The impact of the Covid-19 pandemic on outpatient visits for patients with cancer in Iran: an interrupted time series analysis

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Abstract

Background The Covid-19 pandemic has posed unprecedented challenges to healthcare systems worldwide, affecting routine medical services, including for cancer patients. This study investigates the impact of the Covid-19 pandemic on outpatient visits for patients with cancer in Iran.

Methods We conducted an interrupted time series analysis (ITSA) on data collected from electronic medical records. The ITSA methodology was employed to analyze monthly outpatient visits for patients with cancer data from March 2017 to January 2023 in Lorestan University of Medical Sciences.

Results Following the announcement of Covid-19 in Iran, outpatient visits for patients with cancer decreased immediately and sharply, with a mean of 247.08 visits per month, which has a 95% confidence interval of [-297; -197]. Subsequent waves in June 2020, September 2020, April 2021, July 2021, and January 2022 further affected outpatient visits. However, the initiation of Covid-19 vaccination, particularly for cancer patients, marked a positive turning point, leading to an increase of 156.39 outpatient visits between January and February 2022.

Conclusion Our study provides critical insights into the dynamic relationship between the Covid-19 pandemic, patient behavior, and cancer care utilization. The observed decrease in outpatient visits underscores the multifaceted challenges faced by cancer patients during the pandemic, while the positive influence of vaccination signals a pathway towards recovery. The importance of vaccination is highlighted as a key factor in improving outpatient visit rates. As healthcare systems adapt to ongoing challenges, understanding the complex interplay between public health crises and patient behavior is crucial for shaping resilient and patient-centric healthcare systems.

Keywords Covid-19, Cancer patients, Health policy, Health services accessibility, Interrupted time series analysis, Iran, Outpatient visits

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Background

The Covid-19 pandemic, precipitated by the outbreak of the novel coronavirus SARS-CoV-2 in December 2019, has led to unprecedented global health challenges [1]. This crisis has not only caused direct health impacts due to the virus itself but has also severely disrupted routine healthcare services, including the provision of care for chronic diseases such as cancer [2]. Cancer patients, who often undergo immunosuppressive treatments such as chemotherapy or surgery, are particularly vulnerable to infections [3]. The pandemic exacerbated this vulnerability, as healthcare resources were diverted to manage Covid-19 cases, leading to reduced access to essential cancer care [4]. These disruptions have raised concerns about the long-term impact on cancer morbidity and mortality, as timely diagnosis and continuous treatment are critical for favorable cancer outcomes [5].

Iran, like many nations, faced unique challenges in maintaining continuity in healthcare services during the pandemic [6]. The multifaceted nature of cancer care, which often involves a delicate balance of timely interventions and ongoing support, became inherently vulnerable in the face of disruptions caused by Covid-19 [7]. The onset of Covid-19 in Iran marked a significant challenge for the country's healthcare system. Iran experienced one of the earliest and most severe outbreaks of the virus in February 2020. Specifically, February 20, 2020, is recognized as a pivotal date when Iranian authorities publicly acknowledged the rapid spread of the virus and began implementing emergency measures to address the crisis [8]. Despite facing economic sanctions and limited resources, the Iranian healthcare infrastructure made commendable efforts to access and provide health services to the population [9]. The government implemented various measures, including widespread testing, contact tracing, and quarantine protocols, to curb the spread of the virus. Hospitals and healthcare professionals worked tirelessly, often under challenging circumstances, to treat and care for Covid-19 patients [10].

The purpose of this study was to assess the impact of the Covid-19 pandemic, its various waves, and Covid-19 vaccination on outpatient visits for cancer patients at service centers within hospitals and clinics affiliated with the Ministry of Health and Medical Education (MOHME) in Khorramabad, located in western Iran. This research aims to assist policymakers in identifying specific areas of cancer care most affected by the pandemic, thereby guiding resource allocation and planning to address the most critical needs. The insights gained can inform the development of strategies to enhance the preparedness of health systems for future pandemics, ensuring that cancer care services remain resilient and adaptable in times of crisis. The findings are intended to support the formulation of evidence-based policies to safeguard cancer care during pandemics. This study has the potential to contribute significantly to evidence-based policymaking, bolster the resilience of healthcare systems, and ensure the continuity of care for cancer patients during challenging periods. It can serve as a crucial resource for policy development, resource allocation, and the improvement of health crisis response strategies.

Methods

Study design

We conducted an interrupted time series analysis (ITSA) study using retrospective data from the electronic medical records (EMR) system. ITSA is a statistical method used in health studies to evaluate the impact of an intervention, policy, or event on a specific outcome over time [11]. It is particularly useful for assessing the effectiveness of public health policies, programs, or external events on health-related outcomes [12]. The method involves collecting data at multiple time points before and after the intervention or event, allowing researchers to model and analyze the temporal trends in the outcome variable [13].

Setting

Lorestan is a province in western Iran, situated in the Zagros mountain range. It shares borders with several other Iranian provinces, including Kermanshah, Khuzestan, Markazi, Isfahan, and Ilam. The capital of Lorestan Province is Khorramabad, and the province has a population of around 1.8 million people. Lorestan University of Medical Sciences (LUMS) is responsible for providing health services in 11 cities.

Data source

In recent years, numerous specialized clinics have been established, and a hospital in the province's center now offers services to cancer patients. These facilities extend their services to patients residing in the province as well as those from neighboring cities within Lorestan province. All pertinent patient information and the corresponding services are meticulously documented within these centers. Healthcare providers record patient information directly into the EMR at the point of care. Utilizing the center's data system, a comprehensive record of patient visits has been compiled, spanning from March 2017 to January 2023. A form was designed by the researchers, and demographic information and the number of visitors to the clinic were extracted separately by month. The data were extracted as individual records, ensuring anonymity, and included information such as age, gender, date of birth, region of residence, date of diagnosis, type of cancer, type and morphology, stage of cancer captured from pathology and the date of receiving the Covid-19 vaccine. The data for this study were

recorded from the beginning of the Covid-19 pandemic, and the researchers collected it in November 2023.

Outcome measures

The outcome labeled as the number of outpatient visits for patients with cancer was determined by totaling the unique dates of patient encounters recorded in EMR forms. These forms are completed during in-person cancer care events such as oncology clinical intake, cancer diagnosis, staging, and treatment planning. This measure encompasses both scheduled and unscheduled follow-up care visits for current patients, providing a comprehensive overview of monthly clinical activity.

Statistical analysis

We employed segmented regression analysis to quantify the impact of the Covid-19 pandemic on outpatient visits for patients with cancer. The segmented regression model used was: $Y_t = \beta_0 + \beta_1\,T_t + \beta_2\,X_t + \beta_3\,X_tT_t + \varepsilon_t$.

Y_t: is the number of outpatient visits per month,

- Yt: Number of outpatient visits per month.
- Xt: Intervention indicator (e.g., onset of Covid-19 or vaccination period).
- XtTt: Interaction term between time and the intervention.
- β1: Underlying time trend.
- β2: Immediate effect of the intervention on the outcome.
- β3: Change in trend due to the intervention.
- εt: Error term.

The seasonal adjustment was performed using the ARIMA method. Given the count nature of our outcome, we used a Poisson regression model. An offset variable for the population at risk (number of cancer patients) was included to adjust for population changes over time. To account for seasonal patterns, we included monthly dummy variables in the regression model. This approach helps to adjust for regular fluctuations in outpatient visits that occur due to seasonality. Seasonal patterns were identified and adjusted in the regression model to account for regular fluctuations in outpatient visits. Autocorrelation of residuals was assessed using partial autocorrelation functions. If significant autocorrelation was detected, autoregressive terms were included in the model. We conducted an ITSA comparing the number of outpatient visits during a usual care period (March 1, 2017 to February 19, 2020; 36 months) with the number of outpatient visits during the Covid-19 period (February 20, 2020 to February 28, 2023; 37 months). The choice of February 20, 2020, as the starting point for Covid-19 in Iran corresponds to the date when the first cases were officially reported by the Iranian Ministry of Health and

Medical Education (MOHME). This date marks the recognition of Covid-19 as a significant public health threat in Iran. After the announcement of Covid-19 in Iran five waves occurred that had a significant impact on all aspects of Iranian life. These months refer to the periods of peak intensity of the Covid-19 waves, which had a significant impact on the number of outpatient visits. We also analyzed the impact of each of these waves on the number of outpatient visits for patients with cancer. These waves occurred in June 2020, September 2020, April 2021, July 2021, and January 2022. In February 2021 the government accorded high priority to administering the Covid-19 vaccination to cancer patients. Additionally, we analyzed to assess the impact of Covid-19 vaccination on the outpatient visits for patients with cancer. To facilitate the analysis, several R packages were installed and loaded, including dplyr, pander, stargazer, scales, nlme, carData, car, ggplot2, plotly, and Wats. We initially plotted the number of patients over time to visualize the trends before and after the onset of the Covid-19 pandemic in Iran. The fitted values from the regression model were plotted to visualize the trends. The model fitting process involved employing the Newey-West technique and assuming independence of residuals [14]. We employed an Ordinary Least Squares (OLS) regression model to estimate the impact of the pandemic [15, 16]. We also created a secondary prediction to compare the actual and counterfactual scenarios. To ensure the robustness of the OLS model, we examined the residuals for autocorrelation using the Durbin-Watson test and plotted the autocorrelation function (ACF) [16, 17]. The results of the regression model were reported using the stargazer package for a clear and formatted output. *P*-value < 0.05 was considered significant.

Results

The impact of the Covid-19

At the beginning of the observation period, the mean monthly outpatient visits for patients with cancer were 318.90 (95% CI: 282.04 to 355.77). After the announcement of the Covid-19 pandemic in Iran by the MOHME, the mean decreased by 247.08 per monthly (95% CI: -297.38 to -196.79). The findings from the segmented regression model from March 2017 up to February 2023 are demonstrated in Table 1.

The results in Table 1 show both an immediate and significant drop in outpatient visits (level change) as well as a significant change in the trend after the start of Covid-19. Specifically, the level change of -247.08 indicates a substantial initial decrease in visits. However, the trend change of 9.97 per month suggests a gradual reversion to the mean, implying that over time, the utilization of outpatient services began to recover. This gradual increase could indicate that the healthcare system adapted over

Table 1 Change in the number of outpatient visits of patients with cancer according to the seasonally adjusted segmented regression models considering the announcement of the beginning of Covid-19 in February 2020 in Iran

Parameter	Coefficients	95% CI		Standard Errors	P-Value
Intercept	318.90	282.04	355.77	36.62	0.00
Baseline trend	-0.27	-2.05	1.51	1.83	0.76
Level change after the intervention	-247.08	-297.38	-196.79	32.45	0.00
Trend change after the intervention	9.97	7.54	12.40	1.00	0.00
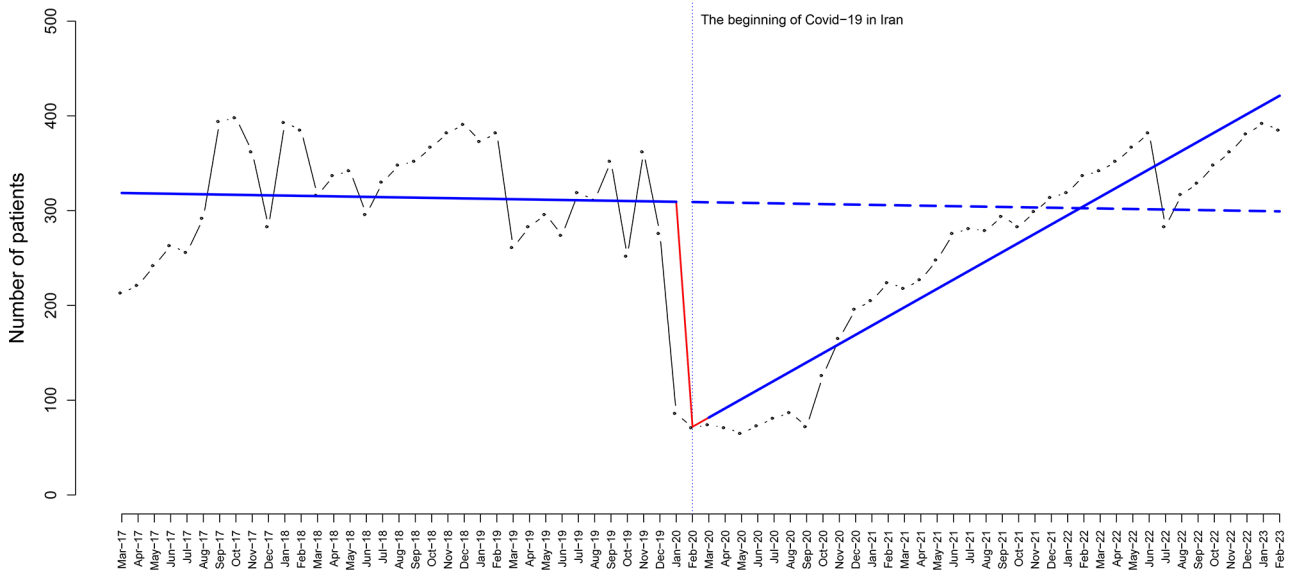
Fig. 1 The temporal trend of the rate of outpatient visits for patients with cancer before and after the announcement of the beginning of Covid-19 in Iran

time, finding ways to manage and treat patients despite the ongoing pandemic. However, it also implies that the observed pattern is expected to hold within a certain range of healthcare under-utilization, and complete reversion to pre-pandemic levels may not occur immediately. Also, Fig. 1 shows the time trend of outpatient visits to patients with cancer before and after the announcement of Covid-19 in Iran in February 2020.

The impact of the waves of Covid-19 after February 2020
Figure 2 shows the impact of the waves that happened after February 2020 on outpatient visits to patients with cancer. The findings indicated that with the start of each wave of the Covid-19 epidemic in Iran, the number of outpatient visits to patients with cancer has decreased. The findings of the segmented regression model on the effect of different waves of Covid-19 are shown in Table 2. The findings indicate that with the start of each wave of the Covid-19 epidemic in Iran, the number of outpatient visits for patients with cancer decreased. The findings of the segmented regression model on the effect of different waves of Covid-19 are shown in Table 2. The non-significance of the level changes in several waves suggests that the immediate impact of these waves on outpatient visits was not statistically significant, although the trend

changes indicate variations in the rate of recovery or decline. The analysis of the different waves of Covid-19 (Table 2) reveals that not all waves had a statistically significant immediate impact on the level of outpatient visits. This suggests that while the announcement and peaks of the waves disrupted healthcare services, the immediate reduction in outpatient visits was not uniform across all waves. However, the significant trend changes observed in some waves (e.g., the third wave) indicate a gradual recovery or continued decline over time. This nuanced understanding is critical, as it highlights the variability in how different waves impacted healthcare utilization and suggests that other factors, such as adaptation of healthcare services and patient behavior, played a role in the observed patterns.

The effect of Covid-19 vaccination
At the beginning of the observation period in Covid-19 pandemic, the mean monthly outpatient visits to patients with cancer was 126.75 (95% CI: -65.32 to 158.83). After the Covid-19 vaccination started in Iran by the MOHME for cancer patients, the visits increased by 156.39 (95% CI: 120.85 to 191.93) of outpatient visits patients. The findings from the segmented regression model from February 2020 up to February 2023 are demonstrated
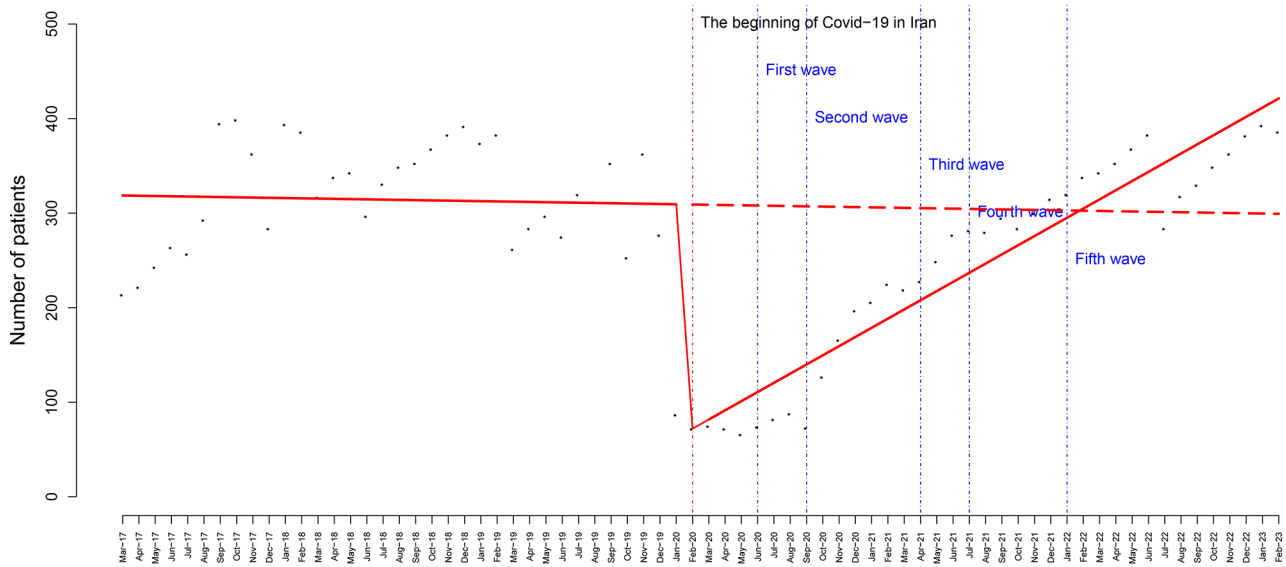
Fig. 2 The temporal trend of the rate of outpatient visits for patients with cancer after the waves of Covid-19 from February 2020 onward

Table 2 Changes in the number of outpatient visits of cancer patients during different waves of Covid-19

Wave	Parameter	Coefficients	95% CI		Standard Errors	*P*-Value
First	Intercept	75.50	-12.57	163.57	43.29	0.09
	Baseline trend	-2.10	-34.25	30.05	15.81	0.89
	Level change after the intervention	-15.47	-22.91	107.86	32.14	0.01
	Trend change after the intervention	11.42	-20.76	43.60	15.82	0.47
Second	Intercept	66.33	-36.04	168.71	50.05	0.19
	Baseline trend	-7.00	-40.39	54.39	23.17	0.76
	Level change after the intervention	-16.29	-35.16	137.42	32.33	0.03
	Trend change after the intervention	1.26	-46.14	48.67	23.18	0.95
Third	Intercept	76.00	34.79	117.20	20.04	0.00
	Baseline trend	-2.07	-14.85	33.28	4.48	1.27
	Level change after the intervention	-7.32	-31.97	46.63	19.12	0.07
	Trend change after the intervention	-18.25	-27.59	-8.91	4.54	0.00
Fourth	Intercept	201.33	126.01	276.65	35.98	0.28
	Baseline trend	-4.50	-10.36	59.36	16.65	0.15
	Level change after the intervention	-4.14	-46.36	54.65	24.13	0.03
	Trend change after the intervention	-19.42	-54.34	15.49	16.68	0.25
Fifth	Intercept	270.26	221.33	319.20	23.08	0.52
	Baseline trend	6.11	-6.45	18.67	5.92	0.31
	Level change after the intervention	-15.33	-32.91	63.58	22.75	0.05
	Trend change after the intervention	-2.45	-15.49	10.58	6.15	0.69

in Table 3. The dashed line indicates the start of Covid-19 vaccination with priority for cancer patients in Iran. Figure 3 shows the time trend of outpatient visits of patients with cancer after the announcement of vaccination Covid-19 in Iran in February 2020. The results presented in Table 3 show that after the introduction of the Covid-19 vaccination, there was a significant immediate increase in the level of outpatient visits (156.39). However, the trend change of -16.06 indicates a slower recovery of cancer care utilization following the start of vaccination. This counter-intuitive result suggests that while the vaccination led to an initial boost in patient visits, the subsequent rate of increase in visits slowed down. This phenomenon could be attributed to several factors, such as vaccine-related side effects, changes in healthcare policy, or continued patient apprehension about visiting healthcare facilities. Additionally, the substantial decline in cancer care utilization observed between June and July 2022 may be due to specific events or policy changes during this period.

Table 3 Change in the number of outpatient visits of patients with cancer in Iran according to the seasonally adjusted segmented regression models considering the announcement of the beginning of Covid-19 vaccination in February 2021 in Iran

Parameter	Coefficients	95% CI		Standard Errors	P-Value
Intercept	126.75	-65.32	158.83	15.13	0.09
Baseline trend	112.37	18.01	116.72	2.63	0.00
Level change after the intervention	156.39	120.85	191.93	24.20	0.01
Trend change after the intervention	-16.06	-20.65	-1.47	0.63	0.05
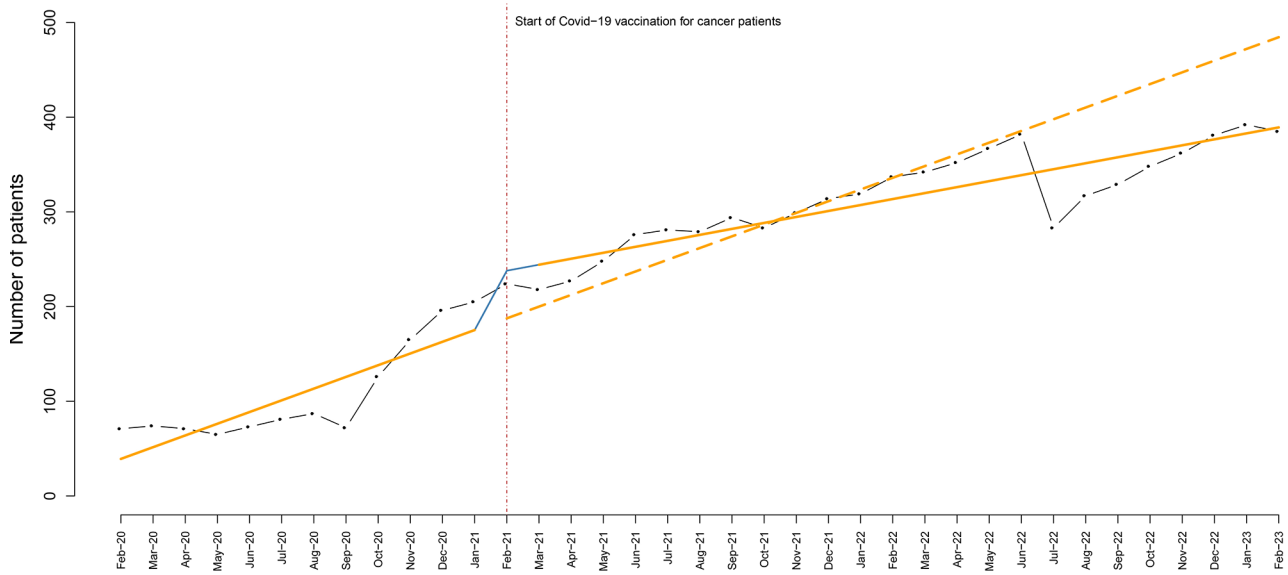
Fig. 3 The temporal trend of outpatient visits for patients with cancer before and after the start of Covid-19 vaccination in Iran

Discussion

Cancer patients faced a myriad of challenges during the initial months of the Covid-19 pandemic. Many cancer treatments, such as chemotherapy and radiation therapy, were postponed or altered to minimize the risk of exposure to the virus [18]. Elective surgeries, including certain cancer-related procedures, were delayed, affecting treatment timelines [19].

We found that the number of outpatient visits for cancer patients decreased immediately after the onset of Covid-19, which was consistent with findings made for different patients in other countries in other countries during the Covid-19 pandemic [20]. Furthermore, the findings revealed that the various waves occurring after the onset of the Covid-19 pandemic in Iran resulted in a decrease in both referrals and outpatient visits patients with cancer. The most noteworthy reason that can justify this decrease was the patients' fear of contracting Covid-19 [21, 22].

Fear of contracting Covid-19 at hospitals and healthcare facilities led some cancer patients to avoid seeking necessary medical care [23]. Support services, such as counseling, support groups, and in-person interactions, were limited, affecting the mental health and emotional well-being of cancer patients [24]. Different studies showed that cancer patients had experienced a higher level of stress, anxiety and depression to receive health services when compared to non-cancer patients with the onset of Covid-19 [25, 26].

After the spread of Covid-19 in Iran, severe restrictions were adopted by the government to control this disease. Many cancer patients, especially those on immunosuppressive treatments, were concerned about the increased risk of contracting Covid-19 in healthcare settings. Studies have shown that patients avoided receiving services in the early stages of Covid-19 [27, 28]. The same fear of exposure to the virus has caused some patients to delay or avoid scheduled appointments [29]. Measures such as social distancing and traffic restrictions, which were applied to control the spread of Covid-19, are also effective factors in reducing the outpatient visits of cancer patients [26].

Studies from other countries indicated a decrease in cancer patient visits due to control policies such as social distancing and quarantine [30, 31]. These studies showed that with the reduction of these policies, the number of patients' referrals to service centers increased.

Cancer patients were reluctant to travel, especially to medical centers, due to concerns about exposing themselves and their companions to the virus. As a vulnerable

population, these patients may be especially cautious about attending healthcare appointments during periods of strict social distancing and traffic restrictions [32].

On the other hand, increasing cases of Covid-19 strained healthcare systems around the world. Hospitals and clinics faced challenges in managing the influx of Covid-19 patients, which led to disruptions in routine medical services [33]. Resources were diverted to address the immediate crisis, affecting the capacity to provide regular care, such as services to cancer patients [34].

Other studies showed that providing health care with a relatively low priority or postponement for non-Covid-19 patients was on the agenda of health centers at the beginning of the pandemic [35–37].

To manage the demand for healthcare resources and reduce the risk of transmission of the virus, many hospitals and healthcare facilities have canceled or postponed non-urgent medical procedures, including cancer screenings, surgeries and follow-up appointments [34].

The increase in Covid-19 cases, especially severe cases requiring hospitalization in the first months, strained the healthcare system and resources, including staff and facilities, to manage the influx of Covid-19 patients, which potentially led to a reduction in available resources for routine outpatient visits [19].

Our findings showed that after the start of Covid-19 vaccination in Iran and its priority for cancer patients, they saw an increase in the number of patients for their visits.Cancer patients are generally more vulnerable to infections. With the start of vaccination and its availability, patients' fear of contracting Covid-19 will decrease and they felt more secure. Studies showed that vaccination and reducing the fear of patients increased visits and receiving services, and on the other hand, service providers were more willing to provide services to non-Covid-19 patients [38, 39].

Studies have shown that people with cancer and other people with weakened immune systems are at high risk of severe complications from Covid-19, and getting the Covid-19 vaccine reduces the risk of hospitalization and death from Covid-19 [40–42].

Knowing that they are a priority for vaccination will increase their confidence to seek health care services. Additionally, vaccination campaigns and emphasis on uptake for vulnerable populations, such as cancer patients, can encourage them to prioritize routine medical visits, including cancer-related appointments [43]. Initiating a Covid-19 vaccination program may imply a commitment to greater healthcare and patient safety and instill confidence in the healthcare system. This confidence can lead to an increase in cancer patients' willingness to interact with the healthcare system [26, 44].

By implementing control and prevention policies and programs, the government has succeeded in reducing the burden of the Covid-19 disease in the society [32]. With the start of vaccination, this reduction intensified, leading to a decrease in the risk of contracting the virus during hospital or clinic visits, which in turn increased cancer patients' willingness to seek medical care [34].

Also, with the start of the Covid-19 vaccination in Iran, there was a reduction in travel restrictions and quarantine measures. Patients who were worried about traveling a distance for their visits were able to make their visits more regularly. It seems that positive vaccination experiences in the cancer patient community or among peers may create a ripple effect and encourage more people to seek medical visits after vaccination. It is important to note that specific factors influencing patient behavior can vary based on local conditions, public health measures, and the success of the vaccination campaign. Additionally, the interplay of psychological, social, and healthcare system factors can contribute to changes in patient referral and healthcare-seeking behavior.

Limitations

While our study provides valuable insights into the impact of the Covid-19 pandemic on cancer patients and the subsequent changes in healthcare-seeking behavior post-vaccination, it is essential to acknowledge several limitations inherent in our study design. Firstly, the retrospective nature of our study may introduce biases related to data availability and accuracy. The reliance on medical records and patient self-reports might not capture the full spectrum of factors that influence healthcare-seeking behavior during the pandemic. Future studies employing a prospective design and incorporating qualitative methodologies could offer a more nuanced understanding of patient experiences. Secondly, our study primarily focused on quantitative measures, such as the number of outpatient visits, and referrals. While these metrics provide important insights, they may not fully capture the qualitative aspects of patient experiences, such as the emotional and psychological factors influencing healthcare decisions. A more comprehensive approach, including patient interviews or surveys, could enhance our understanding of the nuanced challenges faced by cancer patients. Furthermore, the study's generalizability may be limited due to its specific focus on the Iranian context. Cultural, socioeconomic, and healthcare system differences may influence the applicability of our findings to other regions. Comparative studies across diverse populations can provide a more comprehensive understanding of the global impact of the pandemic on cancer care. The study design also did not explicitly explore variations in the quality of healthcare services received by cancer patients. Understanding whether disruptions in routine care translated into adverse outcomes or disease progression would have added valuable clinical

context. Future research should aim to assess the long-term consequences of healthcare interruptions on cancer patient outcomes. Additionally, the ITSA method makes several assumptions, most notably that the method cannot distinguish the effect of the intervention/change under investigation (namely 'start of Covid-19') and other changes that may have occurred around the same time. In other words, it is assumed that the modeled pre-interruption trend would have continued in the absence of the event that occurred at the time of the interruption in the time series. While it seems plausible that the observed effects on healthcare utilization can be attributed mainly to the start of Covid-19, it is important to briefly discuss the importance of these methodological assumptions.

Conclusion

Our study sheds light on the profound impact of the Covid-19 pandemic on outpatient visits for cancer patients in, Iran. The observed decrease in outpatient visits following the onset of the pandemic, exacerbated by subsequent waves of Covid-19, highlights the complex interplay of public health crises, fear, and healthcare-seeking behavior. Fear of Covid-19, compounded by stringent restrictions, social distancing measures, and strained healthcare resources, led to a substantial reduction in cancer-related healthcare utilization. This decrease not only reflects the challenges faced by cancer patients but also underscores the broader repercussions of the pandemic on routine medical services. Patients' heightened apprehension during each wave, fueled by the perceived risk of infection, contributed to a reluctance to seek medical care. The multifaceted challenges faced by cancer patients, from limited support services to increased stress and anxiety, underscore the broader implications of pandemic-related disruptions on mental health within this vulnerable population. However, the initiation of Covid-19 vaccination, particularly with prioritization for cancer patients, marked a turning point. The subsequent increase in outpatient visits signals a positive shift in patient behavior, driven by reduced fears of Covid-19 contraction and increased confidence in the healthcare system. Vaccination campaigns not only serve as a protective measure for cancer patients but also play a crucial role in restoring their trust in healthcare services.

Abbreviations
ITSA	Interrupted time series analysis
MOHME	Ministry of Health and Medical Education
EMR	Electronic medical records
LUMS	Lorestan University of Medical Sciences

Supplementary Information
The online version contains supplementary material available at https://doi.org/10.1186/s13690-024-01482-3.

Supplementary Material 1

Declarations

Ethics approval and consent to participate
The Ethics Committee of the Lorestan University of Medical Sciences approved this study with code IR.LUMS.REC.1402.232. All stages of the study, including design, implementation, and reporting, were conducted without the involvement of patients or the public. Claims data analyzed anonymously. All methods were carried out in accordance with Helsinki guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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