



# Has the cancer-related death trend been changing in Turkey? An evaluation of the period between 2009 and 2019

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## ABSTRACT

**Background:** The objective of this study was to determine the trend of cancer-related death rates between 2009 and 2019 in Turkey for all cancers combined and the five cancer types with the highest mortality: lung, stomach, pancreas, breast, and colon cancers.

**Methods:** Cancer mortality data were obtained from the Turkish Statistical Institute (TURKSTAT) and standardized by age using the World Health Organization (WHO) standard population ratios. The change in cancer-related mortality over the years was evaluated using Joinpoint Regression Analysis (JRA).

**Results:** Total cancer-related deaths increased by 2.2% annually between 2009 and 2014 and decreased by 2.9% annually between 2014 and 2019 ( $p < 0.05$ ). Among men; lung cancer-related deaths increased by 2.4% annually between 2009 and 2014 and decreased by 3.4% annually between 2014 and 2019 ( $p < 0.05$ ), stomach cancer-related deaths decreased by 5.1% annually between 2014 and 2019 ( $p < 0.05$ ), colon cancer-related deaths increased by 5.8% annually between 2009 and 2015 and decreased by 3.3% annually between 2015 and 2019 ( $p < 0.05$ ), pancreatic cancer-related deaths increased annually by 5.6% in 2009–2013 ( $p < 0.05$ ). Among women; lung cancer-related deaths increased by 2.5% annually between 2009 and 2016 ( $p < 0.05$ ), stomach cancer-related deaths increased annually by 2.3% between 2009 and 2014 and decreased annually by 4.5% between 2014 and 2019 ( $p < 0.05$ ), colon cancer-related deaths increased by 2.5% annually between 2009 and 2017 ( $p < 0.05$ ), pancreatic cancer-related deaths increased by 7.4% annually between 2009 and 2013 ( $p < 0.05$ ) and breast cancer-related deaths increased by 2.2% annually between 2009 and 2019 ( $p < 0.05$ ).

**Conclusion:** Mortality data in Turkey are collected only by TURKSTAT, which raises concern regarding the incompleteness of the data. While this might lead to underestimation, the trend shows that there has been a decrease in total cancer-related deaths in Turkey. Pancreatic cancer, on the other hand, gains a higher proportion in cancer-related deaths in Turkey as in the world. Increasing deaths from lung and breast cancer in women remind of the importance of tobacco control interventions and cancer screening programs.

## 1. Introduction

Non-communicable diseases constitute 71% of deaths worldwide and within this group cancers rank as the second most common cause of mortality [1]. One out of every six deaths in the world and one out of every five deaths in Turkey are related to cancer [2,3]. GLOBOCAN estimates for 2020 indicated that worldwide there were approximately 20 million new cancer cases and 10 million cancer-related deaths [4]. The estimations for Turkey showed that there were 126,335 cancer-related deaths in 2020 and lung, stomach, pancreas, breast, and colon cancers (excluding lymphoid and hematopoietic cancers) were the cases with the highest mortality [5].

Some regions in the world have achieved a reduction in cancer-related deaths by progress in prevention, screening, and treatment methods. However, this downward trend was primarily limited only to high-income countries and was not observed in low to middle-income countries [6]. Currently, 70% of cancer-related deaths occur in low to middle-income countries [2]. In a study evaluating premature deaths, it was found that cancer is the most common cause of premature death in 57 of 127 countries, including Turkey. The same research emphasizes that cancer-related deaths will increase and will be the leading cause of premature deaths in most countries by the end of this century [7].

Accurate evaluation of cancer-related deaths depends on the availability of an effective cancer registry system. Active population-based

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cancer registry started in Turkey in 1992. There are 14 cancer registry centers available, covering 50.2% of the population [8]. However, Turkey's data, which is included in the global cancer survival surveillance trends (CONCORD-3) and in GLOBOCAN 2020, were obtained from only nine centers that were qualified to be included. The coverage of these nine centers is 23.4% [5,9]. The cancer registry in these centers does not include mortality data, which presents another limitation [8].

Death recording in Turkey has been carried out since 1931. The death records at the national level are collected and published annually by the Turkish Statistical Institute (TURKSTAT). To increase death registration coverage and improve the quality of the data, some modifications were made in 2009. There were two major changes. Firstly, deaths before 2009 were collected only in provinces and districts. However after 2009 deaths from villages were also included in the registration system. Secondly, the classification system for death causes had changed in 2009 and the International Classification of Diseases, Tenth Revision (ICD-10) [10] started to be used since then.

The certificate for each death is filled by the physician in charge. This form includes the place and date of death as well as demographic data of the deceased, the main cause of death, and other causes that are not relevant to this main cause but are associated with death. The main cause of death which is used for cause of death classification is defined as the conditions, an accident, or a violent act that results in illness or injury or fatal injury, leading to the onset of disease conditions that directly cause death. Contributing causes are diseases or conditions that are not part of the chain of events leading to death but have contributed to death. If the death has occurred in the hospital, it is reported by the responsible physician, and if the death has occurred at home or elsewhere, it is reported by the family physician, the municipality physician, or another designated physician. It is essential that the person reporting the death is a physician; however, another officer, headman of village, or military officer in the rural regions where a physician is not present can fill out the death registration form [11].

Cancer-related deaths make up a considerable proportion of the mortality burden [12]. Determining cancer-related death rates and following the developments over time are essential for evaluating the effectiveness of prevention and control strategies. The objective of this study was to determine the trend of cancer-related death rates between 2009 and 2019 in Turkey for all cancers combined and the five cancer types with the highest mortality using the TURKSTAT data.

## 2. Materials and methods

This is a descriptive study evaluating the cancer mortality trend for 11 years between 2009 and 2019. In Turkey the coding system for death classification had changed in 2009. So in order to prevent misclassification bias due to the use of different coding systems, only 2009 and the subsequent years were analysed. In addition, TURKSTAT did not publish the causes of death after 2019. Therefore, the analyzes were restricted to the years between 2009 and 2019.

Cancer mortality data by gender and age groups were obtained from TURKSTAT. Total cancer-related deaths (malignant tumors according to ICD-10 classification: C00-C97) were included in the study. Cancers of the lung (ICD-10: C32-C34), stomach (ICD-10: C16), pancreas (ICD-10: C25), breast (ICD-10: C50), and colon (ICD-10: C18) were also evaluated separately. The World Health Organization (WHO) standard population ratios were used to calculate the age-standardized mortality rates [13].

### 2.1. Statistical analysis

Age-specific and age-standardized mortality rates were calculated through the Microsoft Excel and R program version 3.4.3 to double check. The changes in age-standardized cancer-related deaths over the years were evaluated by the Joinpoint Regression Analysis (JRA) with the Joinpoint Regression Program, Version 4.9.1.0. - April 2022; Statistical Methodology and Applications Branch, Surveillance Research

Program, National Cancer Institute. Average annual percentage changes (Average Annual Percent Change-AAPC) and annual percentage changes (Annual Percent Change-APC) of age-standardized mortality rates (ASMRs) were calculated. Statistical significance level was set as  $< 0.05$ .

Ethics committee approval for the study was obtained from Ethics Committee of Marmara University School of Medicine (Protocol Number: 09.2021.455 Date: 07.05.2021).

## 3. Results

Between 2009 and 2019, a total of 801 682 cancer-related deaths were registered. The change in the crude mortality rate per year is presented in Fig. 1. The crude mortality rate increased during 2009–2016. While the rates were similar in 2017 and 2018, it was lower in 2019 compared to 2018 (Fig. 1). Among all deaths, 521,185 (65%) were men and 280,497 (35%) were women. Deaths in men and in women were most common in the 65–69 (15.09%) and 75–79 (12.87%) age groups, respectively (Table 1).

Total ASMRs for men in 2009 and 2019 were 129.5 and 119.8 per 100,000, respectively. For women, the total ASMRs in 2009 and 2019 were 57.1 and 55.4 per 100,000, respectively. The rank of lung, stomach, pancreatic, breast, and colon cancers did not change for men from 2009 to 2019. Among men, between 2009 and 2019 lung cancer accounted for 41.2% and 40.6% of all cancer-related deaths, respectively. Lung cancer was followed by stomach, colon, and pancreatic cancers in men. In women, lung cancer ranked as the first with a proportion of 12.9% of all cancers in 2009, followed by breast, stomach, colon, and pancreatic cancers. In 2019, breast cancer was placed first with a proportion of 15.3% of all cancers, followed by lung, colon, stomach, and pancreatic cancers (Table 2).

The change in ASMRs over the years was evaluated with the JRA. In men, lung cancer-related deaths increased by 2.4% annually in the 2009–2014 period and decreased by 3.4% annually in the 2014–2019 period ( $p < 0.05$ ). Stomach cancer-related deaths decreased by 5.1% annually in the 2014–2019 period ( $p < 0.05$ ). Colon cancer-related deaths increased by 5.8% annually between 2009 and 2015 and decreased by 3.3% annually between 2015 and 2019 ( $p < 0.05$ ). Pancreatic cancer-related deaths increased at an annual rate of 5.6% in the 2009–2013 period ( $p < 0.05$ ). The trend of total cancer-related deaths in men increased between 2009 and 2014 (2.2% per year); and decreased between 2014 and 2019 (3.2% per year) ( $p < 0.05$ ) (Table 3).

In women; Lung cancer-related deaths increased by 2.5% annually between 2009 and 2016 ( $p < 0.05$ ). Stomach cancer-related deaths increased between 2009 and 2014 (2.3% per year) and decreased between 2014 and 2019 (4.5% per year) ( $p < 0.05$ ). Colon cancer-related deaths increased by 2.5% annually between 2009 and 2017 ( $p < 0.05$ ), pancreatic cancer-related deaths increased 7.4% annually between 2009 and 2013 ( $p < 0.05$ ). Breast cancer-related deaths increased by 4.1% annually between 2009 and 2015 ( $p < 0.05$ ) and there was no significant change afterwards. The JRA analysis suggested choosing the model evaluating breast cancer-related deaths as a single period in the 2009–2019 period, and accordingly an average annual increase of 2.2% was observed in breast cancer-related deaths between 2009 and 2019 ( $p < 0.05$ ). The trend of total cancer-related deaths in women decreased between 2014 and 2019 (2.3% per year) ( $p < 0.05$ ) (Table 3).

## 4. Discussion

This study evaluated the trend of cancer-related deaths in Turkey for a period of 11 years between 2009 and 2019 with JRA. There was a significant increase between 2009 and 2014 and a significant decrease between 2014 and 2019 in total cancer-related deaths. Pancreatic cancer-related deaths, on the other hand, tend to increase in both genders. There was a high trend in breast and lung cancer-related deaths in women.

Lung cancer is the leading cause of cancer-related death in the world

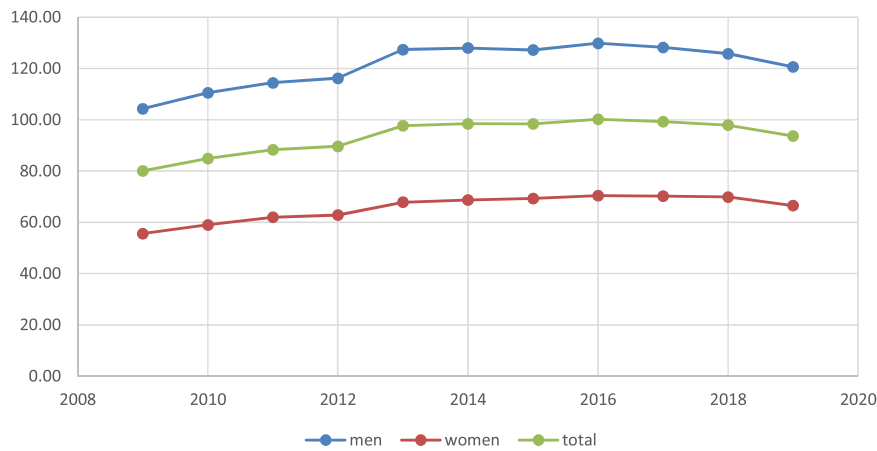


Fig. 1. Crude cancer-related mortality rates between 2009 and 2019 (in 100,000).

**Table 1**  
Cancer-related deaths in women and men by age groups, 2009–2019.

Age groups	Men		Women		Total
	n	%	n	%	
0–4	1323	0.25	1135	0.40	2458
5–9	1307	0.25	954	0.34	2261
10–14	1247	0.24	917	0.33	2164
15–19	1780	0.34	1176	0.42	2956
20–24	2068	0.40	1339	0.48	3407
25–29	2462	0.47	2061	0.73	4523
30–34	3572	0.69	3722	1.33	7294
35–39	5800	1.11	6567	2.34	12,367
40–44	10,276	1.97	9918	3.54	20,194
45–49	20,674	3.97	15,040	5.36	35,714
50–54	38,632	7.41	20,879	7.44	59,511
55–59	58,853	11.29	25,912	9.24	84,765
60–64	75,222	14.43	30,328	10.81	105,550
65–69	78,632	15.09	32,898	11.73	111,530
70–74	74,317	14.26	35,030	12.49	109,347
75–79	67,635	12.98	36,104	12.87	103,739
80–84	49,163	9.43	31,057	11.07	80,220
85 +	28,210	5.41	25,456	9.08	53,666
unknown	12	< 0.01	4	< 0.01	16
<b>total</b>	<b>521,185</b>	<b>100.00</b>	<b>280,497</b>	<b>100.00</b>	<b>801,682</b>

and caused 1.8 million deaths in 2020 [14]. This study determined that lung cancer-related deaths accounted for almost half of all cancer-related deaths in men. Turkey ranks first worldwide in lung cancer with an annual incidence of over 60 per 100,000 in men [15]. In this study, it was observed that while lung cancer-related deaths in men increased between 2009 and 2014, there was a decrease between 2014 and 2019. In women, there was an increase in 2009–2016, and no significant change was observed after 2016. Dogan et al., evaluated the trend of cancer-related deaths between 2009 and 2017 in Turkey and reported similar findings regarding lung cancer-related deaths for both men and women [16]. It was stated in the World Cancer Report that the

**Table 2**  
Distribution of cancer types age standardized mortality rates (ASMRs) for men and women, per 100,000.

	Men				Women			
	2009		2019		2009		2019	
	%	ASMRs	%	ASMRs	%	ASMRs	%	ASMRs
lung	41.2	51.1	40.6	47.4	12.9	7.4	13.7	7.6
stomach	8.5	10.6	8.6	10.0	8.9	5.1	7.9	4.4
colon	5.3	6.7	7.0	8.2	8.1	4.6	8.9	4.9
pancreas	4.6	5.7	5.9	7.1	5.8	3.3	7.7	4.2
breast	0.2	0.3	0.1	0.1	12.7	7.2	15.3	8.8
<b>total cancers</b>	<b>100.0</b>	<b>129.5</b>	<b>100.0</b>	<b>119.8</b>	<b>100.0</b>	<b>57.1</b>	<b>100.0</b>	<b>55.4</b>

increase in tobacco consumption would cause an increase in lung cancer-related deaths in women. Accordingly, there has been an increase in the number of lung cancers in women in countries such as Australia, Japan, UK and USA due to increased tobacco use in women [6]. Similarly, the prevalence of women who use tobacco daily in Turkey has increased by more than 25% since 2010. In women, the rate of daily smokers was 15% in 2019, while it was 10.8% in 2010. In men, the prevalence of tobacco use has remained stable at around 40% since 2010 or has changed only slightly [17]. This explains the increase in lung cancer incidence in women [18].

Screening lung cancer is still controversial. In a study conducted in the United States (USA), lung cancer screening with low-dose computed tomography (CT) reduced mortality by 16% in heavy smokers [19]. In Europe, there is a recommendation to perform lung cancer screening with low-dose CT for heavy smokers [20]. However, this issue remains controversial as its long-term benefits are offset by its potential harm and high cost. Lung cancer screening is not included in the Turkish National Cancer Screening Standards [21]. Since smoking is the main risk factor for lung cancer, preventing tobacco use is still the primary strategy for controlling lung cancer [6].

This study determined that stomach cancer-related deaths increased from 2009 to 2014 and decreased between 2014 and 2019 for both men and women. Dogan et al., showed similar increase and decrease trends for women, while no significant change was observed in men [16]. The incidence of stomach cancer has been decreasing in Turkey since 2011 [19]. Of all stomach cancers 75–90% are associated with Helicobacter pylori infection [22]. This infection is acquired at young ages. The improvements in living conditions, nutrition, and food preparation might have contributed to a decrease in Helicobacter pylori infection leading to reduced incidence and stomach cancer-related deaths [6].

In this study, there was an increase in colon cancer-related deaths between 2009 and 2015 in men and between 2009 and 2017 in women. These increases were also shown by Dogan et al. [16]. In this study, after 2015, a decrease was observed in colon cancer-related deaths in men.

**Table 3**  
Changes in cancer-related deaths in women and men over the years, 2009–2019.

	AAPC (95% CI)	Trend			
	2009–2019	Period 1	APC (95% CI)	Period 2	APC (95% CI)
<b>men</b>					
lung	-0.6 (-1.4; 0.3)	2009–2014	2.4* (0.8; 3.9)	2014–2019	-3.4* (-4.8; -1.9)
stomach	-1.0 (-3.5; 1.6)	2009–2014	3.3 (-1.3; 8.1)	2014–2019	-5.1* (-9.3; -0.7)
colon	2.1* (0.7; 3.4)	2009–2015	5.8* (4.0; 7.7)	2015–2019	-3.3* (-6.4; -0.1)
pancreas	2.4* (1.5; 3.3)	2009–2013	5.6* (3.3; 7.8)	2013–2019	0.4 (-0.7; 1.5)
breast	-4.5* (-8.5; -0.4) <sup>a</sup>	2009–2016	-0.4 (-8.3; 8.2)	2016–2019	-16.8 (-39.0; 3.4)
total cancer	-0.5 (-1.5; 0.4)	2009–2014	2.2* (0.4; 4.0)	2014–2019	-3.2* (-4.9; -1.5)
<b>women</b>					
lung	0.6 (-0.7; 1.9)	2009–2016	2.5* (1.2; 3.8)	2016–2019	-3.6 (-8.1; 1.0)
stomach	-1.2 (-3.5; 1.6)	2009–2014	2.3* (0.2; 4.5)	2014–2019	-4.5* (-6.5; -2.5)
colon	0.4 (-1.5; 2.4)	2009–2017	2.5* (1.2; 3.7)	2017–2019	-7.3 (-17.1; 3.5)
pancreas	2.7* (1.3; 4.2)	2009–2013	7.4* (3.7; 11.2)	2013–2019	-0.2 (-2.1; 1.6)
breast	2.2* (0.8; 3.5) <sup>a</sup>	2009–2015	4.1* (0.8; 7.4)	2015–2019	-1.1 (-6.8; 5.0)
total cancer	-0.0 (-0.9; 0.9)	2009–2014	2.3 (0.7; 3.3)	2014–2019	-2.3* (-3.8; -0.8)
<b>total</b>					
lung	-0.3 (-1.4; 0.3)	2009–2014	2.5* (1.0; 3.9)	2014–2019	-3.1* (-4.4; -1.6)
stomach	-0.5 (-1.9; 0.9)	2009–2014	3.2* (0.8; 5.8)	2014–2019	-4.1* (-6.4; -1.8)
colon	1.6* (0.3; 3.0)	2009–2015	5.7* (3.9; 7.6)	2015–2019	-4.2* (-7.3; -1.1)
pancreas	2.3* (1.1; 3.5)	2009–2013	6.5* (3.5; 9.6)	2013–2019	-0.4 (-1.9; 1.1)
breast	2.0* (0.7; 3.3) <sup>a</sup>	2009–2015	3.9* (0.9; 7.1)	2015–2019	-1.3 (-6.6; 4.3)
total cancer	-0.4 (-1.3; 0.6)	2009–2014	2.2* (0.5; 3.9)	2014–2019	-2.9* (-4.5; -1.2)

AAPC: Average Annual Percent Change.

APC: Annual Percent Change.

\*  $p < 0.05$ .

<sup>a</sup> The model chosen by the program in the JRA analysis.

Today there is a decrease in colon cancer incidence in high-income countries [6,23], but incidence is increasing in low to middle-income countries, including Turkey [6,17]. Colon cancer screening had been initiated in 2012 in Turkey. People between the ages of 50–70 are screened with fecal occult blood test (FOBT) every 2 years or colonoscopy every 10 years [21]. In a report published by the Turkish Ministry

of Health, it is stated that the coverage of colon cancer screening is 20–30% [24]. Despite the low coverage of colon cancer screening, easy access to advanced examinations such as colonoscopy in Turkey's healthcare system might have let to early diagnosis and treatment.

In this study, an increase was observed in pancreatic cancer-related deaths in both genders between 2009 and 2013 which is consistent with the results of Dogan et al. [16]. Pancreatic cancer-related deaths are expected to increase and become one of the leading causes of cancer-related deaths due to the lack of screening methods, effective treatment options, and low survival rates [23,25–26].

Breast cancer ranks the first among the most common female cancers globally; 2.3 million in the world and 24,175 women in Turkey were diagnosed with breast cancer in 2020 [27,28]. This study showed that there was an increase in breast cancer-related mortality in women between the years 2009–2019 and breast cancer was the most common cause of cancer-related deaths in women in 2019. Dogan et al., showed a similar increase in breast cancer-related deaths [16]. Successful screening programs and effective treatment and care have let to a decrease in breast cancer-related deaths in high-income countries. Conversely, breast cancer-related deaths have increased in low to middle-income countries [6]. The breast cancer screening program had been initiated in Turkey in 2012. The program includes mammography evaluations for every 2 years among women aged 40–69 years [21]. This should be noted that there is currently no national data on the coverage of the breast cancer screening program in Turkey. Even if we could have accessed data related to the screening coverage, the 11-year period would still be too short to examine the impact of these factors on cancer-related deaths. Yet the increasing incidence [18] and mortality rates suggest that the coverage of the program should be monitored and its effectiveness should be evaluated.

The strength of this research is that all cancer-related deaths between 2009 and 2019 were evaluated with the JRA analysis. However, the quality of the mortality data might have affected our results and misclassification might have let to lower than expected cancer-related death rates. GLOBOCAN estimated cancer-related deaths in Turkey for 2019 as 116,710 [29] while TURKSTAT reported only 77,887 cancer-related deaths for that year. Also data from TURKSTAT indicated that all-cause mortality had been increasing. While the crude mortality rate was 5.1 per thousand in 2009, it reached to 5.3 in 2019 [30]. Tan [31] states that misclassification regarding the cause of death causes underestimation in cancer-related deaths. So classification of cancer-related deaths as non-cancer causes in the mortality registration system might have let to an underestimation. Previous studies have also suggested drawbacks in the efficacy of the mortality registration system and the validity of the reported causes of mortality in Turkey [32]. For more accurate cancer-related death reporting strengthening active cancer registry, increasing data diversity, and detailed data collection have also been suggested [28]. The only source of information on cancer-related mortality is TURKSTAT; not to collect mortality data in cancer registry centers stands out as an important deficiency in active cancer registry in Turkey [33]. Ensuring international standards in active cancer registry and inclusion of mortality and survival data in cancer registry will improve the quality of cancer-related mortality data. We suggest regular linkages between TURKSTAT and the national cancer registry system, to improve data quality in the cancer registry system. Also we do not have enough data regarding the cancer incidences by types, coverage of cancer screening programs, and the frequency of risk factors which let to limitations when interpreting mortality trends in this study. Such data are critical for a more accurate interpretation of cancer-related deaths. Even if we could have accessed data related to risk factors, protective measures and screening coverage, still the 11-year period would be too short to examine the impact of these factors on cancer-related deaths.

## 5. Conclusion

This study determined an increase in total cancer-related deaths between 2009 and 2014; and a decrease in the 2014–2019 period. In men, lung, stomach, and colon cancer-related deaths decreased as of 2014 and 2015; pancreatic cancer-related deaths, on the other hand, tend to increase in both genders similar to the rest of the world. In women, stomach cancer-related deaths decreased after 2014. However, lung cancer-related deaths increased between 2009 and 2016 as a striking consequence of increased tobacco use in women. Breast cancer-related deaths also increased in the period between 2009 and 2019. Although, breast cancer screening is included in the national cancer screening program in Turkey, increasing mortality rates suggest that the effectiveness and coverage of the program need to be reevaluated. Underestimation might be the major problem in cancer-related mortality presented in this study, due to the drawbacks of the insufficiency of the registry system. Evaluation of the mortality registration system, strengthening the cancer registry, collection of mortality and survival data in cancer registry centers and regularly sharing cancer-related data such as incidence, screening rates and risk factors are important factors for monitoring cancer-related deaths.

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## Ethics committee approval

Ethics committee approval was received for this study from the Ethics Committee of Marmara University School of Medicine (Protocol Number: 09.2021.455 Date: 07.05.2021).

## CRediT authorship contribution statement

**Ayşe Gulsen Teker:** Conceptualization, Methodology, Software, Validation, Formal analysis, Data curation, Writing – original draft, Visualization, Supervision. **Pinar Ay:** Conceptualization, Methodology, Writing – original draft, Visualization, Supervision.

## Conflict of interest

Authors have no conflict of interest associated with this paper.

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