

## Impact of the COVID-19 pandemic on number and stages of tumors – data of a German cancer registry

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### Introduction

In the last two years, the world has been conquered by the coronavirus disease 2019 (COVID-19). During the first year of the pandemic, delays in cancer diagnoses were observed for several types of tumors all over the world [1–4]. This might be caused by healthcare congestions and drop in preventive healthcare in fear of COVID-19 including disruption of screening programs [5,6]. As a consequence, it has been suggested that the number of tumors diagnosed in advanced stages will increase. This trend will need to be monitored in upcoming years. However, such effect has already been reported by some investigations on breast cancer [7–10]. For colon cancer, contrary results have been published. Two studies observed elevated numbers of advanced tumor stages [7,11] but another investigation reported no effect [10]. These findings reveal that further investigation of a potential associations between a pandemic-associated decrease in diagnoses and a parallel increase in tumor stages in large well-designed studies is needed. Consequently, we used the data of the Cancer Registry Rhineland-Platinate and analyzed data on 4,785 colon, 1,045 pancreatic, 6,834 breast and 5,780 prostate tumors diagnosed in the years 2019 to 2020. These four cancer sites were selected because they represent the two most frequent female and male cancers with low mortality rates (breast and prostate), colon with medium incidence and mortality rates and pancreatic cancer with low incidence and high mortality rates [12]. The herein performed analyses were based on entire years to facilitate comparability with other data sources such as nationwide data of the Robert Koch-Institute, Berlin, Germany. 2019 was used as refence year only, because incidence rates documented by the Cancer Registry of Rhineland-Palatinate are stable over the past years [12].

### Methods

#### Study cohort

This study was based on the database of the Cancer Registry of Rhineland-Palatinate, Germany. Cancer registration in the German federal state Rhineland-Palatinate originally started on the level of epidemiological data, covering a population

of approximately 4 million inhabitants. For this aim an epidemiological cancer registry was founded in 1997 [13]. In 2016, epidemiological cancer registration was transferred to the newly founded clinical cancer registry. Focus of the follow-on institution was the centralization of data regarding diagnosis, histo-pathological characteristics of tumors, treatment and follow-up of cancer patients, which are resident and/or treated in Rhineland-Palatinate. Data were collected in accordance with the recommendations of the nationwide uniform oncological dataset [14]. In detail, coding of diagnoses is defined in accordance to the International Classification of Diseases for Oncology. ICD-10-GM codes C00-C96.9 (except C77.x, C78.x and C79.x), D00.0-D09.9, D32.0, D32.1, D32.9, D33.0, D33.1, D33.2, D33.3, D33.4, D33.7, D33.9, D35.2, D35.3, D35.4 and D37.x-D48.x need to be reported to Cancer Registries in Germany. Date of diagnosis is documented according to the information reported by the facility that made the diagnosis [14]. More than 97% of diagnoses are verified by pathology reports [12]. UICC stages are determined for each tumor entity according to international recommendations [15]. Meanwhile, comprehensive clinical information as well as follow-up data of more than 100,000 patients are available in the dataset of the Cancer Registry of Rhineland-Palatinate.

#### Statistical analysis

Our investigation was restricted to information from reports which have passed quality controls of the Cancer Registry. Based on these data, the number of diagnosed colon, pancreatic, breast and prostate tumors in the pre-pandemic year 2019 and the pandemic year 2020 were evaluated. In detail, number of diagnoses in 2020 was subtracted from number of diagnoses in 2019. The calculated difference is given in Table 1. This difference was divided by the total number of diagnoses in 2019 to calculate the percentage of the difference.

Moreover, a potential effect of the pandemic on tumor stages was assessed. Thus, based on information on T status (size and extent of the main tumor), N status (spread of cancer to nearby lymph nodes) and M status (presence of metastases), UICC stages were determined according to

**Table 1.** Number of colon, pancreatic, breast and prostate tumors diagnosed in the years 2019 (pre pandemic) and 2020 (pandemic) reported to the Cancer Registry of Rhineland-Palatine, Germany.

Tumors	2019	2020	Difference	Difference
	N	N	N	%
Colon C18-20	2,673	2,112	561	21.0
Pancreatic C25	713	332	381	53.4
Breast C50	3,654	3,180	474	13.0
Prostate C61	3,827	1,953	1,874	49.0

**Table 2.** Percentages and distributions of UICC stages of colon (C18-20), pancreatic (C25), breast (C50) and prostate (C61) tumors reported to the Cancer Registry of Rhineland-Palatine, Germany in the years 2019 (pre pandemic) and 2020 (pandemic).

UICC	Colon		Pancreatic		Breast		Prostate	
	2019 %	2020 %	2019 %	2020 %	2019 %	2020 %	2019 %	2020 %
I	21.9	19.4	12.9	12.0	43.5	46.6	61.7	54.6
II	26.1	28.0	22.5	22.3	36.8	35.1	20.2	23.6
III	31.0	27.4	12.5	16.9	9.8	10.3	6.0	9.0
IV	21.0	25.2	52.1	48.8	9.9	7.9	12.1	12.8
p Value	0.647		0.697		0.831		0.474	

international recommendations [15]. Percentages of different stages were compared between 2019 and 2020. Chi square test was used to determine potential statistical significance of the observed differences. The statistical software R [16] was used for analyses. The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

## Results

Our investigation included 4,785 colon, 1,045 pancreatic, 6,834 breast and 5,780 prostate tumors diagnosed in Rhineland-Palatinate in the years 2019 to 2020. The comparison of the years 2019 and 2020 showed a decrease in diagnoses in the pandemic year 2020 for each analyzed entity (Table 1). In detail, strongest effects were observed for pancreatic and prostate tumors with a reduction of 53.4% and 49.0% in 2020, respectively. Colon tumors showed a decrease of 21.0%. Breast tumors were least affected with a reduction of 13.0%.

With respect to tumor stages our data showed a shift from UICC IV to UICC III by about 3% for pancreatic tumors in the year 2020 (Table 2). For prostate tumors, UICC I decreased by 7% in 2020. In parallel, UICC II as well as III increased by about 3%. For the remaining entities (breast, pancreas), minor differences were observed when comparing 2019 with 2020 (Table 2). None of the observed effects reached statistical significance.

## Discussion

The decrease in cancer diagnoses during the pandemic has been shown by several studies worldwide [1–4]. Only a minority distinguished between the types of cancer. Eglum et al. estimated a decrease of 23% with respect to diagnoses of prostate cancers, in addition, they reported 13% fewer lung cancers, 18% fewer bladder cancers and 20% fewer colorectal cancers due to the pandemic in the USA [1].

Peacock et al. analyzed the data of the Belgian Cancer Registry. The comparison of April 2020 with April 2019 revealed a reduction of prostate cancer diagnoses by 57% as well as a reduction of breast and colorectal cancer by 50% [3]. Our investigation aimed to shed more light on the impact of the entire pandemic year 2020 on a variety of tumors. We analyzed the entire year, because tremendous efforts have been made to catch up with preventive oncological care and cancer screening after the lockdown in spring 2020. For the first time, we present the impact on the number of diagnoses of colon, pancreatic, breast and prostate tumors in Germany in 2020. Smallest effect was observed for breast cancer which might be owed to the very short interruption of the screening program from end of March 2020 to beginning of May 2020 [17]. Colon tumors were about 20% less frequently diagnosed in 2020. With respect to colon cancer our finding is in line with the crucial refuse of preventive medical checkups during the pandemic [18]. Eglum et al. reported in a USA based study a similar reduction of screening procedures for colon cancer but a dramatically increased number of undetected prostate tumors [1]. These findings correspond with our results revealing 49.0% fewer prostate tumors in 2020. Greatest reduction in numbers of tumors was observed for pancreatic cancer. Our analysis revealed 53.4% fewer tumors in 2020. To the best of our knowledge, information from other sources on number of diagnoses for these tumors are rare. As of yet, one abstract reported results of two academic medical centers in the USA with equal numbers of pancreatic cancers in the years 2019 and 2020 [19]. This investigation differed from ours in the collection of patients (hospital based vs. Cancer Registry data) as well as considered period of time (6 month in 2020 vs. entire year). We assume that further investigations on the effect of the pandemic on number of tumor diagnoses in independent studies are needed.

Beside the pandemic effect on cancer diagnoses, the stage of detected tumors is under discussion. Previous investigations on the effect of the pandemic on breast cancer reported increased tumor stages [7–10]. These results are not in line with our finding. However, these studies were based on less than 500 patients while the analysis performed here included more than 6,000 patients. Moreover, currently available reports mainly focus on data collected in one hospital, but we used data of a Cancer Registry comprising information of patients treated in all medical facilities in Rhineland-Palatinate.

For colon cancer, contradictory results were reported with respect to an association between tumor stages and pandemic [7,10,11]. These studies included less than 300 clinical collected patients, ours more than 4,000 population-based cases. The herein performed analysis supported the assumption of no effect of the pandemic on tumor stages with respect to colon cancer in 2020.

To the best of our knowledge, no study on a potential impact of the pandemic on stages of pancreatic and prostate tumors has been reported. The increase of stage III and parallel decrease of stage IV might be biased by the low number of pancreatic tumors in 2020. Number of prostate tumors

is statistically more robust even in 2020. Reduced diagnosis of stage I tumors by 7% with a parallel increase of stage II and III tumors might be caused by the nearly 60% drop in visits to ambulatory care, which has been reported recently [5].

In conclusion, our statistically robust population-based setting showed that there is a remarkable pandemic-related decrease in cancer diagnoses in 2020 which varied among tumor entities. An effect on tumor stages was observed for pancreatic and prostate tumors. Both effects will be affected by the course of the pandemic and need to be further monitored in upcoming years.

### Disclosure statement

No potential conflict of interest was reported by the author(s).

### Data availability statement

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

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