more common in breast cancer (C50) and testicular cancer (C62). Further studies of the phenomenon of second primary tumors are warranted, as they might provide important insights into causal relationships between different types of cancer. Additionally, it represents an opportunity for prevention and improved targeting of already diagnosed and treated cancer patients.

Inter-regional differences in reporting to the cancer registry need to be considered when mapping the national cancer burden. Although we cannot exclude some degree of under-registration in some regions, it is highly probable that its real impact is limited, particularly in the recent period since 2000. This assumption is based on regional profiles of mortality rates which fully correspond to those observed for incidence profiles. Mortality estimates in the Czech Republic are double-checked using two independent sources of information on death events, i.e. the cancer registry and the Death Records Database, are used [18,19]. The CNCR management follows the administrative division of the country into 14 regions and data are collected in the same manner in each of them. Moreover, the observed regional differences in the cancer burden are different for various cancers and do not reveal any consistent pattern (Fig. 3).

Therefore, in the light of regional differences (Tab. 9, Fig. 3), we cannot ignore the possible influence of environmental factors, although their contribution to the etiology of different types of human cancer has been disputed in the literature [39,40]. Czech adults in the risk age categories of 50–60 years or older were probably at least partially exposed to relatively

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Tab. 8. Classification of malignant neoplasms in the Czech Republic according to trends in incidence rates and clinical stage at the time of diagnosis.

Classification according to trends in incidence rates		
diagnoses of malignant tumors with raising incidence rates	**diagnoses of malignant tumors with stabilized incidence rates**	**diagnoses of malignant tumors with decreasing incidence rates**
C61 (GI: +115.3%)	C91–C95 (GI: +8.0%)	C81 (GI: –6.4%)
C73 (GI: +81.2%)	C67 (GI: +7.6%)	C56 (GI: –7.0%)
C44 (GI: +60.7%)	C18–C21 (GI: +6.0%)	C53 (GI: –7.5%)
C43 (GI: +41.1%)	C33, C34 (GI: +5.7%)	C23, C24 (GI: –11.9%)
C15 (GI: +40.4%)	C32 (GI: +1.0%)	C16 (GI: –14.0%)
C25 (GI: +29.5%)		
C82–85, C96 (GI: +23.2%)		
C50 (GI: +22.9%)		
C64 (GI: +22.0%)		
C00–C14 (GI: +21.7%)		
C62 (GI: +21.4%)		
C47, C49 (GI: +17.2%)		
C70–C72 (GI: +14.4%)		
C22 (GI: +13.3%)		
C54, C55 (GI: +12.4%)		
C90 (GI: +10.0%)		

Classification according to detection rates of less advanced stages of malignant tumors		
low detection rates at stages I and II	**middle detection rates at stages I and II**	**high detection rates at stages (S) I and II**
C25 (S I + II: 17.7%)	C18–C21 (S I + II: 46.1%)	C44 (S I + II: 97.2%)
C33, C34 (S I + II: 15.4%)	C47, C49 (S I + II: 42.3%)	C43 (S I + II: 84.2%)
C22 (S I + II: 11.0%)	C32 (S I + II: 39.0%)	C62 (S I + II: 80.3%)
	C16 (S I + II: 30.0%)	C67 (S I + II: 76.2%)
	C56 (S I + II: 27.1%)	C50 (S I + II: 75.3%)
	C23, C24 (S I + II: 25.6%)	C73 (S I + II: 72.4%)
	C00–C14 (S I + II: 25.5%)	C54, C55 (S I + II: 72.4%)
	C15 (S I + II: 25.3%)	C61 (S I + II: 66.8%)
		C53 (S I + II: 61.4%)
		C64 (S I + II: 56.8%)

C00–C14 – oral cavity and pharynx, C15 – oesophagus, C16 – stomach, C18–C21 – colon and rectum, C22 – liver and intrahepatic bile ducts, C23, C24 – gallbladder and biliary tract, C25 – pancreas, C32 – pharynx, C33, C34 – trachea, bronchus and lung, C43 – skin melanoma, C44 – other malignant neoplasm of the skin, C47, C49 – connective and soft tissue, C50 – breast (women), C53 – cervix uteri, C54, C55 – uterus, C56 – ovary, C61 – prostate, C62 – testis, C64 – kidney, C67 – bladder, C70–C72 – brain and spinal cord, C73 – thyroid gland, C81 – Hodgkin lymphoma, C82–C85, C96 – non-Hodgkin lymphoma, C90 – multiple myeloma, C91–C95 – leukaemia, GI – growth index related to the period 2001–2011, S I + II – proportion of clinical stages I + II in the overall incidence of the disease, data from period 2007–2011

high concentrations of environmental pollutants, including polychlorinated biphenyls (PCBs), DDT and other pesticides in the 1960s–1970s [6]. This exposure, however, cannot be quantified precisely due to the lack of environmental data from the period of Communist government before 1989. Although we cannot address the role of

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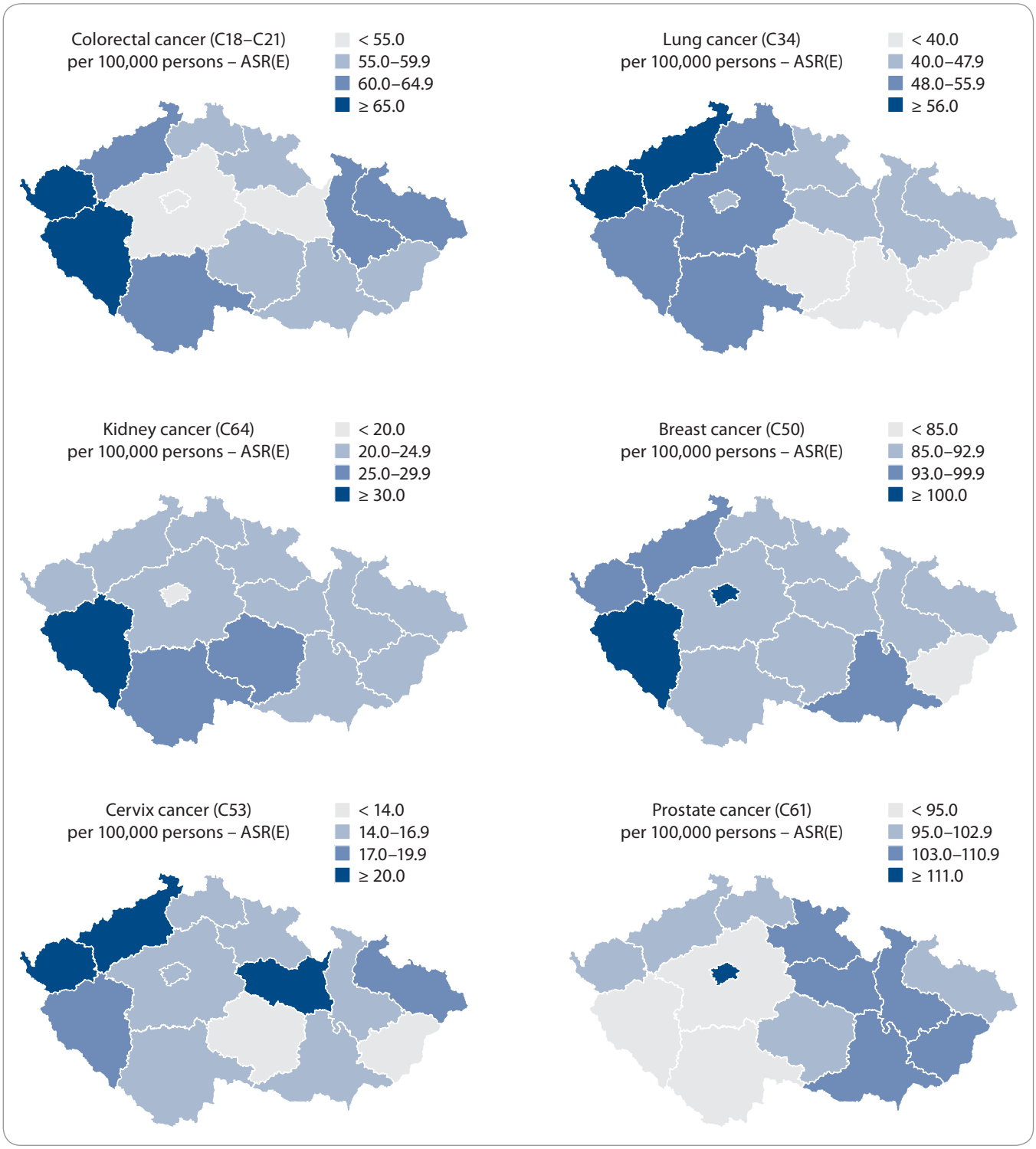

Fig. 3A. Examples of regional differences in cancer incidence in period 2007–2011 (selected most frequent cancers, Czech National Cancer Registry).

the environment in cancer causation, some birth-cohort effects should be studied as an indirect population indicator of unspecified harmful effects in the past. This information should be translated in well-designed future studies focused on the space variability of cancer epidemiology in the Czech Republic.

The present analysis is based on 34 years of experience of a nationwide, fully representative cancer registry. It supports the idea that cancer registries can be accepted as one of the main sources for improvement of our understanding of cancer and its

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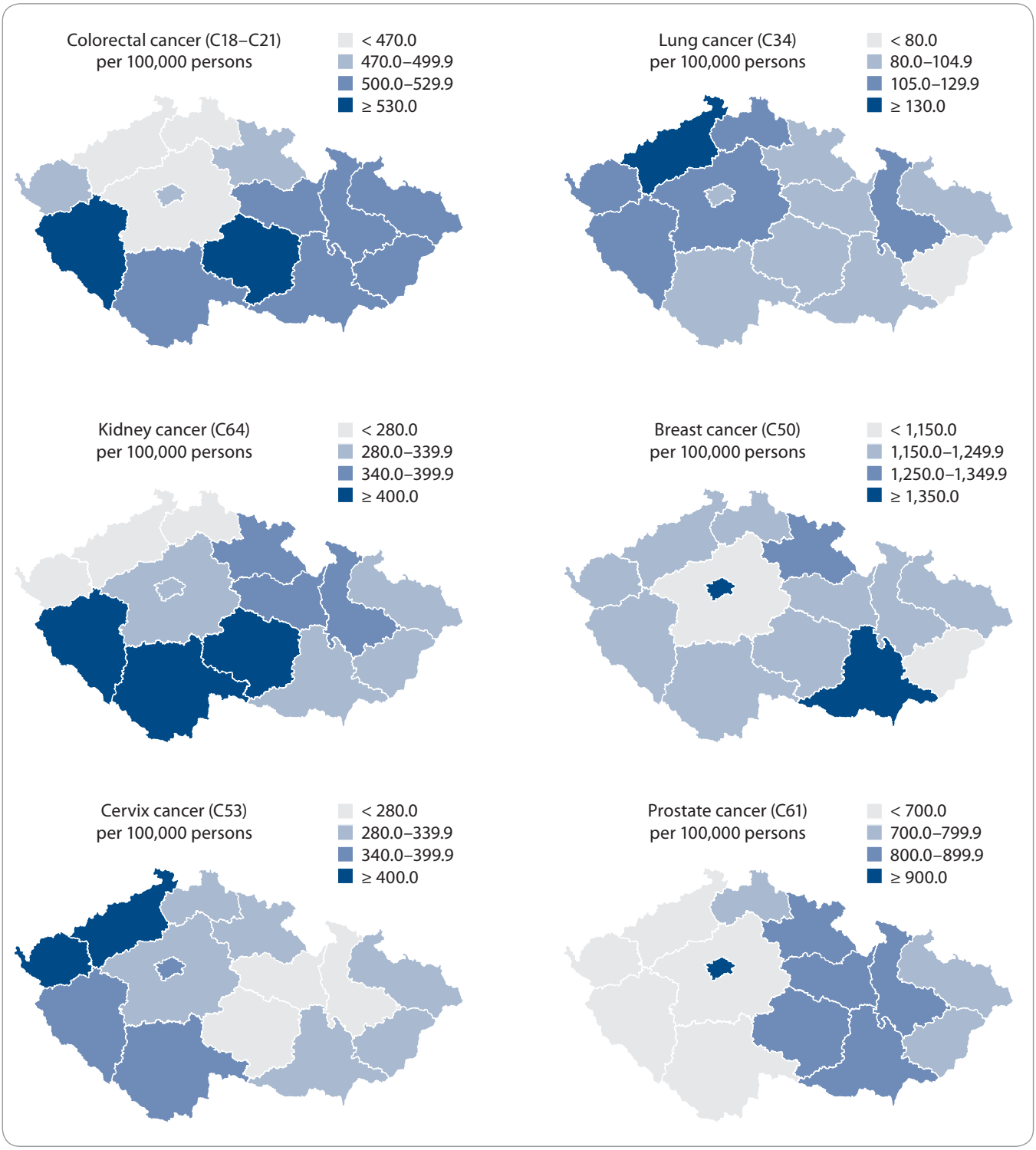

Fig. 3B. Examples of regional differences in cancer prevalence, end of year 2011 (selected most frequent cancers, Czech National Cancer Registry).

causation. Representative registries may reveal factors that are underlying trends in cancer incidence; moreover, they can detect significant changes over time in the main diagnostic parameters (such as morphology and staging). This information is necessary to promote prevention which might ultimately lead to better control of the disease. The CNCR contains complete and comprehensive records on the clinical stage at the time of diagnosis, including detailed records on individual components of TNM classification. The overall CNCR assessment has revealed only 3.8% of

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Tab. 9. Regional differences in the main epidemiological trends of malignant neoplasms excluding non-melanoma skin cancer (C00–C97 excluding C44) in the Czech Republic. Mortality statistics – Czech Statistical Office.

Indicator	Data from period	Average value over the whole population	Range of values in regions (min.; max.; n = 14 regions)
incidence rate per 100,000 population	2007–2011	533.2	(499.8; 637.1)
age standardized incidence rate, ASR(E)	2007–2011	415.1	(384.5; 484.3)
incidence growth index related to 2001	2001–2011	18.9%	(9.6%; 35.4%)
mortality rate per 100,000 population	2007–2011	261.4	(237.4; 281.6)
age standardized mortality rate, ASR(E)	2007–2011	193.8	(172.6; 224.8)
mortality growth index related to 2001	2001–2011	–5.1%	(–14.0%; 4.8%)
prevalence rate per 100,000 population	2011	3,308	(2,986; 3,629)
prevalence growth index related to 2001	2001–2011	57.5%	(42.9%; 69.7%)
mortality/incidence index	2007–2011	0.49	(0.44; 0.54)
selected diagnostic groups: detection rate at clinical stages I + II	2007–2011		
stomach (C16)		30.0%	(23.5%; 38.7%)
colon and rectum (C18–C21)		46.1%	(42.0%; 52.3%)
pancreas (C25)		17.7%	(11.5%; 25.3%)
trachea, bronchus and lung (C33, C34)		15.4%	(12.4%; 19.7%)
skin melanoma (C43)		84.2%	(74.3%; 90.2%)
breast – women (C50)		75.3%	(72.3%; 79.3%)
uterus (C54, C55)		72.4%	(60.5%; 86.3%)
prostate (C61)		66.8%	(56.8%; 78.9%)
kidney (C64)		56.8%	(47.7%; 62.7%)
bladder (C67)		76.2%	(65.1%; 88.7%)
proportion of cancer detection during autopsy and from DCO	2007–2011	3.8%	(1.2%; 6.2%)

records which are missing information on both TNM classification and clinical stage in an unexplained manner (Fig. 2). The completeness of CNCR data increases with time, and the most recent period (2000–2011) provides high-quality data. The CNCR is equipped with a web-based analytic tool which allows any user to perform comprehensive analyses in a user-friendly environment [20]. We regard the CNCR database and associated software as one of the strongest points of the Czech National Cancer Control Program, providing a basis for international collaborative efforts [41].

Conclusion

Using the available epidemiologic data, the cancer burden in the Czech Republic can be assessed throughout the population and for individual regions. The proportion of clinical stages as well as the success rate of early detection can be analyzed and the time trends calculated based on available data. The strongest point of the present study lies in the accessibility of information over a 34-year period of continuous and standardized registration covering virtually 100% of cancer diagnoses within the entire Czech population. The data summary is also available as a public on-line interactive tool [20]. The main challenge for the future is to use these tools to contribute to the reduction of cancer mortality, particularly by decreasing the proportion of late-stage diagnoses and addressing the remarkable regional differences in diagnostic efficacy.

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Informace z České onkologické společnosti

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