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CANCER INCIDENCE IN UKRAINE: TRENDS IN 2010-2019 AND THE IMPACT OF COVID-19 PANDEMIC

Background. In 2020, a sharp decrease in the number of new cancer cases was registered in Ukraine in the setting of the quarantine restrictions due to the COVID-19 pandemic, which contrasted with the previous trends. **Aim.** To study trends of cancer incidence rates in Ukraine in the recent decade and to assess the impact of COVID-19 pandemic on cancer detection in 2020. **Materials and Methods.** Records on cancer cases diagnosed during 2010—2020 (n = 1,498,911) from the database of the National Cancer Registry of Ukraine were used; the data being submitted early in 2022. Trends of the age-standardized incidence rates in 2010—2019 were estimated by the Joinpoint Regression Program. **Results.** During 2010—2019, the incidence rates increased ($p < 0.05$) for colon, prostate, and pharyngeal cancers in males and for colon, thyroid, and pancreas in females with the rates of other prevalent cancers being stable or decreasing (lung and larynx in males, cervix and rectum in females, stomach in both genders); the incidence increased mainly at the expense of the population aged 60—74 years. A significant decrease in cancer incidence was in males aged 40—59 years. In 2020, the serious negative impact of COVID-19 outbreak on the timely detection of cancer occurred in all adult age groups of the Ukrainian population and involved all the most common cancers. The most pronounced diminution of the incidence rate was observed for non-melanoma skin cancers (by 35.9%—37.9%); the decrements of the rates for other prevalent cancers varied from –23.0% (prostate gland) to –9.7% (pharynx) in males and from –21.2% (kidney) to –9.1% (pancreas) in females, the greatest ones being in the population aged 75+. **Conclusions.** The sharp drop of the cancer incidence rates registered in Ukraine 2020 is evidently the result of the limited access to healthcare facilities as well as the reduced oncological alertness of the population due to the predominant focus on COVID-19 during the pandemic. However, it is not a manifestation of a decrease in cancer incidence as such. In the following years, this may increase the proportion of advanced-stage diagnoses, the load on the cancer care system, and cancer mortality in the Ukrainian population. An evaluation of the short-term and long-term effects of the COVID-19 pandemic on the cancer burden in Ukraine requires further monitoring.

Keywords: cancer incidence rates, COVID-19, National Cancer Registry of Ukraine.

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In 2020—2021, the active implementation of the packages of the State Program of Medical Guarantees for assisting cancer patients began in Ukraine. The free provision of diagnostic and treatment services under the Program of Medical Guarantees was supposed to contribute to the timely detection of cancer and the growth of demand for medical services. However, these years were marked by the outbreaks of the COVID-19 pandemic with the appropriate quarantine restrictions that made access to healthcare facilities difficult for patients.

Surveillance of the dynamic and structural changes in cancer incidence over the past years with the use of the National Cancer Registry of Ukraine (NCRU) database makes it possible to study the features of cancer burden in Ukraine and evaluate its further progress [1]. Meanwhile, NCRU registered an extraordinary drop in the number of new cancer diagnoses in the Ukrainian population in 2020 [2], which can be due to the quarantine restrictions and other impacts of the pandemic.

In 2020, the measures for preventing the spread of the acute respiratory disease COVID-19 caused by the SARS-CoV-2 coronavirus in Ukraine were regulated by Resolution No. 211 of the Cabinet of Ministers of Ukraine (CMU) of March 11, 2020, which was amended with 17 other resolutions till the end of 2020. Starting from March 12, 2020, the CMU established quarantine restrictions in all administrative territories of Ukraine, which regulated the activities of health care institutions as follows: "…to ensure the temporary suspension of planned measures for hospitalization and planned operations, except for urgent ones; to ensure maximum readiness and repurposing of medical facilities for reception and treatment of the infected patients in serious conditions" [3]. Resolution No. 332 of the CMU of May 4, 2020 slightly relaxed the restrictions, allowing "the provision of medical care in the specialized departments of health care institutions to patients with oncological diseases" [4]. During the following months, the activity of healthcare institutions was regulated at the regional level depending on the local degree of the epidemic danger.

Materials and Methods

Our study was conducted in 2022 using the records of cancer patients registered in the NCRU database till the end of 2021; it covers 1,498,911 records of cancer cases diagnosed in Ukrainian residents in 2010—2020. The data on the residents of the Crimean Autonomous Republic, Donetsk and Luhansk oblasts were excluded to minimize the impact of changes caused by the occupation of these regions by the Russian Federation in 2014 as well as due to the impossibility of obtaining an appropriate population in the controlled territories of these regions. The population estimates were obtained from the official website of the State Statistics Service of Ukraine [5].

The incidence rates were age-standardized to the world standard population [6] and expressed per 100,000 of population (ASRW). In like manner, the truncated age-standardized incidence rates (TASRW) were calculated for gender and age groups 0—19, 20—44, 45—59, 60—74, and 75+ years.

The temporal trends in incidence for 2010—2019 were estimated by Joinpoint Regression Program (JRP) software (version 4.8.0.1) [7] with a segmented regression method (maximum number of join points allowed for this time interval was two) and expressed as annual percent changes (APCs) within time segments defined with the analysis. Derived from the APCs, estimated average APCs (AAPCs) take into account the trend transitions and are used here for characterizing and making comparisons of trends of the data series over the whole decade 2010 to 2019. The "increase" or "decrease" term is here used when APC or AAPC is statistically significant (appropriate tests determined its statisti-

cal significance when the *p*-value was less than 0.05); otherwise, the fluctuations are supposed insignificant and the incidence may be considered stable. For comparison of the rates of 2019 and 2020, the standardized rate ratio was used [8].

A literature survey was conducted using PubMed, NCRU, Embase, Cochrane Library, Web of Science (WOS), and the China National Knowledge Infrastructure (CNKI) for studies on the changes in cancer incidence registered in 2020.

Results

To ascertain the relationship between the decrease in cancer diagnoses and the introduction of quarantine restrictions in 2020, the distribution of cancer cases by the date of diagnosis (year and month) was analyzed. For smoothing out random annual fluctuations, we compared the monthly distribution of the number of cancer cases diagnosed in 2020 with the respective averaged number for 2015—2019, as during this period no significant fluctuations in cancer incidence were observed and the population covered by cancer registration did not change.

The total difference in the number of cancer cases diagnosed in the population under the study in 2020 was about –25,000 cases or –18%, compared to the average number of cases diagnosed in 2015—2019, though in the previous years, the annual change did not exceed ± 1%. The distribution of cases of 2015—2020 by the date of diagnosis (year and month) is shown in Table 1 and the Figure [1]. The obtained data reveal a sharp decrease in the number of cancer cases diagnosed from March to December 2020. The largest negative difference compared to the average number of cases diagnosed in 2015—2019 was observed in April (–5,100 or –47%), May (–4,300 or –36%), and November (–3,500 or –30%). The analysis of these data by the regions showed that the monthly distribution of cancer cases diagnosed in 2020 in all regions under the study was very similar.

In 2020, the calendar changes in cancer detection differ from its seasonal fluctuations over the past 5 years and coincide with the calendar of quarantine restrictions for medical institutions. That is, the extraordinary decrease in the number of new cancer cases in both the spring

[1] Full Supplementary materials (Tables and Figures) are available by the following link: http://www.ncru.inf.ua/ExpOncol_2023/Suppl_Tables&Figures_Cancer_incidence_in_Ukraine_trends_in_2010-2019_and_the_impact_of_COVID-19_pandemic.pdf

Table 1. **Number of cancer cases by the date of diagnosis, Ukraine*, 2015—2020**

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
2015	14115	12048	12075	10784	11074	11468	12001	10006	11025	10749	11649	10668	137450
2016	11835	13404	13346	11222	10956	11007	11289	11271	11161	10574	11668	9711	137029
2017	12324	12524	13394	10391	11911	11706	11508	10681	10946	11077	12143	9912	138535
2018	12498	14038	11794	10990	12626	11087	12203	11215	10476	11816	11517	9332	139018
2019	13304	11897	12132	11285	12409	10403	12589	10703	11098	11713	11357	9815	139432
2020	11562	13412	9791	5823	7531	9395	10886	9026	9728	9053	8172	8028	113368
Average in 2015—2019	13914	12093	12548	10934	11795	11134	11918	10775	10941	11186	11667	9888	138293
Difference between the number of cases in 2020 and its average in 2015—2019													
Number	626	–196	–2757	–5111	–4264	–1739	–1032	–1749	–1213	–2133	–3495	–1860	–24925
%	4.7	–1.6	–22.0	–46.7	–36.2	–15.6	–8.7	–16.2	–11.1	–19.1	–30.0	–18.8	–18.0

Note: * The data on residents of the Crimean Autonomous Republic and Donetsk and Luhansk oblasts are excluded.

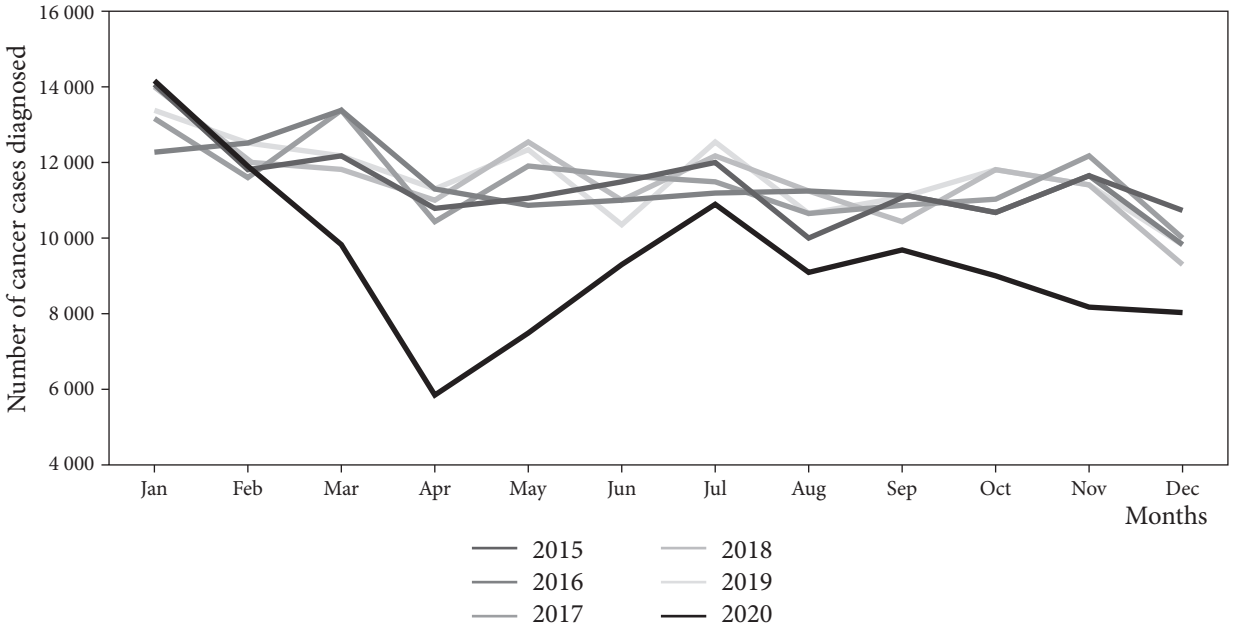

Figure. Number of cancer cases by the date of diagnosis, Ukraine*, 2015—2020
* The data on residents of the Crimean Autonomous Republic and Donetsk and Luhansk oblasts are excluded

and autumn — winter periods of 2020 was not a manifestation of a decrease in cancer incidence as such but resulted from the limited access to medical services and other consequences of the COVID-19 pandemic.

The dynamics of cancer incidence rates for all sites combined during the study period are shown in Table 2. From 2010 to 2020, non-melanoma skin cancers (NMSCs) were among the most common cancer types in both male (about 10%) and female (about 12.5%) populations of Ukraine. The incidence rates for all types of cancer except NMSC are also presented.

The JRP analysis determines significant inflection points in the incidence curve and APC values for each of the time segments. We assessed the summarizing trend of incidence with AAPC obtained by JRP for the entire period of 2010—2019.

In 2012—2019, the incidence rate for all sites combined in males of all ages (0—85+ years) was moderately decreasing (APC = –0.7%, 95% confidence interval (CI) = –1.1% to –0.2%) following the insignificant growth in 2010—2012. The insignificant AAPC value –0.1% for the whole interval of 2010—2019 indicates the stable cancer incidence in males; in females of all ages, the incidence was growing insignificantly too. The trends of male and female incidence rates for all types of cancer except NMSC were very similar.

Incidence rates for all cancers in male patients aged 0—19 years increased during 2010—2016 (APC = 2.6%, 95% CI = 1.5% to 3.7%) and next decreased in 2016—2019 (APC = –4.6%, 95% CI = –7.6% to –1.4%). The female incidence in this age group had an insignificant downward trend in 2010—2012, then it notably increased till 2015 (APC = 3.5%, 95% CI = 0.9% to 6.3%) and decreased with the same slope over 2015—2019 (APC = –3.6%, 95% CI = –4.4% to –2.8%). Over the entire period 2010—2019, the incidence for all cancers in females aged 0—19 years showed a decreasing trend with AAPC –0.8% while in the male group of this age, it can be considered unchanged.

Incidence for all cancers in both male and female groups aged 20—44 years did not change

Table 2. **Cancer incidence rates, all sites combined, Ukraine, 2010—2020**

Site	Age group	ASRW (TASRW) per 100,000 of population											AAPC, %	95% CI, %	APC, %
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2010—2019		2020
Males															
All sites (C00—C96)	0—85+	265.9	270.2	275.8	276.7	269.4	268.5	264.6	266.4	265.2	263.9	215.6	–0.1	–0.8 to 0.5	–18.3**
	0—19	15.2	15.6	15.9	16.6	17.5	17.1	17.4	17.1	16.4	15.3	15.8	0.2	–0.7 to 1.2	3.2
	20—44	58.8	58.1	59.1	59.2	58.2	60.6	57.2	56.5	57.3	55.4	48.5	–0.5	–1.0 to 0.0	–12.4**
	45—59	488.8	484.8	493.9	483.9	471.5	476.7	462.0	450.2	440.1	435.9	365.7	–1.2*	–1.9 to –0.5	–16.1**
	60—74	1467.9	1512.7	1523.3	1552.3	1517.8	1496.2	1499.5	1528.6	1543.4	1543.9	1247.3	0.3	–0.1 to 0.7	–19.2**
	75+	1719.9	1765.9	1909.0	1881.9	1763.7	1744.9	1698.2	1760.0	1712.8	1730.8	1284.6	0.2	–2.1 to 2.5	–25.8**
All sites; NMSC excl.	0—85+	240.7	244.3	249.3	250.2	244.3	243.4	240.0	241.6	240.5	239.2	199.8	–0.1	–0.7 to 0.5	–16.5**
	0—19	15.2	15.5	15.8	16.4	17.4	17.1	17.2	16.9	16.2	15.2	15.7	0.1	–0.8 to 1.0	2.8
	20—44	54.6	54.2	54.8	54.9	53.8	55.6	52.8	52.6	53.3	50.7	45.0	–0.6*	–1.1 to –0.1	–11.4**
	45—59	452.1	448.6	457.1	448.0	436.8	441.3	428.0	415.5	405.3	403.5	343.1	–1.2*	–2.0 to –0.5	–15.0**
	60—74	1330.9	1368.1	1377.1	1405.9	1381.7	1362.3	1362.9	1391.3	1405.8	1402.6	1161.2	0.4*	0.0 to 0.7	–17.2**
	75+	1422.0	1463.6	1590.7	1559.0	1459.9	1444.7	1413.4	1469.5	1430.7	1453.3	1111.8	0.3	–2.0 to 2.7	–23.5**
Females															
All sites (C00—C96)	0—85+	203.2	206.7	208.3	210.2	203.9	208.1	206.9	208.2	209.4	208.8	173.8	0.2	–0.1 to 0.4	–16.7**
	0—19	14.7	15.0	14.3	14.8	15.5	16.3	15.2	14.7	14.3	14.0	13.8	–0.8*	–1.3 to –0.3	–1.6
	20—44	106.6	110.4	109.2	107.7	107.8	114.8	109.8	111.7	111.0	108.2	96.0	0.2	–0.3 to 0.8	–11.3**
	45—59	460.2	454.3	460.9	464.8	446.7	454.9	458.2	452.4	459.2	463.7	391.5	0.0	–0.3 to 0.3	–15.6**
	60—74	849.5	870.5	871.1	886.5	853.0	864.5	864.9	882.6	891.6	887.3	717.6	0.3	0.0 to 0.7	–19.1**
	75+	782.6	836.4	899.3	905.9	864.3	826.7	848.7	855.0	839.7	848.9	620.4	1.0	–0.1 to 2.1	–26.9**
All sites; NMSC excl.	0—85+	182.5	186.1	186.4	187.5	183.6	187.7	186.7	187.9	189.1	187.8	160.8	0.3*	0.0 to 0.5	–14.4**
	0—19	14.7	14.8	14.2	14.7	15.4	16.2	15.1	14.7	14.2	14.0	13.6	–0.8*	–1.3 to –0.3	–2.5
	20—44	101.3	106.2	104.5	102.3	103.0	109.7	104.7	106.7	106.1	103.6	92.3	0.3	–0.3 to 0.9	–10.9**
	45—59	426.7	422.0	423.8	428.4	413.6	420.3	425.6	420.5	426.4	430.5	370.1	0.1	–0.2 to 0.4	–14.0**
	60—74	735.7	755.5	754.2	763.4	745.3	756.4	757.5	772.1	782.9	771.7	649.2	0.5*	0.2 to 0.8	–15.9**
	75+	597.8	638.6	686.6	691.9	662.2	640.8	650.3	657.9	644.2	649.9	503.8	1.0	–0.3 to 2.2	–22.5**

Notes: * Indicates that AAPC is significantly different from zero at the alfa = 0.05 level

** Indicates that APC is significantly different from zero at the alfa = 0.01 level

Abbreviations: AAPC — average annual percent change; APC — annual percent change; ASRW — age-standardized incidence rate, world standard population; NMSC — non-melanoma skin cancer; TASRW — truncated ASRW.

Table 3. **Cancer incidence, most common cancer types, Ukraine, 2010—2020**

Rank in 2020	Site	ASRW per 100,000 of population											AAPC, %	95% CI, %	APC, %
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2010—2019		2020
	Males														
1	Trachea, bronchus, lung (C33—C34)	45.6	46.0	46.0	45.2	44.0	42.0	41.0	41.4	39.0	39.7	32.0	–1.9*	–2.5 to –1.4	–19.4**
2	Prostate gland (C61)	23.2	24.6	26.2	27.0	26.9	27.0	27.0	29.1	30.3	31.0	23.8	3.4*	2.8 to 4.1	–23.0**
3	NMSC (C44)	25.2	25.9	26.5	26.5	25.1	25.1	24.6	24.8	24.7	24.7	15.8	–0.2	–1.7 to 1.3	–35.9**
4	Colon (C18)	15.2	15.9	16.3	16.5	16.6	16.5	16.4	17.0	17.3	17.4	14.7	1.6*	1.0 to 2.1	–15.2**
5	Stomach (C16)	22.5	22.3	21.4	21.3	20.5	19.6	19.1	18.4	17.8	17.3	14.3	–3.0*	–3.3 to –2.7	–17.5**
6	Rectum, anus (C19—C21)	15.8	16.0	16.2	16.4	15.9	15.7	15.7	16.0	16.0	16.2	14.0	0.0	–0.4 to 0.4	–13.3**
7	Bladder (C67)	13.8	14.0	14.5	14.2	13.7	13.7	14.0	13.7	13.8	13.8	11.1	–0.3	–0.7 to 0.2	–20.0**
8	Kidney (C64)	11.1	11.4	12.0	11.9	11.3	11.9	11.8	11.4	11.6	11.5	9.1	0.1	–0.6 to 0.8	–20.7**
9	Pancreas (C25)	8.9	9.3	9.2	9.9	9.3	9.5	9.3	9.1	9.3	9.5	8.3	0.2	–0.6 to 1.0	–13.3**
10	Pharynx (C09—C14)	7.6	7.4	8.0	8.4	8.1	8.7	8.6	8.6	9.0	8.3	7.5	1.6*	0.6 to 2.6	–9.7**
11	Oral cavity (C01—C08)	7.2	7.4	7.4	7.4	7.6	7.8	7.2	7.6	7.0	7.2	6.4	–0.2	–1.0 to 0.7	–10.5**
12	Larynx (C32)	8.0	8.4	8.4	8.2	7.9	8.0	7.9	7.3	7.2	7.1	6.0	–1.4*	–2.8 to 0.0	–15.8**
	Females														
1	Breast (C50)	42.4	42.4	43.1	43.3	42.4	44.8	44.6	44.5	45.7	44.8	39.5	0.8*	0.4 to 1.2	–12.0**
2	Corpus uteri (C54)	18.0	18.7	18.8	19.8	18.9	19.1	19.0	19.8	20.1	19.9	17.3	0.9*	0.4 to 1.5	–13.3**
3	NMSC (C44)	20.7	20.6	22.0	22.7	20.4	20.4	20.3	20.4	20.3	20.9	13.0	–0.3	–1.1 to 0.5	–37.9**
4	Cervix uteri (C53)	15.8	15.9	16.5	15.4	15.2	15.4	15.4	15.3	14.8	14.2	12.3	–1.1*	–1.7 to –0.5	–13.2**
5	Ovary (C56)	11.0	11.4	11.6	11.6	11.6	11.6	11.3	11.1	11.5	11.7	10.1	0.7	–0.3 to 1.7	–13.4**
6	Colon (C18)	11.2	11.5	11.3	11.6	11.3	11.5	11.3	11.7	11.5	11.8	9.9	0.4*	0.0 to 0.7	–16.1**
7	Thyroid gland (C73)	7.6	8.7	8.5	9.6	9.6	10.3	10.0	9.8	10.7	10.6	8.6	3.1*	1.8 to 4.3	–19.1**
8	Rectum, anus (C19—C21)	9.1	9.3	9.4	9.1	9.0	9.1	9.0	9.1	8.9	9.0	7.5	–0.4*	–0.7 to 0.0	–16.7**
9	Stomach (C16)	9.5	8.9	8.9	8.4	7.9	7.7	8.0	7.4	7.4	7.3	5.9	–2.8*	–3.4 to –2.2	–19.2**
10	Trachea, bronchus, lung (C33—C34)	6.6	6.6	6.4	6.6	6.2	6.2	6.5	6.5	6.7	6.6	5.3	0.1	–0.6 to 0.8	–18.3**
11	Kidney (C64)	5.6	5.8	5.8	6.1	5.8	5.6	5.7	6.0	6.0	6.0	4.7	0.6	0.0 to 1.2	–21.2**
12	Pancreas (C25)	4.3	4.4	4.5	4.5	4.7	4.7	4.5	4.9	4.9	4.8	4.4	1.3*	0.7 to 1.9	–9.1**

Notes: * Indicates that the AAPC is significantly different from zero at the alfa = 0.05 level

** Indicates that the APC is significantly different from zero at the alfa = 0.01 level

Abbreviations: AAPC — average annual percent change; APC — annual percent change; ASRW — age-standardized incidence rate, world standard population; NMSC — non-melanoma skin cancer.

significantly during 2010—2019 while cancer incidence except for NMSC in the male group showed a moderate annual decrease on average by 0.6%.

In 2012—2019, the incidence rates of male patients aged 45—59 years decreased (APC = –1.7%, 95% CI = –2.3% to –1.2%) after insignificant growth in 2010—2012. Over the whole period 2010—2019, cancer incidence of males aged 45—59 years decreased annually on average by 1.2%. The same changes were in male cancer incidence except NMSC.

Throughout the entire decade, there were no significant changes in the incidence rates for all cancers in female age group 45—59 years as well as in male and female age groups 60—74 years. Meanwhile, cancer incidence except for NMSC of males and females aged 60—74 years increased over the period 2010—2019 with the respective AAPCs 0.4% and 0.5%.

The incidence for all cancers with or without NMSC in the male group of patients aged 75+ years did not significantly change over the whole period 2010—2019. In 2010—2012, in the female age group 75+ years, there was a significant increase in incidence for all cancers combined both with NMSC (APC = 8.1%, 95% CI = 1.7% to 14.8%) and without NMSC (APC = 7.9%, 95% CI = 0.7% to 15.7%), although further changes of the incidence rate were insignificant. Throughout the whole period 2010—2019, cancer incidence in females aged 75+ years may be considered stable.

Over the entire study period of 2010—2020, the most common types of cancer were almost the same: in male population of all ages the 9 leading cancer sites were lung, prostate, NMSC, colon, rectum (C19—C21), stomach, bladder, kidney and pancreas that covered about 70% of cancer cases, and the 10th rank place alternately took cancer of pharynx (C09—C14), larynx or oral cavity (C01—C08) with its share about 3%. In females, the 10 most common cancer sites were breast, NMSC, corpus and cervix uteri, ovary, colon, rectum (C19—C21), stomach, lung, and thyroid, all in total they covered about 75% of cancer cases. Cancers of pancreas and kidney with their shares of about 3% were next to the leading 10 sites in the female population.

In 2010—2019, trends of incidence for the most common cancers differed (Table 3). The incidence of NMSC was stable in both male and female patients during the whole decade.

In the male population, the incidence has increased in 3 of the 12 prevalent cancers and decreased in 3 of them. Until 2012, cancer incidence of colon and prostate gland increased with respective APC = 3.8% (95% CI = 0.5% to 7.2%) and APC = 6.8% (95% CI = 2.4% to 11.3%), with the following period of stabilization. In 2016—2019, the incidence rates of these two cancers were increasing more moderately: with APC = 1.9% (95% CI = 0.4% to 3.4%) for colon cancer and APC = 4.6% (95% CI = 2.9% to 5.3%) for prostate cancer. Ultimately, during the whole period of 2010—2019, the incidence rate of colon cancer as well as pharyngeal cancer increased annually by 1.6% and prostate cancer incidence rate increased annually by 3.4%, while male cancer incidence of lungs, stomach, and larynx was constantly decreasing.

Over the same decade, incidence rates decreased for 3 of the 12 leading female cancers: the most active decrease was in cancer incidence of stomach and cervix uteri with a moderate decrease in the incidence of rectum. In contrast, a substantial increase in cancer incidence for thyroid and pancreas was observed, while cancer incidence rates of breast, corpus uteri, and colon were increasing moderately.

The fluctuations in the incidence rates of other prevalent cancers in 2010—2019 were insignificant.

In 2020, a sharp drop in cancer incidence rates was registered in Ukraine: incidence rates for all sites combined decreased significantly ($p < 0.01$) in all gender and age groups, except for patients aged 0—19 years (Tables 2, 3). In male patients

of all ages, the cancer incidence rate for all sites combined decreased by 18.3% and in females by 16.7%. The impact of COVID-19 on cancer detection was greater in older age groups. The largest changes in the incidence rates were in groups aged 75+ years: –25.8% in males and –26.9% in females. Incidence rates shortened the least in age groups 20—44 years, where APCs were –14.4% in males and –13.4% in females. Cancer incidence of children and adolescents (0—19) was decreasing from 2015—2016 till 2019 and remained unchanged in 2020, that is, its dependence on the COVID-19 outbreak was minimal.

In the population of all ages, a significant decrease in incidence rates was registered for all leading cancer types. The most significant decrease of 36%—38% for both genders was observed in the incidence rate for NMSC after being stable through the previous decade. Among other frequent cancers in males, the incidence rates of pharyngeal cancer, oral cavity sites, pancreas, and rectum have decreased less (by 10%—13%) and cancer incidence rates of prostate gland, kidney, bladder, and lung have decreased most (by 19%—23%). In the female population, the most decrements in the incidence rate of the leading cancers were registered for kidney, stomach, and thyroid gland (by 19%—21%) and the least ones, by 9%—13%, were observed for cancer of pancreas, breast, cervix uteri, and corpus uteri.

Discussion

To summarize the trends in the pre-COVID years 2010—2019, almost all age-specific incidence rates for all cancers combined in male and female adult age groups were stable; the decrease was observed only in males aged 45—59 years. Cancer incidence except for NMSC increased in males and females aged 60—74 years and decreased in male age groups 20—44 and 45—59 years. The highest incidence rates for all cancers combined were in the male population aged 75+ and in females aged 60—74 years, but in 2018—2019, male incidence rates for all cancers without NMSC in the age group 60—74 years almost equaled those in the age group 75+.

In the age group 60—74 years, an increase in the male cancer incidence occurred due to cancer of pharynx, colon, rectum, pancreas, prostate, kidney, and bladder. In the females aged 60—74 years, the rates of colon, pancreas, breast, corpus uteri, and kidney cancer have increased. The decrease in cancer incidence of the males aged 20—44 and 45—59 was mainly formed by decreasing incidence of stomach, pancreas, larynx, lung, kidney, and bladder cancer, and in the males aged 45—59 years – by decreasing incidence of colon cancer as well.

In 2020, a significant reduction in the number of cancer diagnoses was observed in all adult age groups as well as for all prevalent cancers in Ukraine, which was in sharp contrast to the previous trends in cancer incidence. The timely detection of cancer in the Ukrainian population was seriously affected by the COVID-19 anti-pandemic measures of 2020. The population aged 75+ years experienced the greatest such influence, given that cancer incidence rates of this group shortened by almost a quarter. At the same time, the comparison of age-specific cancer incidence rates in Ukraine during the last 20 years with other European countries [9] gives reason to suspect a systematic underdiagnosis of cancer in the Ukrainian population aged 75+ years.

The population aged 20—44 is less vulnerable to the coronavirus and more active and alert of adverse symptoms, so, probably due to this, the proportional number of not detected cancer patients among young people in 2020 was much less than among the elderly. Elderly people are more prone to suffer from chronic diseases and more vulnerable to infections but also less likely to seek medical care for adverse symptoms. All of these also contributed to the decrease in cancer detection during the first pandemic year in addition to the impact of quarantine restric-

tions. Among the possible reasons, we can also presume some excessive mortality both from the SARS-CoV-2 coronavirus and from other diseases because of the timely medical care deficiency during the pandemic, especially for elderly people.

A number of European countries, Canada, and the USA during 2020—2023 have reported similar significant declines in the cancer incidence rates observed or the number of new cancer cases detected in 2020, particularly in the spring of 2020 during the first COVID-19 lockdowns [10—22]. They used the data of cancer registries, pathology departments, and the number of suspected cancer referrals for diagnostics or referrals for oncological services. In many countries, the screening examinations for colorectal, cervical, breast, and lung cancer were temporarily suspended, and this also contributed to a notable decrease in the appropriate cancer diagnoses in medical reports when compared with the period before the COVID-19 lockdown [10, 24—26].

The quarantine restrictions affected not only the detection of new cancer patients but also the therapies for patients already diagnosed with cancer. According to the data of hospital registries of 27 specialized Ukrainian oncological medical centers, in 2020, the number of inpatients in most of them decreased by 9%—32% and the number of surgical interventions decreased by 3%—28% compared to those in 2019 [2]. Delayed treatments most likely lead to poorer clinical outcomes especially for cancers with high risk of early death [26, 27]. The implications of pandemic-related diagnostic and treatment delays may be better evaluated after a longer period of follow-up.

In 2020, the dramatic decline in timely cancer detection in Ukraine deranged the cancer incidence trends and may change the predictions made in the pre-COVID years. This was caused by the reduced access to healthcare facilities due to the quarantine restrictions and other reconfigurations in the healthcare system. A no less important cause of the reduced appealability of patients regarding potential cancer symptoms was focusing mainly on COVID-19 symptoms and anxiety about catching the virus while visiting healthcare institutions. In the next years, probable results of the deferred diagnosis may be an increasing proportion of advanced-stage cancer cases detected and most expectedly among elderly patients, with implications on the quality of life and survival of the patients. To assess this, further monitoring of the cancer epidemiology in Ukraine is necessary.

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ЗАХВОРЮВАНІСТЬ НА РАК В УКРАЇНІ:
ТРЕНДИ 2010—2019 РОКІВ ТА ВПЛИВ ПАНДЕМІЇ COVID-19

Стан проблеми. У 2020 році в Україні в умовах карантинних обмежень, спричинених пандемією COVID-19, було зареєстровано різке зменшення кількості виявлених захворювань на злоякісні новоутворення (ЗН), що суперечило попереднім тенденціям. **Мета.** Вивчити тенденції захворюваності на рак в Україні впродовж десятиліття та оцінити вплив пандемії COVID-19 на виявлення раку в 2020 році. **Матеріали та методи.** Для дослідження були використані записи бази даних Національного канцер-реєстру України про 1498911 випадків захворювання на ЗН, виявлених впродовж 2010—2020 років; вибірку виконано на початку 2022 року. Аналіз трендів 2010—2019 років здійснено за допомогою Joinpoint Regression Program на основі стандартизованих за віком (світове населення) показників захворюваності на рак. **Результати.** Впродовж 2010—2019 років поміж найбільш поширених в Україні нозологічних форм раку спостерігалось зростання ($p < 0.05$) показників захворюваності на ЗН ободової кишки, передміхурової залози й глотки у чоловіків та ободової кишки, щитоподібної і підшлункової залоз у жінок, одночасно знижувалась захворюваність на рак легені й гортані у чоловіків, шийки матки та прямої кишки у жінок, а також шлунка в осіб обох статей. Захворюваність на інші найбільш поширені форми ЗН не змінювалась. Зростання захворюваності у ці роки відбувалось переважно через зростання показників у вікової групи населення 60—74 роки; в групі чоловічого населення віком 40—59 років захворюваність знизилась. У 2020 році пандемія COVID-19 вкрай негативно вплинула на своєчасне виявлення ЗН всіх найбільш поширених нозологічних форм у дорослого населення України: найістотніше зменшився показник захворюваності на немеланомні раки шкіри (на 35,9—37,9%); значення приросту інших показників варіювали від –23,0% для ЗН передміхурової залози до –9,7% для ЗН глотки у чоловіків та від –21,1% для ЗН нирки до –9,1% для ЗН підшлункової залози у жінок, і найбільші зміни спостерігались у групах населення віком 75+ років. **Висновки.** Зареєстроване в Україні у 2020 році різке зменшення значень показників захворюваності на ЗН, очевидно, є результатом обмеженого доступу населення до закладів охорони здоров'я впродовж пандемії і низької онкологічної настороги через переважну зосередженість на проявах захворювання на COVID-19, проте не є проявом зниження захворюваності на рак як такої. Наслідком цього може бути ріст пропорційної кількості ЗН, виявлених у пізніх стадіях, збільшення навантаження на систему онкологічної допомоги та зростання онкологічної смертності у наступні роки. Для визначення короткострокових і віддалених наслідків пандемії COVID-19 для онкоепідеміологічної ситуації в Україні слід здійснювати її подальший моніторинг.

Ключові слова: захворюваність на злоякісні новоутворення, COVID-19, Національний канцер-реєстр України.