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IMPACT OF THE COVID-19 PANDEMIC ON RADIOTHERAPY PATIENTS BY AGE AND RESIDENCE

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ABSTRACT

Background/Aim: This epidemiology study aimed to investigate how the COVID-19 pandemic affected the weekly number of external beam radiotherapy (EBRT) fractions concerning patient age and residence distance from our radiotherapy center (RTC). Methods: Twenty-two-month intervals before and after the onset of the COVID-19 pandemic were compared. Results: The average weekly number of fractions from May 2018 to February 2020 was 692.8 (SD 67.6), and from March 2020 to December 2021 was 639.3. (SD 84.7). The weekly number of fractions decreased by 42.4 % in March 2021 and by 67.9 % in April 2020 compared to the same period in 2019. When comparing patients under 70 years of age to those over 70, the decrease was 28.0 % vs. 6.9 %, respectively. According to the Wilcoxon signed-rank test (Z = - 5.2, p = 0.001), the outbreak of the COVID-19 pandemic had a statistically significant impact on the decrease in the weekly number of fractions. The distance between the city of residence and the RTC was not a significant factor but years of life (more than 70) was. Conclusion: During the "waves" of the pandemic, radiation therapy (RT) was not administered to specific groups of cancer patients eligible for it because other medical departments for oncology patients were closed.

Key words: coronavirus disease 2019, hospital patients, external beam radiotherapy, age group, residency.

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic is a global public health emergency that has disrupted our lives and posed the greatest challenge to healthcare systems in decades [1]. This particularly affected risk groups, including cancer patients. The pandemic has led to delays and changes or even treatment discontinuation.

The apparent impact of the COVID-19 pandemic on healthcare systems, including radiotherapy (RT) services, has been the subject of several studies [2,3] showing a quantitative decline of patients per age and diagnosis. Radiotherapy teams are implementing new work procedures and protective equipment to minimize the risk of infection for medical staff and patients while optimizing the treatment and care for oncology patients. Many RT centers have followed the recommendation to use hypo fractionated RT (breast, prostate, palliative treatments, and others), thereby reducing the number of hospital visits [4]. Some RT centers divide staff into physically separate teams to avoid the risk of infection among them. The number of medical control checks and consultations has been reduced, relying on telephone communication [5].

This study aims to investigate the impact of the COVID-19 pandemic on the number of weekly external beam radiotherapy (EBRT) fractions concerning the patients' age and distance from their residence to the RT center.

MATERIAL AND METHODS

The Republic of Srpska (RS) is a constituent part of Bosnia and Herzegovina, with 10 cities and 54 municipalities [6]. Of these municipalities, 35 are located less than 200 kilometers from Affidea Radiation Therapy Center in Banja Luka (Affidea RTC BL) (Figure 1).

In the RS, the anticipated population in 2016 was 1.157.516, with a total of 5.786 new cancer cases [7].

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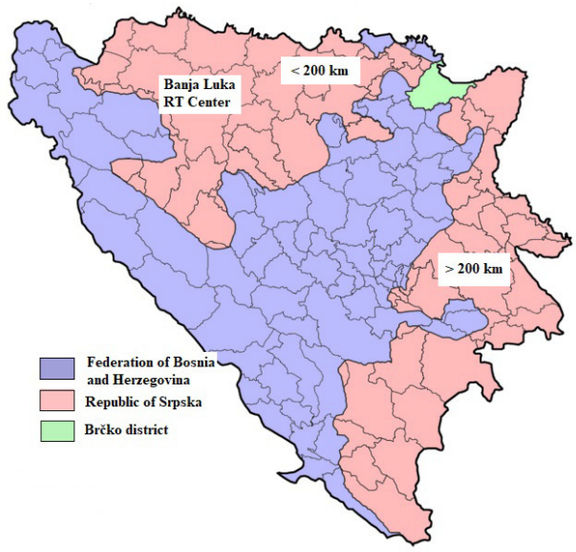


Figure 1. Municipalities of RS.

All RS Health Insurance users can receive external beam radiotherapy (EBRT) and brachytherapy (BT) services from Affidea RTC BL. The center has a Varian GammaMed plus iX high dose rate brachytherapy unit, two Varian True Beam linear accelerators (Linac), and one Varian DHX Linac. We employ volumetric modulated arc therapy (VMAT), intensity modulated radiation (IMRT), and 3D conformal radiotherapy (3DCRT) in routine clinical practice. Radiotherapy was administered in an eight-hour shift for five working days a week.

We used data on the number of EBRT fractions, patients per treatment site, patient age (younger and older than 70) and their residence (less or greater than 200 kilometers from our RT center), in the period before (May 2018 to February 2020) and during the pandemic (March 2020 to December 2021). Each period lasted 22 months (95 weeks). Municipalities with less than or equal to 5 patients in the observed periods were not considered.

Statistical Analysis

The results' median and arithmetic mean values are shown alongside the standard deviation (SD). The relative error (RE) was used to calculate the percent difference. The Kolmogorov-Smirnov test was used to determine if the continuous examined data were normally distributed.

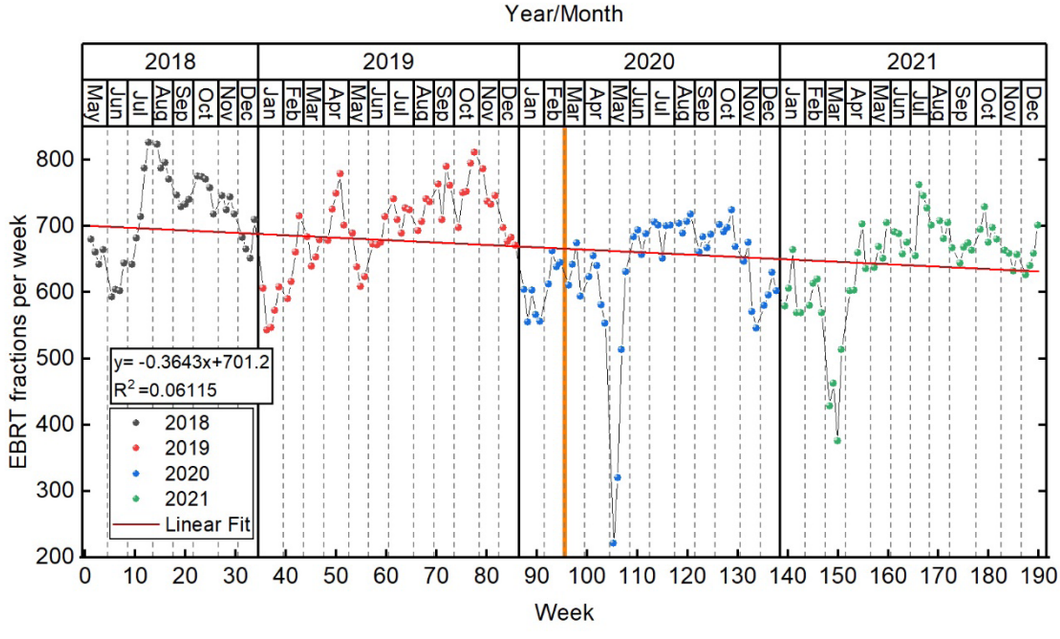
Utilizing the parametric one-tailed paired samples T-test in cases where the data differences have a normal distribution and the non-parametric Wilcoxon signed-rank test in cases where the data differences do not have a normal distribution. When the Wilcox rank test was used the effect size (r) was calculated. Effect size was adopted according to Cohen's criterion. At a minimum level of statistical significance of $p = 0.05$, all the analyses were estimated. The data were analyzed using the statistical program SPSS Statistics 23 (IBM, Armonk NY, USA) [8].

RESULTS

The average number of daily EBRT fractions in 2018, 2019, 2020 and 2021 was 138, 139, 126 and 129, respectively.

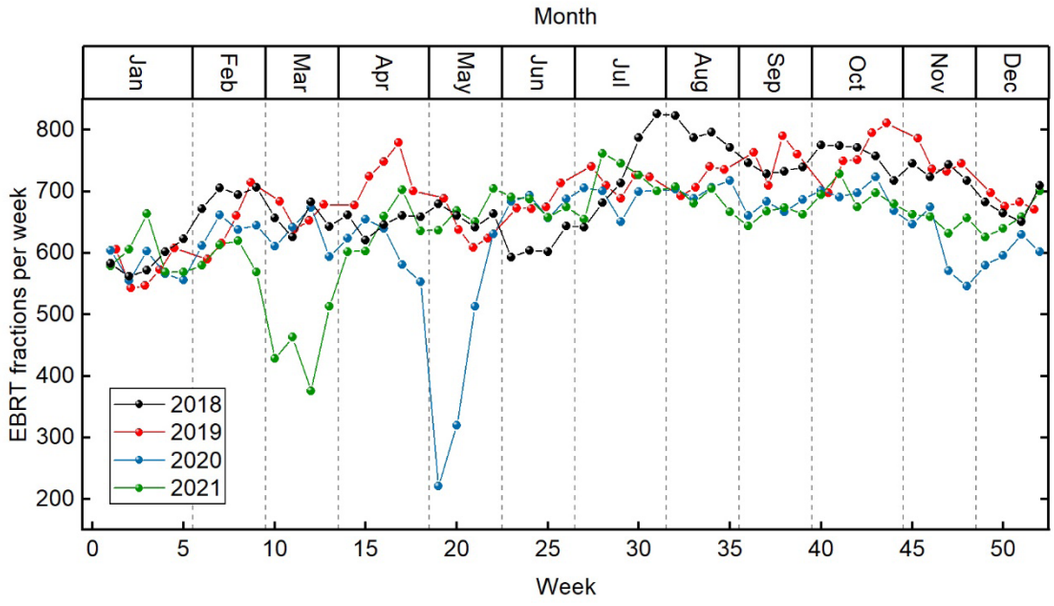
Figure 2 shows the weekly number of EBRT fractions from May 2018 to December 2021.

Figure 2. The weekly number of EBRT fractions from May 2018 to December 2021.



A comparative display of the weekly number of EBRT fractions for 2018, 2019, 2020 and 2021 is shown in Figure 3.

Figure 3. The weekly number of EBRT fractions for 2018, 2019, 2020 and 2021.



The descriptive statistics for the period before and during the pandemic are presented in Table 1.

Table 1. Descriptive statistics based on EBRT fractions before and during the COVID-19 pandemic.

COVID-19	n (weeks)	Median (fractions/week)	Mean (fractions/week)	Min-max (fractions/week)	SD
Before	95	698	693	543-826	68
During	95	660	639	221-762	85

A Kolmogorov-Smirnov test showed that the distribution of the difference in the weekly number of fractions between the two periods does not have a normal distribution (W=0.108, p=0.008). Based on this result, the non -parametric Wilcoxon signed-rank test was used (Z = -5.2, p = 0.001). For Z = -5.2, the effect size is r = 0.38, so this effect is considered a moderate effect according to Cohen's criterion (0.3 < r < 0.5).

A statistical analysis of RT patients who were younger than 70 and older than 70 who lived less than 200 kilometers or more from our RT center was conducted for the same time periods (0 and 1), and there were a minimum of 5 patients in each group (municipality-city).

A Shapiro-Wilk normality test of the difference in the number of patients by groups was conducted for predetermined time periods, age groups, and distances from the RT facility. A parametric (Paired Samples t-test) or non-parametric (Wilcoxon Signed Ranks Test) statistical analysis was used, Table 2, depending on the results.

Table 2. Statistical analysis of Covid-19 influence on patients by age and residence.

EBRT patients	Number of municipalities and cities / mean distance (km)	Number of EBRT patients	Shapiro-Wilk test (p)	Paired samples t-test		Wilcoxon signed ranks test
				t	p	Z
> 200 km < 70 years	13 / 266	2288	0.619	2.104	0.057	
> 200 km > 70 years		1482	0.66	2.345	0.037	
< 200 km < 70 years	20 / 70	1486	0.035			-1.792
< 200 km > 70 years		486	0.003			-3.041

By the most frequent treatment sites, Table 3, we compared the number of patients older than 70, younger than 70, and all patients.

Table 3. The number of patients per diagnosis in the periods before and during COVID-19.

Diagnosis site	Number of patients older than 70 years		Difference (%)	Number of patients younger than 70 years		Difference (%)	Total number of patients	
	No Covid-19[1]	Covid-19[2]		No Covid-19[1]	Covid-19[2]		No Covid-19[1]	Covid-19[2]
Bladder	31	37	19.4	17	29	70.6	48	66
Bone	218	144	-33.9	458	331	-27.7	676	475
Brain	82	49	-40.2	285	292	2.5	367	341
Breast	174	101	-42.0	520	470	-9.6	694	571
Colon-Rect.-Anal C.	89	78	-12.4	202	206	2.0	291	284
GYN[3]	114	70	-38.6	335	293	-12.5	449	363
Head & Neck[4]	81	72	-11.1	235	236	0.4	316	308
Lung	98	96	-2.0	295	250	-15.3	393	346
Lymph Nodes	17	18	5.9	41	27	-34.1	58	45
Prostate	167	124	-25.7	101	152	50.5	268	276
Skin	41	10	-75.6	19	8	-57.9	60	18
Stomach	13	17	30.8	46	50	8.7	59	67
.	.	.	.	.	.	.	.	.
Total	1219	878	-28.0	2806	2612	-6.9	4025	3490

[1]May 2018 – Feb 2020, [2]Mar 2020 – Dec 2021, [3]cervical, corpus uteri carcinoma, ovarian, uterine, vagina and vulva, [4]H&N, hypopharynx, larynx, supraglottis, lip and oral cavity, nasal cavity and sinuses, nasopharynx, oropharynx, pharynx, salivary glands and thyroid gland.

DISCUSSION

Affidea RTC BL experienced a significant reduction in mean daily EBRT patients from 2020 to 2021. On a daily level, compared to 2019, the number of factions fell by 9.3 % and 7.2 % in 2020 and 2021, respectively.

Figure 2 shows the regression line for the number of weekly fractions between May 2018 and December 2018 (direction coefficient is negative, - 0.3643). Due to the COVID-19 pandemic, the weekly fractions for May 2020 and March 2021 are significantly reduced as oncology services have been moved to the COVID-19 department.

The number of weekly fractions decreased by 15.8 % in April 2020 and by 67.9 % in May 2020 compared to the same period in 2019, which is in accordance with the study conducted by Vaandering et al. [9]. Again, the weekly fractions decreased significantly by 17.5 % in November 2020 and by 26.8 % in December 2020, after which there was a 42.4 % drop in March 2021 (Figure 3).

The study's results are comparable to those from US radiation therapy centers, which reported a 20 % to 39 % reduction in treatment during April 2020 [10]. Also, daily RT activities in Switzerland significantly declined in April 2020 [11]. Our findings are consistent with the results from Chauhan et al. [12], although the pandemic in India started two months earlier than in RS.

The number of RT patients decreased by 20.8 % when comparing Spanish hospitals' March-June 2019 and March-June 2020 periods [13]. According to the experience of RT departments in Brazil [14], 10 % fewer patients and 26 % fewer RT sessions were treated. During the pandemic, the number of patients undergoing radiotherapy in China decreased by 31.3 %. [15].

Based on descriptive statistics, the average weekly fractions before COVID-19 are higher than during the pandemic, but the SD is lower. The results presented in Table 1 are consistent with the findings of studies by Martinez et al. [3], Chauhan et al. [12], Nierengarten [16], and Kolarevic et al. [17].

Comparing 22-month periods before and during the pandemic at Affidea RTC BL, a non-parametric Wilcoxon signed-rank test ($Z = -5.2$, $p < 0.05$) showed that the COVID-19 pandemic significantly decreased weekly EBRT fractions.

Depending on the Kolmogorov-Smirnov normality test results for the periods mentioned above, a parametric paired samples t-test or a non-parametric Wilcoxon signed-rank test was carried out for patients grouped by their residence (further and closer than 200 km) and age (younger and older than 70 years). The pandemic did not appear to impact patients grouped by residence significantly, but it impacted a group of patients older than 70 years (Table 2). The number of patients aged over 70 decreased by 28 %, while the number of patients under 70 decreased by 6.9 percent, which was also seen in the study by Spencer et al. [2].

Patients over 70 made up 30.3 % and 25.2 % of all patients in observed periods, respectively, which is higher than the findings of the Chauhan trial [12].

Table 3 shows a percentage decrease per diagnosis site for all patients. GYN (38.6 %), breast (42.0 %), brain (40.2 %), prostate (25.7 %), bone (33.9 %) and skin (75.6 %) were the diagnoses with the highest decrease in patients aged 70 years and older, which is in accordance with the results of the other studies [9,12,18]. Gynecology (12.5 %), breast (9.6 %), lung (15.3 %), bone (27.7 %), and skin (57.9 %) diagnoses in patients younger than 70 years have decreased, while prostate, stomach and bladder diagnoses were increasing.

CONCLUSION

The first 22 months of the COVID-19 pandemic were associated with a statistically significant decrease in the number of treatments at the Affidea RTC BL. Under the local and national public health measures to stem the pandemic's spread, medical departments required for oncology patient diagnosis and treatment were frequently "closed" or turned into COVID-19 wards. The decline in patient numbers was also affected by the worsening financial situation of a group of older oncology patients (pensioners) as the private health sector took over some functions of public hospitals during the COVID-19 pandemic. Surgeries and biopsies were reduced by 50 %. As a result, some patients, particularly those over 70 years old, who were indicated for radiotherapy never received it.

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