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# The impact of economic sanctions on cancer diagnosis and treatment in Iran: a qualitative study

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## Abstract

**Background** The economic sanctions imposed on Iran have had a significant impact on the country's healthcare system. The sanctions have affected the availability and affordability of cancer diagnosis and treatment services, leading to a range of challenges for patients with cancer. This study aimed to explore these challenges and gain a deeper understanding of the impact of economic sanctions on cancer care in Iran.

**Methods** The research method involved qualitative in-depth interviews with 53 experts, including clinical and basic sciences specialists, who were selected through purposeful sampling. The data were analyzed through qualitative content analysis using MAXQDA 2020.

**Results** A total of 900 codes were identified, categorized into three primary groups—input, process, and output—and further divided into 13 subcategories. Within the input category related to health systems providing cancer care to patients, several critical issues emerged. These included instability in financing mechanisms and regulations, shortages of materials, low-quality imported materials, high material prices, and loss of human resources. Meanwhile, in the process of delivering diagnostic and treatment procedures to cancer patients, concerns centered around delayed and inadequate care, non-adherence to guidelines, limited international collaborations, and reduced provider satisfaction. Finally, during the output phase, the main subcategories extracted were lower effectiveness, increased adverse events, and increased equity gaps.

**Conclusions** Although economic sanctions against Iran have not officially targeted healthcare and access to drugs, they have restricted access to standard equipment and modern technologies, leading to increased delays, misdiagnosis, and diagnostic and therapeutic side effects in cancer patients to the point of death.

**Keywords** Economic sanction, Neoplasms, Iran, Treatment outcome, Diagnosis

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## Background

Cancer is the second leading cause of death in Iran [1], with increasing incidence and mortality rates [2], which impose a dramatic economic burden. On the other hand, evidence suggests that previous sanctions have led to a significant shortage of drugs, especially in the noncommunicable disease (NCD) field (e.g., cancer) [3, 4], and have indirectly affected people's health, hygiene, and treatment by severely increasing diagnostic costs, which are not affordable for public service insurance plans. This increase in cost is not limited to diagnosis and affects the follow-up and treatment of patients, including cancer patients [5]. Over 95% of Iranians are covered by government insurance. The inability of government insurance to cover the enormous expenses of these medical interventions has limited the middle and lower economic classes' access to such drugs and diagnostic/therapeutic methods, especially new generations of chemotherapy drugs and biological anticancer agents [6].

From a policy-maker's perspective, the imposition of sanctions on Iran is a complex issue that requires careful consideration of its far-reaching consequences. The restrictions on our oil exports have forced us to seek alternative solutions, such as exchanging goods with third-party countries, which has led to a black market for essential goods, including life-saving medications. This has had a disproportionate impact on our healthcare system, particularly in terms of accessing new treatments for diseases like cancer.

Although some studies have investigated the impact of economic sanctions on cancer, they have some limitations. Some of them were not original articles and were in the type of letter to the editor [7], editorial [8], feature [9], correspondents [10], or newsletter [11]. In addition, others focused on specific parts of delivering cancer care such as nuclear medicine [12] or radiation oncology [9]. A review article by Shahabi et al. showed some limitations such as the scarcity of published data, both in quality and quantity of international economic sanctions impact on Iranian cancer healthcare, and only cancer healthcare conditions in Iran until 2012 were provided in this study.

A recently published systematic review discussing the adverse effects of sanctions on income and low-middle-income countries from 1950 to 2021 highlighted the complexity and multidimensionality of the effects of sanctions on health and the health system [13]. Most of the published literature generally reviews these effects at the macro level. However, some countries, such as Iraq [14, 15], Syria [16], Cuba [15], Iran [11], and Venezuela [17], have reported the adverse effects of economic sanctions on cancer patients .The results of this review suggested qualitative research to collect domain-relevant data [13].

Drug and equipment shortages exist in all cancer-related modules, including screening, diagnosis, treatment, and palliative care, and cancer patients' health will continue to decline as long as the effects of sanctions remain [18]. Cancer diagnosis and treatment are critical aspects of healthcare that are often disproportionately affected by economic sanctions. Cancer patients are particularly vulnerable to the effects of economic sanctions, as they often require ongoing and expensive treatment. Sanctions can disrupt the supply chain of essential medicines, leading to shortages and unavailability of life-saving treatments. Despite the significant impact of economic sanctions on healthcare systems, there is a paucity of research on the specific effects of sanctions on cancer diagnosis and treatment. Our study aims to fill this knowledge gap and provide insights into the consequences of sanctions on cancer care through qualitative research. By examining this issue, we hope to inform policymakers and stakeholders about the unintended consequences of sanctions on healthcare systems and the need for more nuanced approaches to economic sanctions.

## Methods

This was a qualitative study conducted in Iran from 2020 to 2021 involving interviewers with prior knowledge and training on how to conduct the interviews, which enabled us to collect high-quality data that met the study's objectives and contributed to a deeper understanding of the on the impacts of sanctions on the diagnosis and treatment of cancer patients. We selected participants through purposeful and continued sampling up to data saturation when the information obtained from the interviews began to repeat and no new themes or codes emerged when study participants were includedFifty-three healthcare professionals (oncologists, radiologists, pathologists, and surgeons) with at least 5 years of experience in cancer diagnosis and treatment, and Healthcare policymakers and administrators with experience in healthcare management and policy-making in Iran were included in the study. Those who were not fluent in Persian or English and were not Willing to participate in an in-depth interview and provide informed consent were excluded from the study experts. Both male and female experts were interviewed.

The interviews were conducted as allowed by the working conditions of the participants either face to face or remote interviews by telephone, in individual sessions, and at home, the workplace, or other locations requested by them and took about 30 (range: 30–45 min). A total of [$N=30$] interviews were

conducted face-to-face. Due to travel restrictions and logistical challenges, [$N=23$] interviews were conducted remotely via [video conferencing platform/phone calls]. The combination of face-to-face and remote interviews allowed us to reach a broader range of participants, despite the challenges posed by economic sanctions. The facilitators were physicians and researchers familiar with the health system and with previous experience in conducting qualitative studies.

The interviews were semistructured. The interview guide was based on a comprehensive review of existing literature on the impact of economic sanctions on healthcare systems, particularly in the context of cancer diagnosis and treatment. We also drew on the expertise of our research team, which includes healthcare professionals and researchers with experience in the field of oncology and health policy. We piloted the interview guide with [$n=3$] experts to ensure its validity and relevance and made adjustments as needed before conducting the main study.

Our interview guide included a set of open-ended questions, which were designed to be flexible and adaptable to the participants' responses. When necessary, the interviewer used probing questions to Seek clarification on ambiguous or unclear responses, Gather more specific examples or anecdotes to illustrate key points, Explore underlying assumptions or motivations behind the participants' statements, Encourage participants to reflect on their experiences and opinions. During the interviews, a note-taker was also present.

Data management was performed with Maxqda 2020 software.The data analysis involved qualitative content analysis through an inductive approach. For this purpose, the interviews were transcribed verbatim, and similar semantic units were extracted as unique codes. Next, subcategories were extracted from these expressions and then grouped into main categories. The research team engaged in a process of data immersion, where we repeatedly read and re-read the transcripts to become deeply familiar with the data.

To ensure the accuracy and reliability of the data, we employed a rigorous process of reviewing and verifying the interview transcripts. All interviews were audio-recorded and transcribed verbatim by a professional transcription service. The transcripts were then reviewed by the research team to ensure accuracy and completeness.

Each transcript was reviewed multiple times by at least two members of the research team to verify the accuracy of the transcription, Check for any inconsistencies or discrepancies, ensure that the transcript accurately reflected the participant's words and tone. Any discrepancies or errors found during the review process were corrected and verified by the research team.

The rigor of the study was tested using Streubert and Carpenter's (2010) credibility, transferability, dependability, and confirmability criteria [19]. The participants were provided with the credibility results as well as the final categories obtained after revisions of the interpretations and findings. The transferability results were also verified by participants. The dependability of the findings was tested by explaining all research stages to the participants, and it appeared that the results were not time dependent, and the same could be achieved by repeating the study. For confirmability, another researcher not involved in this study examined the research process and findings and found no errors in the methods or results. The data validity was tested through triangulation. That is, experts in various fields were interviewed.

The participants were asked for permission to record their voices and were reassured that all the gathered information would only be used for research purposes and would not be given to anyone other than the research team members. Participants' views and comments were analyzed confidentially and anonymously. The interviewees were also made aware of their right to withdraw from the research at any stage.

## Results

The demographic characteristics of 53 participating experts is provided in Table 1.

A total of 900 codes were extracted and classified into three main categories—input, process, and output—and 13 subcategories (Table 2).

The interviewees believed that the sanctions had affected all stages of cancer diagnosis and treatment. Directly through limited access to essential equipment and drugs and indirectly through high-cost equipment and drugs (Table 3). The participants were also concerned about running out of drug reserves in future years in case of the continuation of sanctions.

Most of the interviewees believed that all patients were affected by the sanctions to some degree, e.g., head and neck cancer; breast, prostate, bladder, cervix, and vulva cancer; lymphoma; and childhood leukemia. The interviewees reported problematic cases in brachytherapy, including tongue, prostate, gynecological, and rectal cancers.

### Input

#### Instability in regulations and financing mechanisms

According to the interviewees, the overstrict financial system of the US and the existing atmosphere of mistrust has led to severe fluctuations in service or drug delivery. On the other hand, imported materials can lose their properties due to long customs clearance durations.

Another reported problem was the refusal of device suppliers to provide consultants with the relevant

**Table 1** Interviewees' characteristics in qualitative study exploring the effect of economic sanctions on cancer diagnosis and treatment in Iran, 2021

| Charachteristic name | | Frequency | Percent |
|---|---|---|---|
| Specialty | Paediatric and adult Haematology Oncology | 9 | 17 |
| | Surgeons | 10 | 19 |
| | Cancer biology, biochemistry, health information management, physics (nanotechnology) | 4 | 8 |
| | Community medicine | 1 | 2 |
| | Radiology | 4 | 8 |
| | Radiation oncology | 8 | 15 |
| | Nuclear medicine | 3 | 6 |
| | Pathology | 5 | 9 |
| | Clinical pharmacology | 2 | 4 |
| | Internal medicine subspecialty( nephrology, endocrinology, gastroenterology) | 6 | 11 |
| | Family physician | 1 | 2 |
| Gender | Male | 25 | 47 |
| | Female | 28 | 53 |
| Total | | 53 | 100 |

software, which resulted in the device becoming inoperable. Moreover, some companies do not produce or deliver diagnostic radiopharmaceuticals.

#### Shortage of materials

According to the interviewees, the sanctions have had devastating effects on cancer diagnostic tests, particularly regarding those who are dependent on special kits. In addition, positron emission tomography (PET) scans, magnetic resonance imaging (MRI), computed tomography (CT) scans, tumor staining, and immunohistochemical processing were performed. A lack of supplies sometimes includes even primary equipment and consumables such as sutures.

One nuclear medicine specialist said:

> *"This problem included the kits used for scanning. The kits were sometimes hard to find or nonexistent for two or three months. The same was true for the radiation generator or radioactive materials. We generally worked with technetium, and the technetium generator would sometimes become scarce" (Nuclear medicine specialist)*

Participants also addressed the shortage of titanium and technetium markers when the radioactive materials required for surgery were discussed.

The lack of primitive tools such as wires and angiocathres, markers, methylene blue, and before-after photography were other points extracted from the interviews.

Another issue raised by the interviewees was the lack of advanced equipment—such as cyberknife—as opposed to neighboring countries.

> *"For example, we could no longer use Iridium because they no longer gave us any, and we had to put away all the devices that functioned with it, despite being in order; just like a gun whose bullets can no longer be found." (Radiation oncologist)*
> *According to the interviews, brand devices are practically useless due to the unavailability of brand kits and the inability to match domestic kits with them.*

#### Low-quality imported materials

A shortage of materials such as brachytherapy and radiotherapy sources leads to behavioral changes among specialists because they are forced to obtain their required sources from small countries such as Ukraine, where the quality of the materials imported is unknown or low-quality materials are used instead.

#### High prices of materials

High costs, which increased fivefold during a short period, were the other major issue raised by experts. The sanctions have also slowed native and domestic solutions such as the production of biological, pharmaceutical, and immunotherapeutic products and the manufacture of domestic equipment. Without such restrictions, domestic brands may be available for patients and medical centers at competitive and cheaper prices. High prices also influence the use of advanced procedures such as targeted therapy and advanced devices:

> *"Advanced devices have become extremely expensive currently. The prices of endoscopy instruments are several times higher than before (Gastroenterologists)."*

**Table 2** Codes extracted from interviews explored the experts' perspectives on economic sanctions and cancer diagnosis and treatment in Iran

| Category | Sub-Category | Codes |
|---|---|---|
| Input | Instability in financing mechanisms and regulations | • *Stopping personalized medicine*<br>• *Money Transfer Problems and refusal to join the Financial Action Task Force*<br>• *Lack of access to required software due to money transfer problems*<br>• *Formation of intermediary companies in neighboring countries for money transfer*<br>• *Withdrawal of countries from working with Iran due to future consequences*<br>• *Unable to purchase laboratory equipment due to an unopened site*<br>• *In addition to that, due to airline sanctions, failure to send goods on time*<br>• *Two years of waiting for access to the newly purchased device* |
| | Shortage of materials | • *Difficulty in the quantity and variety of contrast materials*<br>• *Closure of vacuum biopsy devices due to lack of needles*<br>• *Lack of diagnostic kits and the most minor consumables including suture yarn*<br>• *Lack of diagnostic and therapeutic devices*<br>• *Lack of medicine.* |
| | Low-quality imported materials | • *Forced to supply required materials such as cobalt and iridium source from invalid sources with low-quality*<br>• *Low-quality imported contrast materials from non-reliable sources*<br>• *Using kits made from non-accredited brands to reduce access to trusted brands*<br>• *Use of Low-Quality Alternative Drugs*<br>• *Use of low-quality tools such as biopsy needles and staplers available* |
| | High prices of materials | • *Increased prices due to the increase in the mediators*<br>• *The devaluation of the country's currency due to sanctions, followed by a multiple-fold increase in the price of consumer goods and equipment* |
| | Loss of human resources | • *Reduced income of treatment teams and physicians' migration*<br>• *Anxiety and reduced motivation which results in suicides in some case* |
| process | Delayed care | • *Delay in diagnosis*<br>• *Missed time of treatment due to delayed access to medicine* |
| | Inadequate care | • *Decreased quality and increased diagnosis error (results are not good due to inaccuracy of stage of disease in pet deficiency)*<br>• *Transferring patients to the public sector. Due to financial limitations*<br>• *Exclusion of private centers from providing services and bankruptcy of immunohistochemistry centers*<br>• *Decrease in accuracy and quality of surgery*<br>• *Biopsy quality loss (lower quality biopsy needle, lack of radioactive substance)*<br>• *Withdrawal from Breast reconstruction due to prosthetic gravity* |
| | Non-adherence to guideline | • *Changing the chemotherapy protocol due to a lack of medication (having to remove the drug from the protocol)*<br>• *Impossible to apply knowledge of the day despite complete dominance*<br>• *Ovarian removal in cases of diferline deficiency*<br>• *Removing some surgical treatment steppes inevitably* |
| | Limited international collaborations | • *Inability to participate in international clinical trials*<br>• *Restricted access to articles, resources, and educational websites*<br>• *Limited possibility to participate in international conferences and even inviting foreign professors due to financial limitations and restrictions on money transfer."* |
| | Less Provider satisfaction | • *Emergence of unpleasant feelings in the diagnostic team (team morale decline)."*<br>• *Decrease in therapists' expectations of drug quality.*<br>• *Suffering from drug shortages at all stages of treatment*<br>• *Feelings of helplessness and torment due to the use of unconventional methods* |
| Output | Lower effectiveness | • *Lower Ineffectiveness due to using invalid drugs* |
| | More adverse events | • *Occurrence of adverse events following the prescription of invalid drugs*<br>• *Patient death due to the use of poor-quality blocking agents*<br>• *Liver perforation due to the use of low-quality tools."*<br>• *Loss of ovaries due to deficiency of defibrillin.*<br>• *Loss of anal sphincter due to lack of contour*<br>• *Tumor recurrence due to incomplete and inaccurate removal of tumor tissue.*<br>• *Patient harm due to the use of outdated equipment*<br>• *Surgeon forced to remove kidney and ureter due to stone formation following the use of inappropriate equipment*<br>• *Removal of a larger portion of tissue due to the inability to accurately mark the tumor* |
| | Increased equity gaps | • *Increase in out-of-pocket payments by patients*<br>• *Patients not seeking medical care and follow-up due to financial difficulties*<br>• *Migration of patients to Turkey due to long waiting times for diagnosis and treatment.* |

#### Loss of human resources

One surgeon addressed the reduced income of treatment teams and physicians' migration from Iran and said:

> *"Over a short period —i.e., the past 1–2 years— several nurses have migrated or are migrating just from the Cancer Institute. New students and residents are either migrating or have no motivation to join cancer treatment teams." (Surgeon)*

Other feelings perceived by the experts included anxiety and reduced motivation, which can result in suicide in some cases.

> *"Our residents are all frustrated. There has been an increase in the number of resident suicides; they are all disappointing. They say 'Where in the world can I get 2 billion (IRR) to buy ultrasonography equipment or 12 billion to buy radiology and mammography devices after graduation?!'" (Radiologist)*

### Process

#### Delayed care

Some of the interviewees argued that the sanctions—by increasing costs—have seriously restricted timely cancer screening, as required by guidelines. On the other hand, the lack of devices such as needles leads vacuum-assisted biopsy devices to be out of order and, consequently, to more delays and errors in the diagnosis and treatment of cancer patients. Another major reported issue was the influx of patients to the public sector due to the closure or withdrawal of bankrupt private centers, which triggered substantial delays.

> *"In practice, something that should take a week or two requires three to four months, increasing the risks. For example, telling a patient to wait for four months without treatment and to wait for the test results will become problematic" (Radiation oncologist).*

The same problem occurs with medicines for which physicians or patients refuse alternative medicines; they have to wait a long time for high-quality medicines and lose the golden time for treatment.

#### Inadequate care

The interviewees believed that sanctions from disruptions in diagnostic and therapeutic procedures such as pathology, disruption of patient follow-up processes, analysis of treatment effects, and cancer staging also deprived patients of up-to-date services. According to the interviewees, these problems resulted in suboptimal diagnoses. For example, the rapid increase in tumor staining has seriously decreased the quality of diagnosis.

> *"Sometimes, we could not find a marker, so we'd report that we cannot classify this type of cancer due to the unavailability of the relevant marker, which, naturally, would affect the treatment course and decisions" (Pathologist)*

According to the interviewees' opinions, sanctions have also hindered the development of personalized medicine.

> *"Unfortunately, in the field of research, we tend to choose trivial topics. However, the world is moving toward personalized medicine, gene therapy, and other innovative treatments that provide specific medicines for each disease" (Genetic)*

> *"When our oncologists see that patients don't have money, they don't always inform them of the best options, which can lead to emotional damage" (Oncologists)*

#### Nonadherence to guidelines

The interviewees explained that despite their knowledge of the latest practices, physicians are forced to resort to outdated protocols and sometimes recommend different treatments. For example, in some cases, they would use Indian ink instead of markers, and the impression of the ink would remain on the patient's breast.

> *"This is an absolute tragedy. The contrast material we use for MRI is only gadolinium, in situations where different contrast materials are currently used for each type of cancer and tissue. Several different types of contrast materials are used for the liver, but we have none of them" (radiologist)*

Deactivation of devices due to a shortage of parts and sources of Iridium and Cobalt were also mentioned in the interviews. At times, physicians are left with no choice but to find equivalents for radiotherapy. Replacing the cobalt source with the radioactive source in the brachytherapy device is another consequence of sanctions in this field.

> *"A gamma knife is a device that is been out of order for the past four years and was never repaired afterward." (Radiation oncologist)*

#### Limited international collaboration

Pathologists said that it is impossible to send kits to specialists abroad for consultations. In addition, oncologists mention limited international collaboration due to sanctions as a gap in their field.

> *"Our field is highly specialized and international, but students are not interested in it. As a result, they are unable to conduct new studies, and their communication with other professors is limited. They are also limited in the congresses where the radiotherapy group is placed and lose the training opportunities to update themselves" (Radiation Oncologist)*

> *"We are not a member of any global clinical trial, and Iran is excluded from all international studies due to sanctions." (Hematology-Oncology)*

#### Less provider satisfaction

The difficulties associated with device failure discourage specialists from providing the service in some cases. The participants expressed a sense of guilt over using devices with high complication rates, especially when working with children.

> *"Sometimes the specialist resorts to prayer every day, hoping that there will be no problems in the imaging process" (Radiologist).*

The surgeons reported many shortages of equipment, where they would sometimes have to adopt new methods to cover the shortages, since these methods were not standard such adoptions tortured them and made them feel helpless.

### Output

#### Lower effectiveness

Ineffective treatment and relapse due to the inferior quality or scarcity of imported medicines were other major issues raised by sanctions.

> *".... Sometimes we realize that the medication has had no benefits while creating numerous side effects. I remember that previously, Doxil was not like this. I am not talking about one company or another, but many of the drugs are not as effective as they are supposed to be" (Gynecologic Oncologist)*

#### More adverse events

Based on the interviewees' opinions, difficulty in acquiring high-quality surgical instruments has sometimes even led to organ loss.

> *"Good-quality catheters contain a certain non-precipitating substance, but the ones we use have poor quality, and in one case, it was calcified, and the surgeon could not remove it (catheter). Therefore, the kidney, ureter, and part of the bladder were removed. These are the catastrophes that are occurring currently." (Radiologist)*

> *"We have had cases where the guide wire had entered the liver and exited the duct and perforated the liver." (Gynecologic oncologist)*

> *"Unfortunately, I had to use Chinese staples in a patient; anastomosis leaks will likely increase in these cases." (Surgeon)*

The interviewees reported adverse events due to the low quantity or lack of suitable medicines and the low quality of the existing alternatives.

> *"For example, the contrast materials form crystals in the syringe. When it crystallizes in the syringe, it is going to be deposited in the human body as well, and you can imagine what may happen next. Once a tube was placed in the patient's kidney and bladder, it had turned into a stone due to substandard catheter quality" (Radiologist)*

> *".... We have reports of shock and death in patients due to contrast material injection for CT scans" (radiologist)*

The interviewees reported complications such as the use of extra procedures and surgery due to the absence of medications such as diphereline.

#### Increased equity gaps

Sanctions have resulted in increased out-of-pocket costs for patients, and immunotherapy has deprived patients of the benefits of the latest proven cancer treatment methods.

The high cost of drugs discourages patients from seeking or continuing treatment. For example, patients with breast cancer withdraw from reconstruction due to a lack of or very costly prostheses.

In some cases, patients resort to traveling to neighboring countries such as Turkey to use gamma knives and PET devices.

> *"Either the patient has to wait in the long line to reach what is necessary, or s/he has to go to Turkey." (Radiation oncologist)*

## Discussion

Based on our comprehensive findings, economic sanctions have significantly undermined the input, process, and output within the system responsible for delivering cancer diagnosis and treatment. Instability in financing mechanisms and regulations, shortage of materials, low quality of imported materials, high prices of materials, and loss of human resources were factors influencing the input of the system. In the process of the system, we experienced delayed care, inadequate care, nonadherence to the guidelines, limited international collaboration, and less provider satisfaction, which led to lower effectiveness, more adverse events, and increased equity gaps.

Instability in regulations and financing mechanisms was one of the most problematic issues experienced during economic sanctions, and in some cases, the companies involved did not provide the software and accessories needed to operate the devices properly, rendering the devices unusable in practice. Consistent with findings from other studies, medical matters, although not officially sanctioned, are still affected by secondary sanctions. These include restrictions on air transportation and financial transactions, making dealing with medical equipment companies exceedingly challenging. The processes of purchasing drugs and medical equipment, as well as shipping goods to and from Iran, have become lengthy, difficult, and risky procedures [12].

These mechanisms lead to a lack of consumables and nonconsumables in all aspects of cancer treatment and diagnosis, including surgery, from the use of sutures and biopsy needles to the use of more advanced products such as LigaSure, Harmonic scalpel, and Gamma Contour equipment. Additionally, it was difficult to match substituted consumables and internal kits with previously purchased branded equipment, rendering this equipment unusable. These problems have already been reported in a letter to the editor as well [8]. The same problems have been reported in Iraq under heavy sanctions [20].

Despite the efforts of healthcare specialists in the field of oncology, there are serious deficiencies in access to appropriate resources and healthcare services, including drugs, chemotherapy, and new medical technologies, which have disrupted the balance between supply and demand, which is in line with previous research [9]. Most of the aforementioned challenges in radiation oncology are related to shortages of brachytherapy and radiation sources, including cobalt and iridium, which is another area where economic sanctions have limited patient access to radiation therapy services. This issue has also been mentioned in previous studies [7, 21, 22]. Advanced radiotherapy techniques such as stereotactic body radiotherapy, intensity-modulated radiation therapy, and stereotactic radiosurgery, which are commonly used in developed and developing countries, do not exist in Iran, and the country's only Gamma Knife Centre is closed due to the unavailability of radioactive materials [21].

The lack of kits and sources such as technetium were some of the problems cited by participants in the field of nuclear medicine diagnosis. A study showed that the U.S. withdrawal from the Iran nuclear agreement, followed by economic, commercial, and financial sanctions against Iran, has had a devastating impact on nuclear medicine, according to available evidence, both in the supply of radioactive tracers and nuclear medicine supplies [12]; even domestically produced radio medicines that depend on imported raw materials have become severely deficient [12].

Shortage types of equipment, such as PET, MRI, and CT scanners, leave physicians with no choice but to use equipment with low diagnostic performance, as does brachytherapy (which needs radioactive sources), as they were forced to use old equipment because it was difficult to obtain new equipment for radiation treatment; moreover, the new equipment was also very expensive. Previous studies have shown that after the Joint Comprehensive Plan of Action (JCPOA) between Iran and the 5+1 group, the use of radiotherapy equipment improved briefly. Unfortunately, the U.S. pulled out of the agreement in May 2018, causing problems [21].

Sanctions indirectly caused an arbitrary increase in equipment prices by sharply reducing the value of the national currency. As a result, the inadequacy of tariffs relative to costs has created serious barriers to timely cancer screening (based on guidelines). Sanctions have affected health promotion and cancer prevention plans, as therapeutic plans are prioritized over prevention programs in times of economic crisis [23].

This imbalance between tariffs and costs also led to physicians' migration from Iran, increased levels of anxiety, and reduced motivation, which resulted in suicide in some cases. Although there is no direct evidence linking tariffs and costs to physician migration and suicides in Iran, understanding the broader effects of trade policies and economic conditions can provide insights into related issues. It is essential to consider the complex interplay between tariffs, costs, and their impact on various aspects of society, including healthcare professionals' well-being.

Delayed cancer diagnosis and treatment are among the most important processes influenced by economic sanctions. The unavailability of radiopharmaceuticals and diagnostic contrast media and their lack of variety can immediately delay cancer diagnosis. Nevertheless, studies in several countries confirm the severe effect of economic conditions on the delayed diagnosis of cancer, particularly gastrointestinal and gynecologic cancers, which require special attention [24]. Another challenge was the disruption of the immunohistochemistry department due

to the lack of equipment and high costs, which increased response time as fewer markers were used or more time had to be spent obtaining kits.

In the pathology and laboratory field, since the pathologist was forced to stain only a limited area of the tumor sparingly and to use lesser-known brands, a suboptimal diagnosis was made. A report in Iraq stated that sanctions-related bottlenecks resulted in 20% of pathology diagnoses yielding different results when re-evaluated by an Italian university. Due to the 20% error rate of pathology diagnosis, Pediatric oncologists in Iraq continue to believe that simply improving infrastructure and human resources is not enough, and addressing existing challenges also requires international collaboration with respected cancer centers [14]. Undoubtedly, special attention must be paid to pathology as a central component of cancer diagnosis and staging in the context of pretreatment as well as follow-up and analysis of treatment effects.

Periodic medicine shortages and fluctuations in access to medicines during the chemotherapy phase sometimes ruin the golden period of treatment. In some cases, delayed surgery was the consequence of a lack of anesthetics.

In the treatment phase, physicians were left with no choice but to use either less effective treatment protocols or nonadherence to guidelines. Similar issues have been reported in other countries, which led to an increase in the mortality rate of children with acute lymphoblastic leukemia in Iraq in 1990 following UN sanctions due to the use of less effective treatments [8].

The difficulties associated with device failure can indeed impact specialists' satisfaction. The surgeons' experience of adopting nonstandard methods due to shortages aligns with the challenges faced by healthcare providers. These adaptations can indeed cause feelings of helplessness and frustration. In summary, while there may not be direct evidence for every specific scenario mentioned, the broader context of provider dissatisfaction, coping mechanisms, and equipment shortages is well documented in the literature. Healthcare systems need to address these challenges to improve both patient outcomes and provider well-being [25].

The scarcity of high-quality surgical equipment, including staples, has resulted in limb loss for some patients. Moreover, the absence of essential medications such as diphereline has led to unnecessary procedures and surgeries. This situation was reminiscent of the challenges faced in Iraq during the eight-year occupation, where even basic medical supplies such as antibiotics, sutures, and anesthetics were difficult to obtain. The consequences of this scarcity included not only unnecessary surgeries but also increased complications. Interestingly, the historical context sheds light on a contrasting scenario. During the eight-year period of Iran-Iraq wartime, medical care remained efficient and up-to-date. However, when faced with sanctions, surgical conditions deteriorate significantly, falling far below acceptable standards. The stark difference between wartime efficiency and postsanction struggles underscores the critical role that access to medical resources plays in patient outcomes [20].

In emergencies with a lack of resources, radiologists are forced to use inferior contrast media, sometimes leading to adverse effects such as tissue crystallization and even death. Oncology experts explained that the high cost of drugs sometimes forces physicians to use less expensive drugs with more side effects. The impacts of sanctions include a wide range of complications, from death to complicated adverse events due to limited access to medications. A study in Iran showed that pediatric oncology is one of most affected by the impact because of the important role of nuclear medicine in its diagnosis and treatment [26].

There have been reports of increased recurrence due to inappropriate alternative suture products and/or dangerous complications due to a lack of anesthetics. A study in Iraq showed that during economic sanctions, the use of expired anesthetics resulted in postoperative fever, blood pressure fluctuations, and chest infections [20].

Increased equity gaps, imposed by economic sanctions, not only affect the way healthcare is provided but also impose a financial burden on individuals. They end up paying more for essential services and goods. Patients are forced to leave the private sector and switch to the public sector despite limited services or even discontinue treatment or follow-up due to livelihood problems. According to the literature, sanctions against Iran before 2015 also affected public health care by limiting access to health and reducing purchasing power for medicines and medical care [7]. The resulting financial strain on individuals can exacerbate existing health disparities and hinder equitable access to healthcare resources [25, 27].

There is no question that patients must not be victims of political dissent. Health must be treated as a human rights issue. All sanctioning authorities, banks, and companies are responsible for the humanitarian crisis in Iran, and sanctions must be lifted immediately to save the lives of cancer patients, improve the quality of diagnoses, and increase the quality of life of patients and their caregivers.

The results of the present study reflect only a small portion of the health problems that have resulted from economic sanctions against Iran. A complete picture of the extent and dimensions of this crisis can be obtained through further quantitative studies of the diagnostic and therapeutic care provided to patients in light of the consequences of the sanctions compared with the presanction period, including the prevalence of adverse effects,

stage at presentation and survival rate of cancer patients. Moreover, economic studies include direct and indirect medical costs imposed by sanctions.

Considering the far-reaching impact of the sanction, the qualitative method made it possible to determine more details about the effect of this policy on the diagnosis and treatment processes. Moreover, a clearer picture of the conditions was obtained by interviewing experts from different cancer diagnosis and treatment areas. To the best of our knowledge, this is the first study to address the issue of sanctions and cancer in Iran broadly. This study had also some limitations. Although purposeful sampling decreases the generalizability of the findings, we included participants from different specialties of both genders and from different parts of Iran to overcome this limitation to some degree.

In this study, we did not interview Ministry of Health stakeholders; however, some of the interviewees were key people in their field and were well-experienced. The coincidence of this research project with COVID-19 sometimes shifted the focus of discussions to the pandemic, which was handled by the interviewers' readiness to address the challenge. The sample was selected through convenience sampling, which may have introduced selection bias.

The study was conducted over a limited timeframe, which may not have captured the full range of experiences and perspectives of participants.

Researchers and policymakers should explore alternative solutions to mitigate the impact of economic sanctions on cancer diagnosis and treatment in Iran, such as developing domestic production of cancer medications or finding alternative sources of funding. Healthcare providers and policymakers should provide support to cancer patients and their families, including financial assistance, psychological support, and access to necessary medications and treatments. Further research is needed to fully understand the impact of economic sanctions on cancer diagnosis and treatment in Iran and to identify effective solutions to address these challenges.

We recommend evaluating experts' opinions through questionnaires developed based on the findings of the current study by type of cancer and specialty, with a larger and more generalizable sample sizeand using multiple data collection methods to triangulate the data, Moreover, Exploring the perspectives of other stakeholders, such as policymakers or family members is suggested.

## Conclusions

Although the economic sanctions imposed on Iran have not formally targeted health care or access to medicines, they have indirectly led to a significant increase in spending and limited access to and availability of facilities, resulting in serious problems in the provision of health care services to patients, particularly cancer patients. Sanctions can lead to delayed diagnosis, an increase in diagnostic errors, more side effects, and even death.

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12939-024-02335-9.

Supplementary Material 1

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### Author contributions

K.Z, H.R, L.H and A.A Conceptualized and designed the study. H.R, L.H, L.M, S.A, M.Sh, A.A, M.N, and N.B were involved in the Acquisition of data. H.R, L.H and A.Sh, L.M, and K.Z did the analysis and interpretation of data. H.R, L.H, and L.M drafted the manuscript. H.R and L.H supervised the study. All authors critically revised the manuscript for important intellectual content.

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### Data availability

No datasets were generated or analysed during the current study.

## Declarations

### Ethics approval and consent to participate

The study was approved by the Ethics Committee of the Tehran University of Medical Sciences (project code: IR.TUMS.IKHC.REC.1399.013). Participants were informed of the goals of the research, and verbal or written informed consent was obtained.

### Consent for publication

Not applicable.

### Competing interests

The authors declare no competing interests.

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## Publisher's note