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СУЧАСНИЙ СТАН КОГОРТ ПОСТРАЖДАЛИХ ВНАСЛІДОК ЧОРНОБИЛЬСЬКОЇ КАТАСТРОФИ ТА ДОСВІД МЕДИЧНОЇ ЕКСПЕРТИЗИ ЩОДО ВСТАНОВЛЕННЯ ПРИЧИННО-НАСЛІДКОВОГО ЗВ'ЯЗКУ ЗАХВОРЮВАНЬ, ЩО ПРИЗВОДЯТЬ ДО ВТРАТИ ЗДОРОВ'Я, ПРАЦЕЗДАТНОСТІ ТА СМЕРТІ, З ДІЄЮ РАДІАЦІЙНОГО ОПРОМІНЕННЯ Й ІНШИХ ШКІДЛИВИХ ФАКТОРІВ АВАРІЇ НА ЧОРНОБИЛЬСЬКІЙ АЕС

Вступ. Майже через чотири десятиліття після аварії на Чорнобильській атомній електростанції її медичні та соціальні наслідки й надалі потребують системного аналізу, зокрема в контексті медичної експертизи, спрямованої на встановлення причинно-наслідкового зв'язку між наслідками захворювань і радіаційним опроміненням, пов'язаним з аварією. У віддалений післяаварійний період медична експертиза відіграє ключову роль у національній системі соціального захисту, забезпечуючи юридично обґрунтовані висновки щодо втрати здоров'я, працездатності та причин смерті серед постраждалих контингентів.

Мета: вивчити та охарактеризувати чисельність і структуру категорій постраждалого населення (учасників ліквідації наслідків аварії та потерпілих) на підставі матеріалів Реєстру Національної соціальної служби України та експертних справ Центральної міжвідомчої експертної комісії Міністерства охорони здоров'я України у віддаленому післяаварійному періоді.

Матеріали і методи. Роботу виконано в дизайні ретроспективного дослідження з використанням даних Реєстру Національної соціальної служби України за 2008–2025 роки та матеріалів медико-експертних справ, розглянутих Центральною міжвідомчою експертною комісією МОЗ України у 2023–2025 роках. Аналіз експертної документації здійснювали із застосуванням системного підходу, що включав верифікацію діагнозів та оцінку медичних і немедичних параметрів відповідно до чинних нормативно-правових вимог. Використовували описові аналітичні методи.

Результати. Чисельність постраждалого населення характеризувалася стійкою довготривалою тенденцією до зменшення. Водночас обсяги медико-експертної діяльності залишалися значними. Провідне місце у структурі експертних висновків впродовж 2023–2025 років посідали онкологічні захворювання, далі – тяжкі хронічна неонкологічна патологія, насамперед цереброваскулярні та серцево-судинні захворювання з ускладненнями. Виявлено відмінності між показниками прижиттєвої та посмертної експертизи, що відображали особливості тяжкості перебігу захворювань і летальних наслідків, а не популяційний розподіл хвороб.

Висновки. У віддалений післяаварійний період медична експертиза, пов'язана з наслідками аварії на Чорнобильській АЕС, і надалі формується переважно онкологічними захворюваннями та прогресуючою хронічною патологією системи кровообігу, що призводить до значної втрати здоров'я, працездатності та смертності. Дані медико-експертних спостережень забезпечують специфічний і комплементарний аналітичний підхід до оцінки тривалих медичних і соціальних наслідків аварії та залишаються важливими для прийняття обґрунтованих рішень у системі охорони здоров'я тасоціального захисту.

Ключові слова: радіаційне опромінення; медична експертиза впливу іонізуючого опромінення; довготривалі наслідки для здоров'я; когорти постраждалих внаслідок аварії на ЧАЕС.

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THE CURRENT STATUS OF CHORNOBYL CATASTROPHE VICTIMS' COHORTS AND EXPERIENCE OF MEDICAL EXPERTISE FOR ESTABLISH CAUSATION OF DISEASE, LEADING TO LOSS OF HEALTH, DISABILITY AND DEATH WITH THE ACTION OF IONIZING RADIATION AND OTHER HARMFUL FACTORS OF THE CHORNOBYL NPP ACCIDENT

Introduction. Nearly four decades after the Chornobyl Nuclear Power Plant accident, its medical and social consequences continue to require systematic evaluation, particularly in the context of formal medical expertise aimed at certifying causal relationships between disease outcomes and radiation exposure associated with the accident. In the remote post-accidental period, medical expertise plays a central role within the national system of social protection, providing legally substantiated conclusions on health loss, disability, and causes of death among affected population.
Objective: to study and characterize the number and structure of affected population categories (clean-up workers and victims) based on materials from the National Social Service of Ukraine Register and expert cases of the Central Interdepartmental Expert Commission of the Ministry of Health of Ukraine (CIEC) in the remote post-accidental period.
Methods. A retrospective study was conducted using data from the National Social Service of Ukraine Register (2008–2025) and materials from medical expert cases reviewed by the Central Interdepartmental Expert Commission of the Ministry of Health of Ukraine during 2023–2025. Expert documentation was analyzed using a systematic approach, including verification of diagnoses and assessment of medical and non-medical parameters in accordance with current regulatory requirements. Descriptive analytical methods were applied.
Results. The affected population demonstrated a sustained long-term decline, primarily reflecting cohort ageing and administrative status changes. Despite this reduction, the volume of medical expertise activity remained substantial. Oncological diseases constituted the predominant category of expert assessments, followed by severe chronic non-oncological conditions, mainly cerebrovascular and cardiovascular diseases with complications. Distinct differences were observed between lifetime and postmortem expert assessments, reflecting variations in disease severity, clinical course, and fatal outcomes rather than population-level disease patterns.
Conclusions. In the remote post-accidental period, medical expert assessments related to the Chornobyl accident continue to be dominated by malignant neoplasms and advanced chronic diseases of circulatory system leading to significant loss of health, increasing disability and mortality. Expert-based data provide a specific and complementary perspective on the enduring medical and social consequences of the accident and remain essential for informed decision-making within the national system of health protection and social support.
Key words: radiation exposure; medical expertise of radiation effect; long-term health effects; Chornobyl survivor cohorts.

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INTRODUCTION

The accident that occurred on April 26, 1986 at the Chornobyl Nuclear Power Plant (ChNPP) is considered one of the largest man-made and environmental catastrophes in world human history. The fourth power unit, which contained about 192 tons of nuclear fuel, was completely destroyed and significant part of the radioactivity accumulated in the reactor (45–80 million curies) went beyond the industrial site and got into the environment. [1].

Due to the ChNPP accident in Ukraine, 1986, the largest man-made disaster in human history, 3,259,761 citizens of Ukraine and 2,293 settlements were affected.

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High levels of morbidity and mortality of ChNPP survivors from chronic circulation diseases and oncological pathology with quick reducing their number during last 15 years were described and shown [1, 2].

One of the key issues to minimize the consequences of the ChNPP accident became the problem of medical expertise of survivors for establish the causal relationship of disease that became the reason of loss of health, disability and death with the effect of ionizing radiation and the ChNPP accident consequences [1, 2]. The basis of social protection of the Chornobyl accident survivors is the Law of Ukraine «On status and social protection of citizens affected by the Chornobyl catastrophe» ratified by the Verkhovna Rada (Ukrainian Parliament) on April 1, 1991 [3]. The 12th Article of this low is dedicated to «Establishing a causal link between the disease connected to the Chornobyl catastrophe, partial or complete disability of survivors affected by the Chornobyl catastrophe and the Chornobyl catastrophe». Of significant influence on making decisions in this issue are also articles 2, 14, 27 of these documents [3].

According to the Article 13th of this law, The State assumes responsibility for the damage caused to citizens and undertakes to compensate for it for: 1) damage to health or loss of working capacity by citizens and their children who suffered as a result of the Chornobyl catastrophe; 2) loss of a breadwinner, if his death is related to the Chornobyl catastrophe [3].

According to the decision of Government Commission № 539 from August 13, 1988 in agreement with the Trade-Unions and Goskomtrud of former USSR the order of Ministry of Health (MOH) No 731 from September 28, 1988 was issued «On the organization of the Central Interdepartmental Expert Council to establish causation of disease and disability with the works at the aftermath of ChNPP accident and their professional nature at the All-Union Research Center for Radiation Medicine Academy of Medical Sciences» [4].

On the November 23th 2011, by the 3rd paragraph of the Cabinet of Ministers of Ukraine governmental regulation № 1210 «On improvement of the level of social protection of citizens who suffered as a result of the Chornobyl catastrophe» [5] the activity and regulation of medical expertise reason of loss of health, disability and death with the effect of ionizing radiation and the ChNPP accident consequences were reformed. Today the procedure of expertise is regulated by the jointly Order of the MOH and Ministry of Emergencies of Ukraine № 789,1248 dated 10 October 2012 «On Amendments to the Order of the MOH of Ukraine and the Ministry of Emergencies of Ukraine on May 30, 1997 № 166/129» [6]. The certification of interdependence between the diseases bring to health loss, disability and death with the Chornobyl accident as result of radiation exposure and other harmful factors today is regulated by the Order of the MOH of Ukraine № 441 dated 14 July 2012 «On Amendments to the Order of the MOH of Ukraine № dated 17 May 1997» [7], that containing the list of diseases for which this interdependence can be certified and instructions for its application.

The «Regulation on expert teams for assessing the daily functioning of a person», approved by the Decree of the Cabinet of Ministers of Ukraine dated November 15, 2024 No. 1338 (with additions and clarifications set out in the Decrees of the Cabinet of Ministers of Ukraine dated December 27, 2024 No. 1542 and January 28, 2025 No. 94), namely paragraphs 6, 7, 8, recognizes and defines the need for «expert conclusions on the causal relationship of the disease with the Chornobyl catastrophe» [8].

OBJECTIVE

To study and characterize the number and structure of the affected categories (clean-up workers and victims) of the Chornobyl catastrophe based on the materials of National Social Service of Ukraine Register and expert cases of the Central Interdepartmental Expert Commission of the Ministry of Health of Ukraine (CIEC) in the remote post-accidental period.

MATERIALS AND METHODS

The work was performed in the design of a retrospective study that based on studying of National Social Service of Ukraine Register 2008–2025 years and the 15,051 expert cases, which were considered by CIEC during 2023–2025 to establish a causal relationship between the development and progression of disease that leads to disability and death and influence of radiation exposure and other harmful factors and conditions during ChNPP accident using a systematic analytical approach to assessing the medical and nonmedical parameters presented in medical expert documentation.

In accordance with the requirements of current regulations, the materials of expert cases included documents confirming the status (category) of the victim, passport data and information about the place of residence, professional history and experience, medical documentation regarding health before and after the

ChNPP accident, results of outpatient and inpatient examination and treatment (if necessary – the results of morphological examinations, in case of death – autopsies), also a certificate of permanent disability [6, 7]. The analysis of every case was performed under the condition of the diagnosis verification by the members of the expert group, approved by the voting protocol of the CIEC members.

RESULTS

On 01.07.2025 the status of survivors of the Chornobyl Catastrophe in Ukraine had 1,468,212 persons, including 256,187 children (Table 1).

The total number of adult survivors as on 01.07.2025, compared to 2008, decreased by 581,170 persons, or by 33.93 % (from 1,834,536 to 1,212,025 persons).

During 2008–2025, the number of clean-up workers of the accident decreased from 276,327 to 142,384, or by 133,943 people (48.47 %), that means – during the last 17 years, almost every third-second participant in the liquidation of the consequences of the accident at the ChNPP died.

The number of adult victims decreased from 1,558,209 in 2008 to 1,099,968 in 2025, or by 29.41 % (458,241 persons). The number of children affected by the ChNPP accident has decreased from 534,568 in 2008 to 256,187 in 2025, or by 278,381 (52.07 %). Regarding the reduction of the number of this category, it is necessary to take into account the loss of the status of victims by children upon reaching the age of majority according to the current legislation.

It is impossible to miss the characteristics of the victims of the ChNPP accident such a painful and socially important indicator as 43,234 people who have the status of wife / husband of the deceased citizen whose death was related to the Chornobyl Catastrophe.

Reducing the number of all categories of victims of the Chornobyl NPP accident for the period of 2007–2025 years shown at Figure 1.

Category 1 of victims of the accident at the Chornobyl NPP is the most critical in terms of loss of health and work availability, as it consists of persons who have the status of victims of the accident at the Chornobyl NPP and have lost work capacity due to diseases for which has been established a causal relationship with the impact of the consequences of the ChNPP accident (Fig. 2).

During the period 1995–2014, there was an increase in the number of victims of category 1 (from 86,775 to 117,158). During 2015–2025, there is a gradual decrease in the number of victims of this category from 113,268 on January 1, 2015 to 98,309 on July 1, 2025 (Figure 2).

This study analyzed 15,051 expert cases considered by the CIEC during 2023–2025: 5,837 expert deci-

Table 1

The number of people who have the status of affected under the Chornobyl Catastrophe on July 1, 2025

Name of indicators	Number
total number of survivor persons:	**1,468,212**
of them:	
➤ **clean-up workers of the Chornobyl NPP accident:**	**142,384**
including the following categories:	
Category 1 А from the number of clean-up workers of the Chornobyl NPP accident (persons with disabilities – invalids):	**45,666**
I group of disability	1,829
II group of disability	29,617
III group of disability	14,220
category 2 А from the number of clean-up workers of the Chornobyl NPP accident	**76,657**
category 3 А from the number of clean-up workers of the Chornobyl NPP accident	**20,061**
➤ **victims of the Chornobyl catastrophe:**	**1,069,641**
including the following categories:	
category 1 Б from the number of victims of the Chornobyl catastrophe (persons with disabilities (invalids):	**52,643**
I group of disability	2,879
II group of disability	27,852
III group of disability	21,912
category 2 Б from the number of victims of the Chornobyl catastrophe	**45,306**
category 3 Б from the number of victims of the Chornobyl catastrophe	**320,855**
category 4 В from the number of victims of the Chornobyl catastrophe	**649,664**
category 4 Г from the number of victims of the Chornobyl catastrophe (persons who worked outside the exclusion zone in particularly harmful working conditions – ionizing radiation and open sources of ionizing radiation)	**1,173**
Series category «Д» (victim children)	**256,187**
category «Д» with disabilities (children-invalids):	972

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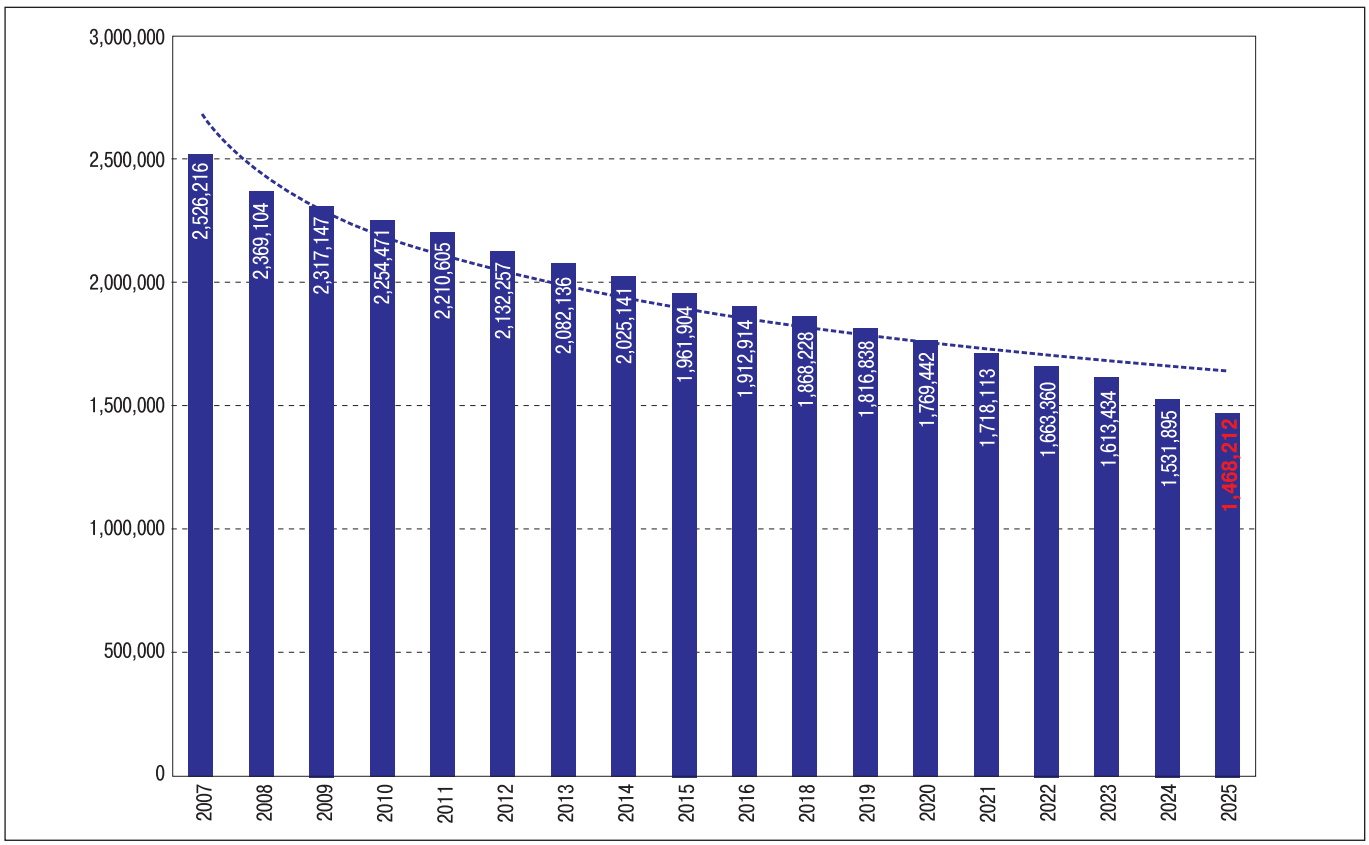

Figure 1. **Reducing the number of all categories of victims of the Chornobyl NPP accident for the period of 2007–2025 years**

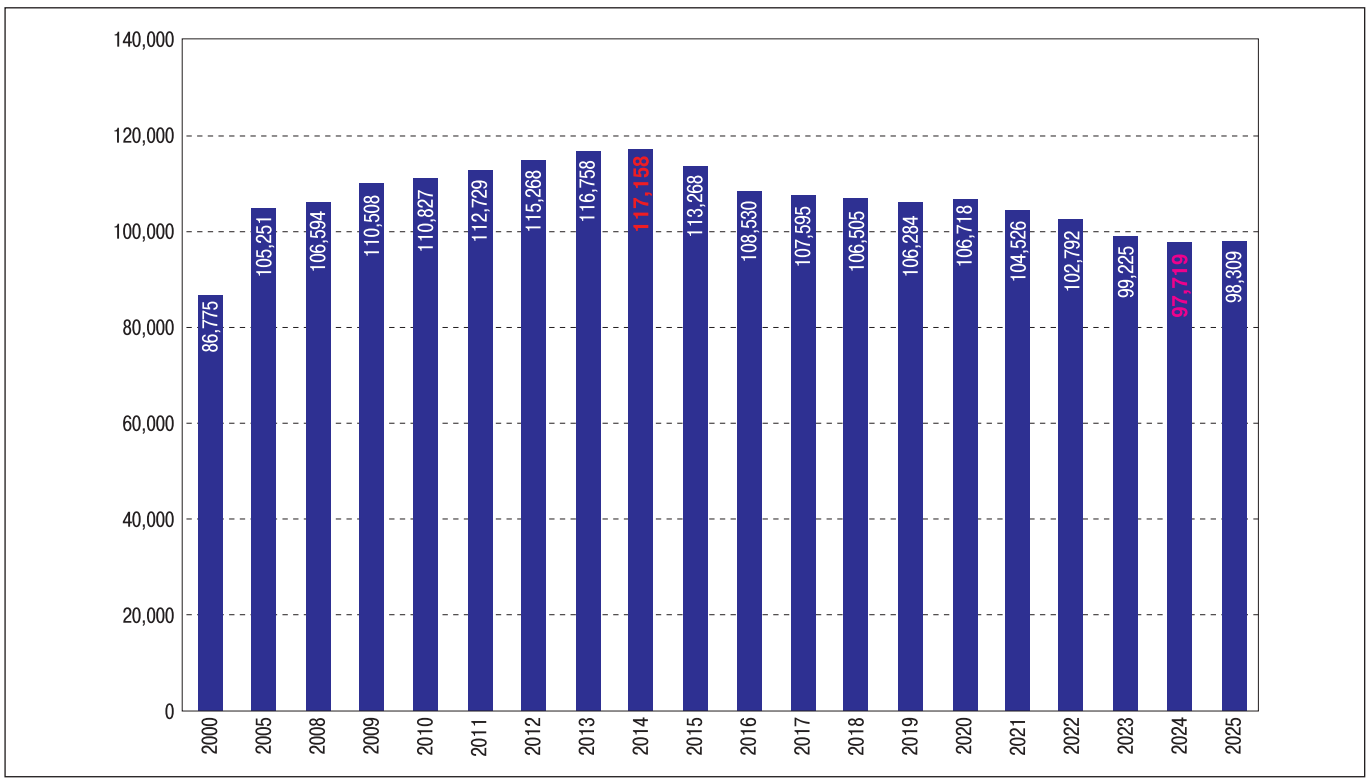

Figure 2. **Dynamics of the number of ChNPP accident victims of the 1st category during 2000–2025 years**

sions were provided in 2023, 5,403 in 2024, and 3,810 in 2025. A notable characteristic of the analysed sample is the high proportion of individuals with oncological diseases. According to the data obtained, 8,669 patients (57.6 %) had oncological pathology, while 6,382 individuals (42.4 %) belonged to the group with

Table 2

Structure of nononcological lifetime and postmortem expert cases (2023–2025)

Class of nosological forms	Lifetime expert cases		Postmortem expertise cases	
	number of cases (n=4,473)	portion (%)	number of cases (n=1,909)	portion (%)
Chronic diseases of cerebrovascular system with complications	2196	49.1	951	49.8
Chronic diseases of cardiovascular system with complications	1807	40.4	865	45.3
Chronic diseases of respiratory system (COPD, BA)	139	3.1	40	2.1
Diseases of thyroid gland	107	2.4	9	0.5
Diabetes mellitus, type II with complications	81	1.8	23	1.2
Other diseases	143	3.2	21	1.1

non-oncological pathology. Portion of postmortem expertise consisted of 3,973 medical cases: oncological pathology – 2,064 cases (51.95 %), non-oncological pathology – 1,909 cases (48.05 %).

Information on the distribution of major chronic diseases within the framework of intra-life and postmortem examination of cases regarding the association of diseases with the effects of ionizing radiation and other harmful factors of the Chornobyl catastrophe is presented in Table 2. A significant predominance of cerebrovascular and cardiovascular diseases and their complications was established. Chronic diseases of the cerebrovascular system and cardiovascular system with complications represent the largest share for lifetime expert cases 49.1 % and 40.4 %, respectively, postmortem cases – 49.8 % and 45.3 %, respectively. This highlights the significant burden of chronic vascular pathology with complications in the studied population.

Chronic diseases of the respiratory system, including chronic obstructive pulmonary disease (COPD) and bronchial asthma (BA), constitute a smaller fraction, with 3.1 % and 2.1 % respectively, reflecting their relative frequency.

Diseases of the thyroid gland and type II diabetes mellitus with complications are less common but notable, with proportions ranging from 0.5 % to 2.4 %, suggesting their clinical relevance in the cohort.

The category «Other diseases» aggregates less frequent conditions, representing 3.2 % of lifetime expert cases and 1.1 % of postmortem cases.

Such data corresponding with our [9] and other authors previous studies [10] and may be useful for determining health care priorities, resource allocation, and further research on the burden of diseases and outcomes in the studied population.

Table 3 illustrates the distribution of oncological diagnoses evaluated within the framework of lifetime and postmortem expert assessments during the study period. Overall, the spectrum of malignancies reviewed by the expert commission was dominated by cancers traditionally associated with high incidence in older populations, including prostate, colorectal, breast (in women), thyroid, stomach, and lung or upper respiratory tract malignancies.

A broadly similar diagnostic profile was observed in both lifetime and postmortem expertise; however,

Table 3

Structure of oncological lifetime and postmortem expert cases (2023–2025)

Class of nosological forms	Lifetime expert cases		Postmortem expertise cases	
	number of cases (n=6,605)	portion (%)	number of cases (n=2,064)	portion (%)
Oncohematological diseases	139	2.1	112	1.7
Lung and upper respiratory tract cancer	575	8.7	746	11.3
Thyroid cancer	938	14.2	475	7.2
Stomach cancer	667	10.1	898	13.6
Liver cancer	53	0.8	79	1.2
Pancreatic cancer	152	2.3	317	4.8
Colon cancer	1083	16.4	1017	15.4
Prostate cancer	1162	17.6	1091	16.5
Breast cancer (women)	1024	15.5	938	14.2
Cancer of the uterus and ovaries	185	2.8	178	2.7
Kidney and urine bladder cancer	172	2.6	344	5.2
Skin cancer	271	4.1	7	0.1
Skin melanoma	72	1.1	238	3.6
Brain tumors	112	1.7	165	2.5

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notable qualitative differences in their structure were evident. Postmortem expert assessments were relatively more frequently associated with malignancies characterised by aggressive clinical course and higher mortality, such as stomach, lung and upper respiratory tract, pancreatic, renal and urinary bladder cancers, as well as malignant melanoma and brain tumours. In contrast, lifetime expertise more commonly involved malignancies with comparatively favourable survival or prolonged clinical trajectories, including thyroid cancer and non-melanoma skin cancer.

These differences suggest that the type of expert assessment is influenced not only by the presence of oncological disease itself, but also by its clinical severity, prognosis, and the circumstances under which causal attribution is required. Consequently, postmortem expertise appears to reflect a case mix skewed towards rapidly progressive or fatal malignancies, whereas lifetime expertise more often encompasses cancers detected and managed over extended periods.

Importantly, the data presented in Table 3 should not be interpreted as population-based incidence or mortality rates. Rather, they represent the structure of oncological conditions submitted for medico-legal expert evaluation, shaped by referral patterns, legal requirements, and the specific aims of causation assessment in the context of long-term consequences of the Chornobyl catastrophe.

DISCUSSION

The present study extends a series of systematic analyses devoted to the long-term medical and medico-legal consequences of the Chornobyl catastrophe, focusing on the structure of expert assessments performed in the remote post-accidental period. In contrast to population-based epidemiological investigations, this work addresses a distinct but highly relevant domain – medical expertise aimed at establishing a causal relationship between disease, disability, or death and exposure to ionizing radiation and associated harmful factors.

The predominance of oncological diseases within the overall structure of expert cases observed in the current analysis is fully consistent with earlier reports based on materials of the Central Interdepartmental Expert Commission covering previous years. Analyses of expert documentation for 2013–2023 demonstrated that malignant neoplasms constituted the leading cause of disease, disability, and death requiring causation assessment, exceeding half of all reviewed cases, while chronic diseases of the cardiovascular and cerebrovascular systems formed the second most significant group. This pattern has been remarkably stable over time, despite the ongoing reduction in the total number of registered Chornobyl catastrophe survivors, reflecting the ageing of the cohort and the cumulative burden of severe chronic pathology [11].

A similar structure was reported in the analysis of postmortem expert cases for 2013–2024, where oncological diseases accounted for more than half of all determinations of causes of death, followed by chronic circulatory diseases and their complications. Importantly, those studies highlighted that postmortem expertise disproportionately involved individuals with advanced or decompensated disease courses, particularly among survivors of the first category, for whom a causal relationship with the consequences of the Chornobyl NPP accident had already been formally established during life [2].

Within the oncological spectrum, the dominance of prostate, colorectal, breast, thyroid, stomach, and lung or upper respiratory tract cancers observed in the present study closely mirrors the nosological profiles described in earlier expert-based analyses. Previous investigations of oncological postmortem expert cases identified oncohematological malignancies, colorectal cancer, breast cancer in women, prostate cancer in men, and lung cancer as the leading causes of death submitted for causation assessment. This concordance supports the interpretation that the current findings reflect a stable medico-legal disease profile rather than short-term fluctuations or artefacts of case selection [2].

Differences between lifetime and postmortem expert assessments observed in the present analysis – particularly the relatively higher representation of aggressive and highly lethal malignancies in postmortem expertise – are also in line with previous observations. Earlier studies emphasised that postmortem expert cases are shaped not only by disease occurrence but by clinical severity, rapid progression, and fatal outcomes, which necessitate formal determination of causation after death. Conversely, lifetime expertise more frequently encompasses conditions with longer clinical trajectories, during which disability status and causal attribution are established while the patient is alive [11].

Taken together, these findings reinforce the concept that medical expertise data constitute a specific analytical layer, complementary to epidemiological surveillance. They provide insight into the diseases that

most often lead to loss of work capacity and death among Chornobyl Catastrophe survivors and, consequently, require formal medico-legal evaluation within the social protection system. The persistence of oncological and chronic circulatory diseases as dominant reasons for expert assessment underscores their central role in shaping long-term medical, social, and legal consequences of the Chornobyl NPP accident in the remote post-accidental period.

CONCLUSION

In the remote post-accidental period, the structure of medical expert assessments related to the Chornobyl Catastrophe reflects a persistent dominance of oncological and severe chronic non-oncological diseases as the principal causes of loss of health, disability, and death requiring formal causation certification. Despite the substantial long-term reduction in the number of registered survivors, the demand for medico-legal expertise remains considerable and is increasingly shaped by age-related, progressive pathology with high clinical and social significance. The present findings confirm the stability of this expert-based disease profile over time and underline the specific role of medical expertise data as a complementary source of evidence for understanding the enduring medical and social consequences of the Chornobyl NPP accident.

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Conflict of interest

The authors confirm that this article is original, has not been published previously in whole or in part, and is not currently under review elsewhere. The authors also declare that there are no financial or other relationships that could cause a conflict of interest with respect to the content of this article.

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