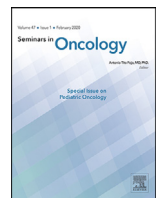




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# Cancer stage and time from cancer diagnosis to first treatment during the COVID-19 pandemic

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## ABSTRACT

The 2019 coronavirus disease (COVID-19) pandemic has impacted cancer care and the diagnosis of new cases of cancer. We analyzed the impact of the COVID-19 pandemic on patients with cancer by comparing the number of newly diagnosed cases, cancer stage, and time to treatment in 2020 with those in 2018, 2019, and 2021. A retrospective cohort of all cancer cases treated at A.C. Camargo Cancer Center in 2018–2021, identified from the Hospital Cancer Registry, was studied. We analyzed single and multiple primary cancer case and patient characteristics—by year and by clinical stage (early v advanced). Times from diagnosis to treatment were compared according to the most frequent tumor sites between 2020 and the other study years. Between 2018 and 2021, a total of 29,796 new cases were treated at the center including 24,891 with a single tumor and 4,905 with multiple tumors, including nonmelanoma skin cancer. The number of new cases decreased by 25% between 2018 and 2020 and 22% between 2019 and 2020, followed by an increase of about 22% in 2021. Clinical stages differed across years, with the number of new advanced cases decreasing from 17.8% in 2018 to 15.2% in 2020. Diagnoses of advanced-stage for lung and kidney cancer decreased between 2018 and 2020, while the number of thyroid and prostate cancer cases diagnosed in advanced-stages increased from 2019 to 2020. The time from diagnosis to treatment decreased between 2018 and 2020 for breast (55.5 v 48 days), prostate (87 v 64 days), cervical/uterine (78 v 55 days) and oropharyngeal (50 v 28 days) cancers. The COVID-19 pandemic affected the numbers of single and multiple cancers diagnosed in 2020. An increase in the number of advanced-stage cases diagnosed was observed only for thyroid and prostate cancer. This pattern may change in coming years due to the possibility that a significant number of cases went undiagnosed in 2020.

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## Introduction

The 2019 coronavirus disease (COVID-19) pandemic has affected the global population since March 2020 [1]. Lockdowns adopted throughout the world to reduce the rapid spread of the virus have had impact on patients with cancer.

São Paulo, Brazil, is the city with the largest population in South America, with 2,418,130 COVID-19 cases and 44,446 COVID-related deaths reported in the city through November 2022 [2]. In 2020, COVID-19 was responsible for 94.4% ( $n=9,000$ ) of excess deaths in São Paulo, which was accompanied by a nonsignificant trend of

reduced mortality for all cancers. Excess deaths were observed in men older than 45 years and women aged 60–79 years [3].

The stay-at-home recommendation applied during the COVID-19 pandemic negatively affected cancer care settings in terms of diagnosis and treatment, resulting in more advanced cancer cases, changes to standard treatment guidelines, and worse outcomes [4,5]. Safety guidelines were established at cancer centers to prevent COVID transmission while ensuring treatment provision [6–9]. COVID-19-related mortality patterns among patients with cancer are heterogeneous and are highest among patients with hematological and lung cancers, those older than 60 years, and those undergoing cancer treatment [10]. However, the long-term impact of the pandemic on cancer progression (including the delay from diagnosis to treatment), morbidity (including the occurrence of multiple primary tumors), and mortality remain under-evaluated [3–5].

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The COVID-19 pandemic delayed cancer diagnosis and treatment worldwide [11–13]. In Brazil, reductions in cancer screening procedures (45%), diagnosis (35%), and treatment (15% for surgery) were observed in 2020 relative to 2019 [14,15]. Correspondingly, a reduction in hospital admission rates for clinical (26%) and surgical (28%) cancer treatment were documented in the country [16], consistent with reported reductions in the number of professionals involved in the management of cancer screening programs in low- and middle-income countries [17]. The purpose of the present study conducted in an oncological cancer center in São Paulo was to analyze the impact of the COVID-19 pandemic on patients with cancer by comparing the numbers of newly diagnosed single and multiple cases, the stage of newly diagnosed cancers, and times to treatment initiation in 2020 with those in 2018, 2019, and 2021.

## Methods

The cohort for this retrospective study comprised all cancer cases recorded (by tumor/cancer type) in the Hospital Cancer Registry (HCR) of A.C. Camargo Cancer Center in 2018–2021. All cancer cases were coded based on their topography and morphology according to the third edition of the International Classification of Diseases for Oncology [18]. This study was approved by the Research Ethics Committee of the Antônio Prudente Foundation, A.C. Camargo Cancer Center (no. 2462/17).

The study data were collected in a manner that enabled stratified analysis by patient and tumor. For each patient, we recorded the sex (male/female), age group (<60/≥60 years), area of residence (metropolitan São Paulo/interior of São Paulo state or other state) and number of tumors per year. For each tumor, we recorded the previous diagnosis of the same cancer before each admission (yes/no), clinical T (primary tumor) stage (cT1 or T2/cT3 or T4) clinical N (regional lymph node) stage (cN0/cN+), clinical M (distant metastasis) stage (cM0/cM+), and clinical stage (CS) at diagnosis (early [0–II]/advanced [III or IV]).

All variables were expressed as absolute and relative frequencies. The chi-squared test was used to compare variable frequencies between 2020 and 2018, 2019, and 2021. The analyses were performed with the inclusion and exclusion of nonmelanoma skin cancer (NMSC) cases, because NMSC includes a high proportion of multiple primary cases. The 10 most frequent tumor sites and tumors of the upper respiratory tract (oral cavity, oropharynx, and larynx) for each year were identified and ranked. They were compared by CS between 2020 and the other study years using the chi-squared test. Hematopoietic tumors, which are not staged with the TNM system, were excluded from this analysis.

The times (in days; means with standard deviations and medians) from dates of diagnosis to first treatments were calculated by year of diagnosis and tumor site and compared using the median test. The significance level was set to 5%, and all analyses were performed using SPSS 23 (IBM Corporation, Armonk, NY).

## Results

From 2018 to 2021, 29,796 new cancer (including nonmelanoma skin cancer (NMSC) and multiple primary tumors) cases were registered and treated at A.C. Camargo Cancer Center (2018,  $n=8,211$ ; 2019,  $n=7,884$ ; 2020,  $n=6,170$ ; 2021,  $n=7,531$ ). The number of newly diagnosed cases decreased by 25% between 2018 and 2020 and by 22% between 2019 and 2020, whereas it increased by about 22% between 2020 and 2021. The number of patients with newly diagnosed cancer decreased by 28% between 2018 and 2020 and by 24% between 2019 and 2020 but increased by 21% between 2020 and 2021 (Table 1). When NMSC cases were excluded, the number of patients with new cases decreased by 32% between 2018 and 2020 and by 25% between 2019 and 2020 and increased by 19%

between 2020 and 2021 (Table 2). The fewest new cancer cases were recorded in 2020, with emphasis in April (Fig. 1).

During the study period, the largest number of cases occurred in males aged 55–74 years and females aged 50–69 years (all cancer cases excluding NMSC); the exclusion of NMSC reduced the number of cases in individuals older than 80 years, as the occurrence of skin cancer together with other malignancies is more common at this age. In 2020, the numbers of cases across all age groups and genders declined (Fig. 2).

The male:female ratio for all cases remained about 0.80 throughout the study period. The patient age distribution differed, with more patients aged 60 years or older in 2019 and 2021 than in 2020 (both  $P < 0.05$ ). The number of patients from the interior of São Paulo State fluctuated over the study period (2018–2020,  $P=0.721$ ; 2019–2020,  $P=0.011$ ; 2020–2021,  $P=0.004$ ). The proportion of cases with multiple primary tumors ranged from 15% in 2018 to 18% in 2021 (2018–2020,  $P=0.003$ ; 2019–2020,  $P=0.002$ ; 2020–2021,  $P=0.522$ ). The previous diagnosis of the same cancer type before admission and cT, cN, and cM stages and CS differed significantly between 2018 and 2020 ( $P < 0.05$ ), with the percentage of advanced CS cases declining from 17.8% to 15.2% (Table 1).

When NMSC cases were excluded, the male:female ratio ranged from 0.67 to 0.72 ( $P > 0.05$ ). The number of patients from the interior of São Paulo State was higher in 2020 than in 2018 (29.0% v 31.5%,  $P=0.013$ ). The percentage of multiple primary tumors ranged from 4.0% in 2018 to 5.0% in 2021 ( $P > 0.05$ ). That of N+ cases increased from 22.2% in 2019 to 24.6% in 2020 ( $P=0.023$ ). The proportion of cM+ cases decreased from 10.6% in 2018 to 8.6% in 2020 ( $P < 0.01$ ) and then remained stable in 2021 (8.8%; Table 2).

The ranking of the 10 most frequent tumor sites treated did not change between 2018 and 2021; but the upper respiratory tract has changed in the period studied with emphasis on the drop in the oral cavity from the 16th position to the 20th in 2021; in general, NMSC was the most frequent, followed by breast, thyroid, prostate, and colorectal cancers, melanoma, and lung, and cervical/uterine neoplasms (Table 3).

The numbers of advanced thyroid and prostate cancer cases increased between 2019 and 2020, from 9.9% to 13.9% ( $P=0.04$ ) and from 26.8% to 38.0% ( $P < 0.01$ ), respectively. Between 2018 and 2020, the numbers of new diagnosed advanced-stage lung and kidney cancer cases decreased from 69.4% to 58.8% ( $P=0.04$ ) and from 33.9% to 13.7% ( $P < 0.01$ ), respectively (Table 4).

Finally, the time from cancer diagnosis to treatment decreased over the study period for 6 types of cancer, with the shortest intervals occurring in 2020 (2018 v 2020: breast cancer, 55.5 v 48.0 days; prostate cancer, 87 v 64 days; melanoma, 49 v 40 days; colorectal cancer, 48 v 35 days; cervical/uterine cancer, 78 v 55 days; oropharyngeal cancer, 50 v 28 days; all  $P \leq 0.001$ ; Table 5).

## Discussion

At the A.C. Camargo Cancer Center in São Paulo, Brazil, the numbers of newly diagnosed cancer cases and patients with single tumors, excluding NMSC, were smaller in 2020, during the COVID-19 pandemic, than in 2018 and 2019. These numbers increased in 2021 but remained smaller than before the pandemic.

The numbers of new cancer cases declined in all regions of Brazil, with decreases ranging from 24.3% in the north to 42.7% in the northeast. The number of newly diagnosed cancer cases also declined in high-income countries, such as Italy (44.9% in 2020 compared to 2018 and 2019) [19]. The extent of reduction in the number of cases diagnosed differs among cancer types [20]. In this study, we observed declines in the number of newly diagnosed cancer cases of 32% and 25% from 2018 and 2019, to 2020. Similar results were observed in a primary health

**Table 1**

Socioeconomic and clinical variables for cancer cases treated at A.C. Camargo Cancer Center, 2018–2021, including nonmelanoma skin cancer.

| Variables  |                   | Chi-square test [ <i>P</i> ] |                    | Chi-square test [ <i>P</i> ] |                    | Chi-square test [ <i>P</i> ] |                     |
|--|-------------------|------------------------------|--------------------|------------------------------|--------------------|------------------------------|---------------------|
| <b>Years</b>   | 2018              | 2018 v 2020                  | 2019               | 2019 v 2020                  | 2020               | 2020 v 2021                  | 2021                |
| <b>Patient number</b>                                    | n = 6,977         |                              | n = 6,654          |                              | n = 5,085          |                              | n = 6,175           |
| <b>Sex ratio (M: F)</b>                                  | 0.81 3,118:3,859) | 0.739                        | 0.84 (3,028:3,626) | 0.581                        | 0.82 (2,288:2,797) | 0.465                        | 0.84 (2,821: 3,354) |
| <b>Age group</b>   |                   | 0.174                        |                    | <b>0.017</b>                 |                    | <b>0.002</b>                 |                     |
| <60  | 3,399 (48.7)      |                              | 3,177 (47.7)       |                              | 2,541 (50.0)       |                              | 2,901 (47.0)        |
| 60+  | 3,578 (51.3)      |                              | 3,477 (52.3)       |                              | 2,544 (50.0)       |                              | 3,274 (53.0)        |
| <b>Area of residence</b>                                 |                   | 0.721                        |                    | <b>0.011</b>                 |                    | <b>0.004</b>                 |                     |
| Metropolitan area of São Paulo                           | 5,026 (72.0)      |                              | 4,629 (69.6)       |                              | 3,648 (71.7)       |                              | 4,277 (69.3)        |
| Countryside of São Paulo or other states                 | 1,951 (28.0)      |                              | 2,025 (30.4)       |                              | 1,437 (28.3)       |                              | 1,898 (30.7)        |
| <b>Tumor</b>   | n = 8,211         |                              | n = 7,884          |                              | n = 6,170          |                              | n = 7,531           |
| <b>Number of tumors by year</b>                          |                   | <b>0.003</b>                 |                    | <b>0.002</b>                 |                    | 0.522                        |                     |
| Unique or first tumor                                    | 6,977 (85.0)      |                              | 6,654 (84.4)       |                              | 5,085 (82.4)       |                              | 6,175 (82.0)        |
| Multiple tumors  | 1,234 (15.0)      |                              | 1,230 (15.6)       |                              | 1,085 (17.6)       |                              | 1,356 (18.0)        |
| <b>Previous diagnosis of the cancer before admission</b> |                   | <b>0.005</b>                 |                    | 0.136                        |                    | 0.736                        |                     |
| No   | 5,440 (66.3)      |                              | 5,304 (67.3)       |                              | 4,224 (68.5)       |                              | 5,176 (68.7)        |
| Yes  | 2,771 (33.7)      |                              | 2,580 (32.7)       |                              | 1,946 (31.5)       |                              | 2,355 (31.3)        |
| <b>Clinical T (tumor size)</b>                           |                   | <b>0.001</b>                 |                    | 0.433                        |                    | 0.610                        |                     |
| cT1-T2   | 4,906 (83.4)      |                              | 4,893 (86.3)       |                              | 3,812 (85.8)       |                              | 4,745 (86.1)        |
| cT3-T4   | 979 (16.6)        |                              | 791 (13.7)         |                              | 633 (14.2)         |                              | 765 (13.9)          |
| <b>Clinical N (lymph node)</b>                           |                   | <b>0.001</b>                 |                    | 0.306                        |                    | 0.215                        |                     |
| cN0  | 5,807 (85.3)      |                              | 5,903 (88.1)       |                              | 4,541 (87.5)       |                              | 5,694 (88.3)        |
| cN+  | 997 (14.7)        |                              | 795 (11.9)         |                              | 648 (12.5)         |                              | 757 (11.7)          |
| <b>Clinical M (distant metastasis)</b>                   |                   | <b>&lt;0.001</b>             |                    | 0.105                        |                    | 0.908                        |                     |
| cM0  | 7,030 (93.5)      |                              | 6,889 (94.7)       |                              | 5,351 (95.3)       |                              | 6,624 (95.3)        |
| cM+  | 488 (6.5)         |                              | 388 (5.3)          |                              | 264 (4.7)          |                              | 330 (4.7)           |
| <b>Clinical stage (CS)</b>                               |                   | <b>&lt;0.001</b>             |                    | 0.999                        |                    | 0.142                        |                     |
| Early (CS 0, I and II)                                   | 6,180 (82.2)      |                              | 6,169 (84.8)       |                              | 4,760 (84.8)       |                              | 5,960 (85.7)        |
| Advanced (CS III and IV)                                 | 1,338 (17.8)      |                              | 1,108 (15.2)       |                              | 855 (15.2)         |                              | 994 (14.3)          |

The values in bold are significant.

\* *P*-value <0.05.**Table 2**

Socioeconomic and clinical variables for cancer cases treated at A.C. Camargo Cancer Center, 2018–2021, excluding nonmelanoma skin cancer.

| Variables  |                     | Chi-square test [ <i>P</i> ] |                     | Chi-square test [ <i>P</i> ] |                     | Chi-square test [ <i>P</i> ] |                     |
|--|---------------------|------------------------------|---------------------|------------------------------|---------------------|------------------------------|---------------------|
| <b>Patient</b>   | 2018                | 2018 v 2020                  | 2019                | 2019 v 2020                  | 2020                | 2020 v 2021                  | 2021                |
|  | n = 5,034           |                              | n = 4,534           |                              | n = 3,411           |                              | n = 4,056           |
| <b>Sex ratio (M: F)</b>                                  | 0.68 (2,035: 2,999) | 0.874                        | 0.72 (1,889: 2,645) | 0.206                        | 0.67 (1,373: 2,038) | 0.317                        | 0.71 (1,679: 2,377) |
| <b>Age group</b>   |                     |                              |                     | 0.068                        |                     | 0.100                        |                     |
| <60  | 2,865 (56.9)        | 0.079                        | 2,575 (56.8)        |                              | 2,007 (58.8)        |                              | 2,310 (57.0)        |
| 60+  | 2,169 (43.1)        |                              | 1,959 (43.2)        |                              | 1,404 (41.2)        |                              | 1,746 (43.0)        |
| <b>Area of residence</b>                                 |                     |                              |                     | 0.272                        |                     | 0.115                        |                     |
| Metropolitan area of São Paulo                           | 3,573 (71.0)        | <b>0.013</b>                 | 3,051 (67.3)        |                              | 2,335 (68.5)        |                              | 2,707 (66.7)        |
| Countryside of São Paulo or other states                 | 1,461 (29.0)        |                              | 1,483 (32.7)        |                              | 1,076 (31.5)        |                              | 1,349 (33.3)        |
| <b>Tumor</b>   | n = 5,246           |                              | n = 4,739           |                              | n = 3,568           |                              | n = 4,270           |
| <b>Number of tumors by year</b>                          |                     | 0.409                        |                     | 0.869                        |                     | 0.204                        |                     |
| Unique or first tumor                                    | 5,034 (96.0)        |                              | 4,534 (95.7)        |                              | 3,411 (95.6)        |                              | 4,056 (95.0)        |
| Multiple tumors  | 212 (4.0)           |                              | 205 (4.3)           |                              | 157 (4.4)           |                              | 214 (5.0)           |
| <b>Previous diagnosis of the cancer before admission</b> |                     | 0.554                        |                     | 0.640                        |                     | 0.587                        |                     |
| No   | 2,782 (53.0)        |                              | 2,519 (53.2)        |                              | 1,915 (53.7)        |                              | 2,318 (54.3)        |
| Yes  | 2,464 (47.0)        |                              | 2,220 (46.8)        |                              | 1,653 (46.3)        |                              | 1,952 (45.7)        |
| <b>Clinical T (tumor size)</b>                           |                     | 0.531                        |                     | 0.062                        |                     | 0.528                        |                     |
| cT1-T2   | 2,466 (71.7)        |                              | 2,324 (74.8)        |                              | 1,652 (72.5)        |                              | 2,073 (73.3)        |
| cT3-T4   | 972 (28.3)          |                              | 785 (25.2)          |                              | 627 (27.5)          |                              | 756 (26.7)          |
| <b>Clinical N (lymph node)</b>                           |                     | 0.315                        |                     | <b>0.023</b>                 |                     | 0.254                        |                     |
| cN0  | 2,873 (74.3)        |                              | 2,790 (77.8)        |                              | 1,982 (75.4)        |                              | 2,480 (76.6)        |
| cN+  | 996 (25.7)          |                              | 795 (22.2)          |                              | 648 (24.6)          |                              | 756 (23.4)          |
| <b>Clinical M (distant metastasis)</b>                   |                     | <b>0.003</b>                 |                     | 0.315                        |                     | 0.750                        |                     |
| cM0  | 4,095 (89.4)        |                              | 3,777 (90.7)        |                              | 2,792 (91.4)        |                              | 3,408 (91.2)        |
| cM+  | 488 (10.6)          |                              | 387 (9.3)           |                              | 263 (8.6)           |                              | 330 (8.8)           |
| <b>Clinical stage (CS)</b>                               |                     | 0.231                        |                     | 0.230                        |                     | 0.194                        |                     |
| Early (CS 0, I and II)                                   | 3,253 (71.0)        |                              | 3,061 (73.5)        |                              | 2,207 (72.2)        |                              | 2,753 (73.6)        |
| Advanced (CS III and IV)                                 | 1,330 (29.0)        |                              | 1,103 (26.5)        |                              | 848 (27.8)          |                              | 985 (26.4)          |

The values in bold are significant.

\* *P*-value <0.05.

**Table 3**

The 10 most frequent tumors and tumors of the upper respiratory tract in men and women by year, treated at the A.C. Camargo Cancer Center, 2018–2021.

| Tumor site              | 2018      |               | 2019      |               | 2020      |               | 2021      |               |
|-------------------------|-----------|---------------|-----------|---------------|-----------|---------------|-----------|---------------|
|                         | Rank      | n (%)         | Rank      | n (%)         | Rank      | n (%)         | Rank      | n (%)         |
| Non-melanoma skin (C44) | <b>1</b>  | 2,987 (36.4)  | <b>1</b>  | 3,161 (40.1)  | <b>1</b>  | 2,630 (42.6)  | <b>1</b>  | 3,287 (43.6)  |
| Breast (C50)            | <b>2</b>  | 1,125 (13.7)  | <b>2</b>  | 935 (11.9)    | <b>2</b>  | 657 (10.6)    | <b>2</b>  | 827 (11.0)    |
| Thyroid (C73)           | <b>3</b>  | 607 (7.4)     | <b>3</b>  | 587 (7.4)     | <b>3</b>  | 501 (8.1)     | <b>3</b>  | 655 (8.7)     |
| Prostate (C61)          | <b>4</b>  | 552 (6.7)     | <b>4</b>  | 509 (6.5)     | <b>5</b>  | 262 (4.2)     | <b>5</b>  | 394 (5.2)     |
| Melanoma skin (C43)     | <b>5</b>  | 500 (6.1)     | <b>5</b>  | 504 (6.4)     | <b>4</b>  | 403 (6.5)     | <b>4</b>  | 472 (6.3)     |
| Colorectal (C18–C20)    | <b>6</b>  | 382 (4.7)     | <b>6</b>  | 360 (4.6)     | <b>6</b>  | 244 (4.0)     | <b>6</b>  | 322 (4.3)     |
| Lung (C33–C34)          | <b>7</b>  | 270 (3.3)     | <b>7</b>  | 211 (2.7)     | <b>7</b>  | 165 (2.7)     | <b>7</b>  | 163 (2.2)     |
| Cervix Uteri (C53)      | <b>8</b>  | 213 (2.6)     | <b>8</b>  | 158 (2.0)     | <b>8</b>  | 144 (2.3)     | <b>8</b>  | 143 (1.9)     |
| Kidney (C64)            | <b>9</b>  | 149 (1.8)     | <b>9</b>  | 144 (1.8)     | <b>10</b> | 86 (1.4)      | <b>10</b> | 113 (1.5)     |
| Stomach (C16)           | <b>10</b> | 143 (1.7)     | <b>10</b> | 114 (1.4)     | <b>9</b>  | 100 (1.6)     | <b>9</b>  | 99 (1.3)      |
| Oral Cavity (C02–C06)   | <b>16</b> | 72 (0.9)      | <b>16</b> | 76 (1.0)      | <b>15</b> | 65 (1.1)      | <b>20</b> | 58 (0.8)      |
| Oropharynx (C01–C10)    | <b>19</b> | 57 (0.7)      | <b>20</b> | 47 (0.6)      | <b>20</b> | 43 (0.7)      | <b>18</b> | 49 (0.7)      |
| Larynx (C32)            | <b>24</b> | 31 (0.4)      | <b>23</b> | 33 (0.4)      | <b>23</b> | 28 (0.5)      | <b>22</b> | 31 (0.4)      |
| Total                   |           | 8,211 (100.0) |           | 7,884 (100.0) |           | 6,170 (100.0) |           | 7,531 (100.0) |

Rank = hierarchical score conveying the numbers of new cases for 2018 and 2021, from the most (1) to the fewest (24).

**Table 4**

Clinical stage at diagnosis by tumor site and year at A.C. Camargo Cancer Center, 2018–2021.

| Tumor site             | Year of diagnosis |            | Chi-square test | Year of diagnosis |            | Chi-square test | Year of diagnosis |            | Chi-square test | Year of diagnosis |            |
|------------------------|-------------------|------------|-----------------|-------------------|------------|-----------------|-------------------|------------|-----------------|-------------------|------------|
|                        | 2018              |            | 2018–2020       | 2019              |            | 2019–2020       | 2020              |            | 2020–2021       | 2021              |            |
|                        | Early             | Advanced   | P <sup>a</sup>  | Early             | Advanced   | P <sup>a</sup>  | Early             | Advanced   | P <sup>a</sup>  | Early             | Advanced   |
| Nonmelanoma skin (C44) | 2,935 (99.7)      | 9 (0.3)    | 0.771           | 3,113 (99.8)      | 5 (0.2)    | 0.150           | 2,559 (99.6)      | 9 (0.4)    | 0.951           | 3,216 (99.7)      | 11 (0.3)   |
| Breast (C50)           | 910 (82.1)        | 198 (17.9) | 0.478           | 765 (84.0)        | 146 (16.0) | 0.788           | 535 (83.5)        | 106 (16.5) | 0.467           | 695 (84.9)        | 124 (15.1) |
| Thyroid (C73)          | 532 (88.7)        | 68 (11.3)  | 0.201           | 518 (90.1)        | 57 (9.9)   | 0.044           | 421 (86.1)        | 68 (13.9)  | 0.079           | 572 (89.5)        | 67 (10.5)  |
| Prostate (C61)         | 367 (67.6)        | 176 (32.4) | 0.120           | 358 (73.2)        | 131 (26.8) | <b>0.002</b>    | 160 (62.0)        | 98 (38.0)  | 0.967           | 240 (62.2)        | 146 (37.8) |
| Melanoma skin (C43)    | 469 (94.6)        | 27 (5.4)   | 0.971           | 474 (94.2)        | 29 (5.8)   | 0.864           | 378 (94.5)        | 22 (5.5)   | 0.190           | 449 (96.4)        | 17 (3.6)   |
| Colorectal (C18–20)    | 143 (41.60)       | 201 (58.4) | 0.346           | 165 (49.4)        | 169 (50.6) | 0.334           | 99 (45.2)         | 120 (54.8) | 0.754           | 137 (46.6)        | 157 (53.4) |
| Lung (C34)             | 72 (30.6)         | 163 (69.4) | <b>0.040</b>    | 62 (31.8)         | 133 (68.2) | 0.080           | 56 (41.2)         | 80 (58.8)  | 0.156           | 44 (32.8)         | 90 (67.2)  |
| Cervix uteri (C53)     | 193 (91.0)        | 19 (9.0)   | 0.263           | 139 (88.5)        | 18 (11.5)  | 0.748           | 124 (87.3)        | 18 (12.7)  | 0.727           | 122 (85.9)        | 20 (14.1)  |
| Kidney (C64)           | 78 (66.1)         | 40 (33.9)  | <b>0.002</b>    | 85 (76.6)         | 26 (23.4)  | 0.104           | 63 (86.3)         | 10 (13.7)  | 0.068           | 65 (74.7)         | 22 (25.3)  |
| Stomach (C16)          | 62 (52.1)         | 57 (47.9)  | 0.932           | 58 (58.0)         | 42 (42.0)  | 0.458           | 49 (52.7)         | 44 (47.3)  | 0.501           | 53 (57.6)         | 39 (42.4)  |
| Oral cavity (C02–C06)  | 31 (44.9)         | 38 (55.1)  | 0.219           | 41 (55.4)         | 33 (44.6)  | 0.969           | 34 (55.7)         | 27 (44.3)  | 0.629           | 24 (51.1)         | 23 (48.9)  |
| Oropharynx (C01–C10)   | 10 (18.5)         | 44 (81.5)  | 0.547           | 6 (14.0)          | 37 (86.0)  | 0.261           | 9 (23.7)          | 29 (76.3)  | 0.518           | 10 (18.2)         | 45 (81.8)  |
| Larynx (C32)           | 12 (38.7)         | 19 (61.3)  | 0.689           | 22 (66.7)         | 11 (33.3)  | 0.084           | 11 (44.0)         | 14 (56.0)  | 0.743           | 15 (48.4)         | 16 (51.6)  |

The values in bold are significant.

Early, clinical stages 0–II; Advanced, clinical stages III and IV.

<sup>a</sup> P-value <0.05.**Table 5**

Time in days between diagnosis and first cancer treatment by tumor site and year at A.C. Camargo Cancer Center, 2018–2021.

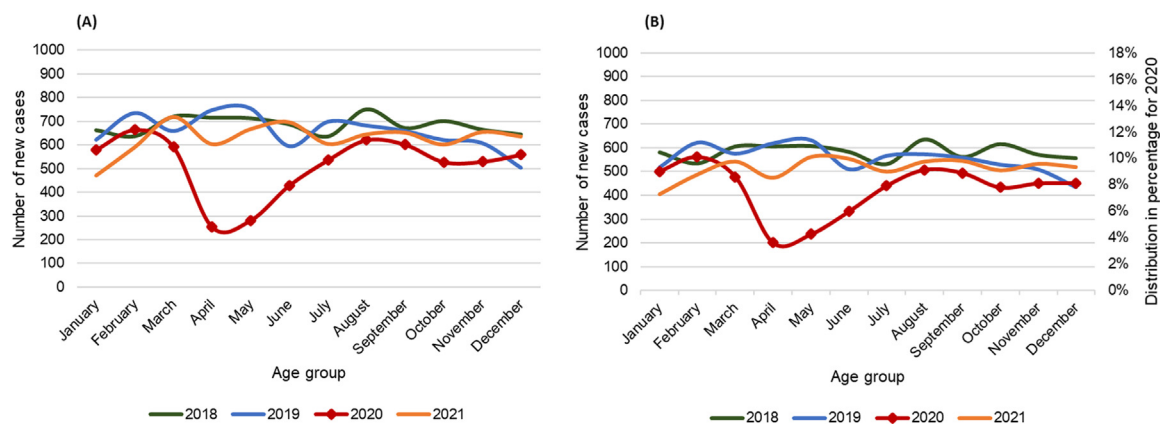
| Tumor site             | Year of diagnosis |             |                |             |                |             |                |             | P*               |
|------------------------|-------------------|-------------|----------------|-------------|----------------|-------------|----------------|-------------|------------------|
|                        | 2018              |             | 2019           |             | 2020           |             | 2021           |             |                  |
|                        | Mean (SD) days    | Median days | Mean (SD) days | Median Days | Mean (SD) days | Median days | Mean (SD) days | Median days |                  |
| Nonmelanoma skin (C44) | 33.53 (±71.7)     | 0           | 37.1 (±75.6)   | 0           | 34.9 (±78.6)   | 0           | 30.1 (±49.7)   | 0           | <b>0.023</b>     |
| Breast (C50)           | 65.9 (±47.7)      | 55.5        | 65.2 (±55.4)   | 57          | 54.9 (±36.7)   | 48          | 56.6 (±36.3)   | 50          | <b>&lt;0.001</b> |
| Thyroid (C73)          | 55.5 (±103.6)     | 40          | 52.2 (±86.7)   | 40          | 48.1 (±69.2)   | 33          | 47.5 (±56.1)   | 38          | 0.067            |
| Prostate (C61)         | 135.0 (±156.7)    | 87          | 119.9 (±145.4) | 76.5        | 92.6 (±102.7)  | 64          | 78.8 (±56.3)   | 71          | <b>&lt;0.001</b> |
| Melanoma skin (C43)    | 60.6 (±66.9)      | 49          | 61.1 (±57.1)   | 49          | 53.6 (±62.2)   | 40          | 56.9 (±46.7)   | 47          | <b>0.001</b>     |
| Colorectal (C18-20)    | 58.2 (±78.7)      | 48          | 49.5 (±58.7)   | 40          | 42.5 (±44.4)   | 35          | 37.5 (±37.1)   | 33          | <b>&lt;0.001</b> |
| Lung (C34)             | 75.6 (±98.8)      | 56          | 59.2 (±57.2)   | 50          | 65.8 (±71.5)   | 45          | 55.1 (±45.6)   | 52          | 0.432            |
| Cervix uteri (C53)     | 100.9 (±106.4)    | 78          | 64.5 (±59.2)   | 61          | 68.0 (±79.7)   | 55          | 52.7 (±43.4)   | 49          | <b>0.001</b>     |
| Kidney (C64)           | 11.3 (±30.8)      | 0           | 19.1 (±82.9)   | 0           | 20.2 (±62.9)   | 0           | 8.7 (±27.7)    | 0           | 0.702            |
| Stomach (C16)          | 71.4 (±73.0)      | 48          | 55.4 (±43.2)   | 49          | 51.3 (±76.8)   | 33          | 54.7 (±38.9)   | 52          | 0.084            |
| Oral cavity (C02-C06)  | 70.2 (±74.4)      | 46          | 68.4 (±79.2)   | 48          | 40.9 (±31.4)   | 36          | 44.2 (±31.2)   | 41          | 0.154            |
| Oropharynx (C01-C10)   | 63.7 (±39.8)      | 50          | 58.3 (±38.8)   | 50          | 32.9 (±22.8)   | 28          | 47.7 (±39.5)   | 37          | <b>&lt;0.001</b> |
| Larynx (C32)           | 57.2 (±52.7)      | 43          | 28.9 (±26.5)   | 27          | 51.9 (±56.6)   | 36          | 32.3 (±28.1)   | 30.5        | 0.213            |

The values in bold are significant.

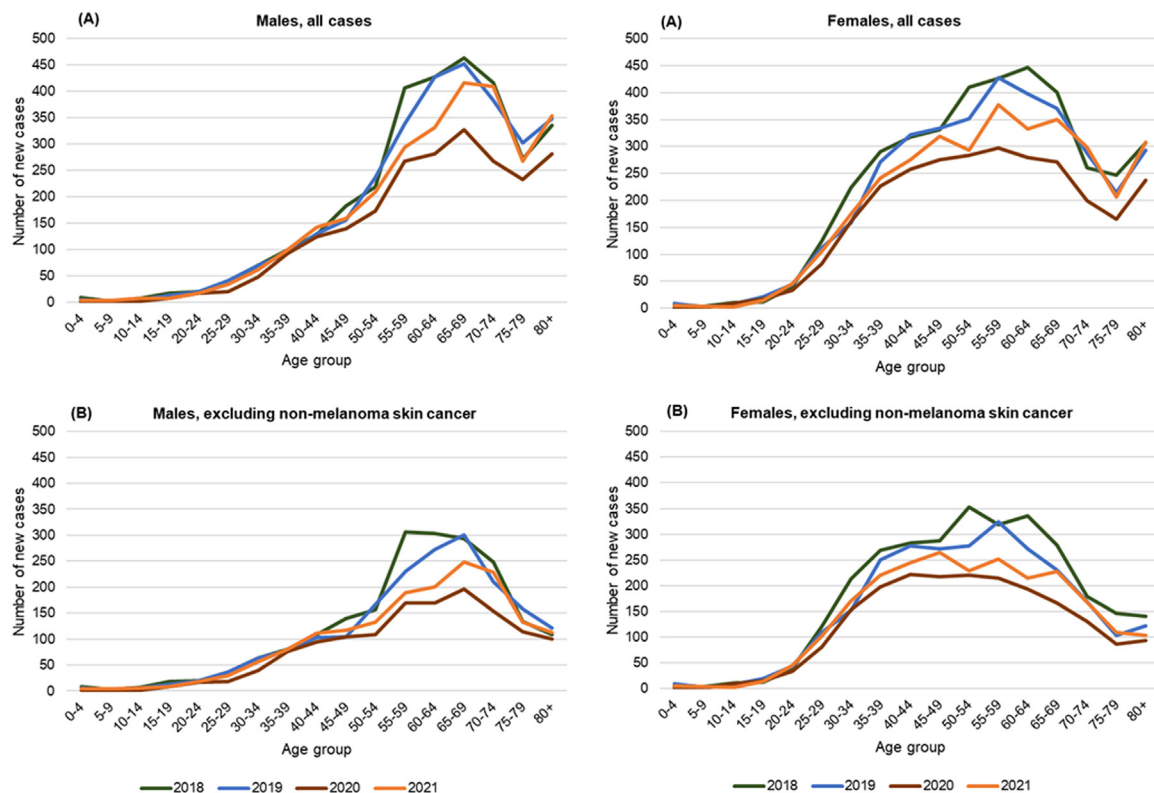
SD = standard deviation.

<sup>a</sup> Median test, P-value <0.05.





**Fig. 1.** Numbers of primary cancer cases multiple (A) and single (B) diagnosed at A.C. Camargo Cancer Center, 2018–2021.



**Fig. 2.** Numbers of new cancer cases diagnosed in males and females at A.C. Camargo Cancer in 2018–2021 by age group. (A) All cases. (B) All cases except nonmelanoma skin cancer.

care center in Spain, where the number of new cancer cases was 34% lower in 2020 than before the pandemic [21]. While, in the United States, the diagnosis of all types of cancer declined significantly during the pandemic, with a reduction of 46.4% for six cancers—breast, colorectal, lung, pancreas, stomach, and esophageal—due to the interruption of health services and medical care and reduced patient attendance during the social distancing period [22].

In the present study, the number of new oncological patients less than 60 years old was larger in 2020 than in prepandemic years. This phenomenon may be due to the higher rate of isolation adherence among older adults, who have poorer COVID-19 outcomes [10,23–25]. Another potential contributing factor is younger people's greater access to cancer-related information due to greater social media literacy. The number of cN+ cases was larger in 2020 than in 2019, and those of cM+ cases were smaller in 2020 and 2021 than in 2018, at our cancer center. These changes may reflect

the change in the profile of patients who sought cancer care during the pandemic. The real impact of these shifts will be revealed in the next few years, mainly with the recording of premature (at 30–69 years) deaths by cancer type [12], as, for example, lung and hematological cancers have poorer prognoses than do other solid tumors [10].

The diagnosis of advanced thyroid and prostate cancers increased and that of advanced kidney and lung cancer decreased in 2020 and/or 2021 in our cohort. The ranking of tumors such as lung, laryngeal, oral-cavity and oropharyngeal cancers, did not change in 2020 relative to previous years, but that of oral-cavity cancer fell 4–5 positions in the 20th position relative to 2021. The CS at diagnosis of head and neck cancer did not change over this study period. In a multicenter study, with advanced tumor staging on admission in 2020 found to correlate with the need for intensive care in patients with surgically treated head and neck cancer [26].

The present study revealed no difference in the clinical stage of NMSC over the study period, but a reduction in the time from diagnosis to treatment for melanoma, possibly due to greater awareness of this neoplasm. One study in Greece, found delays in the treatment of both melanoma and NMSC due to the COVID-19 pandemic were associated with an increased incidence of squamous cell carcinoma of the skin [27]. Shorter intervals between diagnosis and treatment improve prognosis and patient outcomes, such as treatment success and survival. The current target in England, Scotland, and Northern Ireland is 31 days between the decision to treat confirmed cancer and the start of treatment [28]. In Brazil, the recommended maximum time is 60 days after confirmed diagnosis [29]. In a systematic review including 15 articles from the United States and 7 articles from the United Kingdom, the median time from lung cancer diagnosis to treatment was 6–45 days [30]. In this study, the median intervals from diagnosis to first treatment of lung cancer were 45–56 days, with the shortest wait time occurring in 2020. Similarly, the median interval from diagnosis to first treatment of breast cancer decreased to 48 days in 2020, possibly due to the lower volume of new patients commencing treatment. In 2020 and 2021, we observed delays in treatment initiation with a median interval in excess of 60 days only for prostate cancer, possibly due the greater availability of cancer treatment time and beds.

## Conclusion

At the A.C. Camargo Cancer Center in São Paulo, Brazil, whose cases were examined in this study, the COVID-19 pandemic reduced the numbers of new single and multiple tumor cases diagnosed in 2020 and 2021. An increase in the number of advanced-stage cases diagnosed was observed only for thyroid and prostate cancer. The time from diagnosis to treatment initiation decreased for oropharyngeal, breast, prostate, and cervical/uterine tumors. The impact of less cancer diagnosis in 2020 due to the pandemic will become clearer in coming years.

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## Author contribution

Diego Rodrigues Mendonça e Silva: Conceptualization, Methodology, Software, Writing—original draft, Writing—review & editing, Visualization, Investigation; Gisele Aparecida Fernandes: Writing—original draft, Writing—review & editing, Investigation; Ivan Leonardo Avelino França e Silva: Data curation, Writing—original draft, Visualization, Investigation; Maria Paula Curado: Conceptualization, Methodology, Supervision, Writing—review & editing, Visualization, Investigation.

## Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## References

- [1] World Health Organization WHO Director-General's opening remarks at the media briefing on COVID19–11 March 2020, Geneva: World Health Organization; 2020. [cited 2020 October 7] Available at: <https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-themediabriefing-on-covid-19> Accessed October 10, 2022..
- [2] Município de São Paulo. Secretaria da Saúde. Boletim COVID-19 Cidade de São Paulo. Available at: [https://www.prefeitura.sp.gov.br/cidade/secretarias/upload/saude/boletim\\_covid\\_03\\_01\\_2023.pdf](https://www.prefeitura.sp.gov.br/cidade/secretarias/upload/saude/boletim_covid_03_01_2023.pdf). Accessed January 18, 2022.
- [3] Fernandes GA, Junior APN, Azevedo e Silva G, et al. Excess mortality by specific causes of deaths in the city of São Paulo, Brazil, during the COVID-19 pandemic. *PLoS One* 2021;16(6):e0252238.
- [4] van de Haar J, Hoes LR, Coles CE, et al. Caring for patients with cancer in the COVID-19 era. *Nat Med* 2020;26(5):665e71.
- [5] Spicer J, Chamberlain C, Papa S. Provision of cancer care during the COVID-19 pandemic. *Nat Rev Clin Oncol* 2020;17(6):329e31.
- [6] British Columbia Cancer Agency. COVID-19 and cancer treatments—Information for patients. 2020. Available at: [www.bccancer.bc.ca/about/news-stories/news/2020/covid-19-and-cancer-treatments](http://www.bccancer.bc.ca/about/news-stories/news/2020/covid-19-and-cancer-treatments). Accessed March 27, 2020.
- [7] Cancer Council Australia. Information and support regarding cancer and COVID-19. Available at: [www.cancer.org.au/cancerand-covid-19.html](http://www.cancer.org.au/cancerand-covid-19.html). Accessed March 27, 2020.
- [8] National Institute for Health and Care Excellence. COVID-19 rapid guideline: delivery of systemic anticancer treatments. 2020. Available at: <https://www.guidelines.co.uk/infection/covid19-rapid-guideline-delivery-of-systemic-anticancer-treatments/455238>. Accessed March 26, 2020.
- [9] European Society of Medical Oncology. COVID-19 and cancer. Available at: [www.esmo.org](http://www.esmo.org). Accessed March 27, 2022
- [10] Fernandes GA, Feriani D, França E, Silva ILA, et al. Differences in mortality of cancer patients with COVID-19 in a Brazilian cancer center. *Semin Oncol* 2021;48(2):171–80.
- [11] World Health Organization. International classification of diseases for oncology (ICD-O); 3rd ed., 1st revision. World Health Organization; 2013.
- [12] Liang W, Guan W, Chen R, et al. Cancer patients in SARS-CoV-2 infection: a nationwide analysis in China. *Lancet Oncol* 2020;21:335–7.
- [13] Maringe C, Spicer J, Morris M, et al. The impact of the COVID-19 pandemic on cancer deaths due to delays in diagnosis in England, UK: a national, population-based, modelling study. *Lancet Oncol* 2020;21:1023–34.
- [14] Kugbey N, Ohene-Oti N, Vanderpuye V. COVID-19 and its ramifications for cancer patients in low-resource settings: Ghana as a case study. *Ecancermedicalscience* 2020;14:ed99.
- [15] Ribeiro CM, Correa FM, Migowski A. Short-term effects of the COVID-19 pandemic on cancer screening, diagnosis and treatment procedures in Brazil: a descriptive study, 2019–2020. *Epidemiol Serviços Saúde* 2022;31(1):e2021405.
- [16] Mafra da Costa A, Ribeiro AL, Ribeiro AG, et al. Impact of COVID-19 pandemic on cancer-related hospitalizations in Brazil. *Cancer Control* 2021;28:10732748211038736.
- [17] Villain P, Carvalho AL, Lucas E, et al. Cross-sectional survey of the impact of the COVID-19 pandemic on cancer screening programs in selected low- and middle-income countries: study from the IARC COVID-19 impact study group. *Int J Cancer* 2021;149(1):97–107.
- [18] Marques NP, Silveira DMM, Marques NCT, et al. Cancer diagnosis in Brazil in the COVID-19 era. *Semin Oncol* 2021;48(2):156–9. doi:10.1053/j.seminoncol.2020.12.002.
- [19] Ferrara G, De Vincentiis L, Ambrosini-Spaltro A, et al. Cancer diagnostic delay in northern and central Italy during the 2020 lockdown due to the coronavirus disease 2019 pandemic. *Am J Clin Pathol* 2021;155(1):64–8. doi:10.1093/ajcp/aqaa177.
- [20] De Vincentiis L, Carr RA, Mariani MP, Ferrara G. Cancer diagnostic rates during the 2020 'lockdown', due to COVID-19 pandemic, compared with the 2018–2019: an audit study from cellular pathology. *J Clin Pathol* 2021;74(3):187–9. doi:10.1136/jclinpath-2020-206833.
- [21] Coma E, Guirguet C, Mora N, et al. Impact of the COVID-19 pandemic and related control measures on cancer diagnosis in Catalonia: a time-series analysis of primary care electronic health records covering about five million people. *BMJ Open* 2021;11:e047567.
- [22] Kaufman HW, Chen Z, Niles J, et al. Changes in the number of US patients with new identified cancer before and during the coronavirus disease 2019 (COVID-19) pandemic. *JAMA Netw Open* 2020;3(8):e2017267.
- [23] Lee LYW, Cazier J-B, Starkey T, et al. COVID-19 prevalence and mortality in patients with cancer and the effect of primary tumour subtype and patient demographics: a prospective cohort study. *Lancet Oncol* 2020;21:1309–16.
- [24] Melo AC, Thuler LCS, Silva JL, et al. Cancer inpatient with COVID-19: a report from the Brazilian National Cancer Institute. *PLoS One* 2020;15(10):e0241261.
- [25] Bhopal R. COVID-19 worldwide: we need precise data by age group and sex urgently. *BMJ* 2020;369:m1366.
- [26] COVIDSurg Collaborative. Head and neck cancer surgery during the COVID-19 pandemic: an international, multicenter, observational cohort study. *Cancer* 2021;127(14):2476–88. doi:10.1002/cncr.33320.
- [27] Seretis K, Boptsi E, Boptsi A, et al. The impact of treatment delay on skin cancer in COVID-19 era: a case-control study. *World J Surg Oncol* 2021;19(1):350.
- [28] NHS. Cancer – Waiting times (2022). Available at <https://www.nhs.uk/conditions/cancer/> Accessed April 19, 2022.
- [29] Brazil. Presidency of the Republic. Law 12.732/12 - Provides on the first treatment of patients with proven malignant neoplasia and establishes a deadline for its beginning. Brasília-DF: Presidency of the Republic, 2012. Available at: [https://www.planalto.gov.br/ccivil\\_03/\\_ato2011-2014/2012/lei/l12732.htm](https://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12732.htm). Accessed May 10, 2022.
- [30] Jacobsen MM, Silverstein SC, Quinn M, et al. Timeliness of access to lung cancer diagnosis and treatment: a scoping literature review. *Lung Cancer* 2017;112:156–64.