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Review Article

Medicalisation and Postmemory: The Case of Nuclear Power Plant Accidents in Chernobyl and Fukushima

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Abstract

Background: The process of medicalisation is an increasingly common phenomenon, consisting of the interpretation of social life phenomena in medical terms.
The aim of this study was to present the relationship between medicalisation and postmemory in the context of nuclear power plant accidents in Chernobyl in 1986 and Fukushima in 2011.
Material and methods: A thematic analysis of cross-disciplinary academic literature and educational resources was conducted, with sources selected to provide a representative overview of both the radiological data and the sociological shifts in public perception over nuclear disasters.
The study focused on the influence of narratives about these events on the perception of their health consequences and on the formation of postmemory among individuals without direct involvement in the disasters.
Results: The results indicate that the social perception of risks associated with nuclear energy is shaped by social and cultural discourse and memory transmission, rather than solely by medical evidence.
Conclusion: The medicalisation of the consequences of nuclear disasters contributes to the persistence of a negative image of nuclear energy in society.

Keywords: medicalisation, postmemory, Chernobyl, Fukushima, nuclear energy, radionuclides, risk perception

1. Introduction

Research on medicalisation has been conducted since the 1970s. Initially, medicine was reduced solely to the medical profession, which constituted its dominant component. Over time, researchers’ interest expanded to include institutions involved in broadly understood health [1].

With the development of science and social changes, the approach to various conditions and behaviours has also evolved, and they have increasingly been classified as diseases or disorders. Conrad, a sociologist of medicine, indicates that the scope of phenomena considered medical has gradually expanded. Conditions such as obesity, alcoholism, attention deficit hyperactivity disorder, chronic fatigue syndrome, and post-traumatic stress disorder were not previously regarded as diseases [2].

Słońska and Misiuna define medicalisation as “a process that assigns extensive areas of life to the jurisdiction of medicine, ranging from the control of normal bodily functions to political, moral, and social issues” [3]. In this approach, phenomena previously considered non-medical begin to be defined and perceived in medical terms. This process most often concerns problems interpreted as diseases or disorders. The process of medicalisation is now so widespread that elements of medical discourse can be found in many areas of life [2,4]. Reverse processes, referred to as demedicalisation, are also observed, although on a smaller scale. Examples include masturbation [5], hysteria [6], and homosexuality [2,7]. The definition of hysteria has changed, and the historical concept has been replaced by more precise diagnostic categories, such as conversion disorders or functional neurological disorders [6]. The approach to masturbation has also changed, as it is no longer classified as a disorder. An exception includes situations involving a loss of control over sexual behaviours and their impact on functioning, which may be classified as compulsive sexual behaviour disorder in current diagnostic systems [5].

The analysis of these cases indicates the variability of the ways in which particular phenomena are defined and interpreted over time.

At the same time, socio-economic changes drive the development of technology and science. In healthcare, this results in efforts to standardise medical procedures, often by adopting models developed in the United States, where systems of standardisation are particularly advanced [8].

A traditional assumption of medicalisation is that medicine is based not only on empirical research but also on historical experience. As knowledge expands, it increasingly encompasses broader areas of social life that were previously not the focus of medicine. This contributes to the expansion of medical institutions and practices, supported by economic and social conditions [4,9,10].

1.1. Aim of the study

The aim of this study was to present the relationships between sociological aspects, including medicalisation and postmemory, and nuclear energy-related phenomena. This article attempts to address how postmemory practices relate to the disasters in Chernobyl and Fukushima. The study sought to present the most important facts related to both events as well as their long-term social and health consequences.

The formation of knowledge about these disasters results from the overlap of disciplines within both the natural sciences and the humanities. It should also be emphasised that this knowledge is not entirely objective, but remains shaped by social, cultural, and interpretative contexts.

2. The Chernobyl Disaster and Medicalisation

On 26 April 1986, a failure occurred in one of the reactors of the Chernobyl nuclear power plant, located in the territory of the then Ukrainian Soviet Socialist Republic. As a result of violations of safety procedures, design flaws of the reactor, and operator actions, a rapid increase in reactor temperature above critical levels occurred. The direct cause of the accident, and subsequently the explosion, was the shutdown of the reactor cooling system. The reactor was destroyed by two explosions, followed by a graphite fire that lasted for approximately 10 days, leading to the release of large amounts of radioactive substances into the environment. As a result, 8.9% of the territory of Ukraine suffered environmental contamination [11,12].

It is estimated that approximately 6 million people in Ukraine, Belarus, and Russia lived in areas classified as contaminated (>37 kBq $^{137}Cs\ m^{-2}$), while in areas with higher levels of contamination (>555 kBq $^{137}Cs\ m^{-2}$), there were 640 settlements inhabited by approximately 270,000 people [12–14].

The prolonged concealment of the disaster by the authorities of the Soviet Union contributed to an increase in its negative consequences. The scale of the event was only revealed after elevated radiation levels were detected by monitoring systems in Western European countries. Immediately after the disaster, deaths were reported among power plant workers and emergency responders due to acute radiation syndrome; approximately 30 individuals died shortly after the incident [14]. It is estimated that around 350,000 people were resettled due to contamination, 4.5 million people lived in contaminated areas, and approximately 150,000 individuals became radiation-related invalids [15].

Medical interventions following the disaster primarily involved providing care to individuals directly affected by the explosion and subsequently treating those with symptoms of acute radiation syndrome. Cases of acute radiation syndrome were diagnosed among power plant workers and emergency responders, some of which resulted in death shortly after exposure [14,16]. Long-term health monitoring was also conducted among exposed individuals and their family members to enable early medical intervention if necessary [12,16].

To this day, studies are conducted on individuals without direct involvement in the disaster. It has been suggested that extended monitoring is not always necessary and may even lead to unintended social and psychological consequences [14,17].

Despite the lack of consistent evidence of significant health effects in the general population, health monitoring of individuals living in areas affected by the disaster or indirectly related to it is still ongoing [14,18,19]. This contributes to the creation of an atmosphere of nuclear threat, which in turn influences the social perception of nuclear power plants as a potential source of danger [18].

At the same time, long-term health monitoring after a nuclear disaster can constitute an important element of public health policy. It is particularly relevant when its aim is to detect delayed health effects of radiation exposure, provide care for high-risk groups, and support populations affected by the disaster [14,17,19]. Therefore, health surveillance itself should not be automatically regarded as an example of medicalisation.

The boundary between public health surveillance and medicalisation becomes problematic in several situations. This applies primarily to long-term follow-up conducted on a large scale among asymptomatic individuals or low-risk populations, despite limited expected benefits. The problem also arises when potential radiation exposure alone becomes a sufficient reason for including an individual in medical monitoring. A similar effect may occur when health surveillance reinforces anxiety and the perception of affected individuals as biologically vulnerable or permanently at risk of disease [14,17,18].

From this perspective, the medicalisation of the Chernobyl disaster does not consist in monitoring itself. Rather, it refers to the expansion of medical categories and practices beyond clearly justified, evidence-based risk assessment. In this way, a technological and environmental event is transformed into a persistent medical and social framework of interpretation [10,18].

Against this background, medical discourse became one of the main ways of interpreting the social consequences of the disaster. Expanded health monitoring and long-term population studies conducted in subsequent years further reinforced the perception of a widespread threat associated with nuclear energy [18]. Other studies indicate that, after nuclear disasters, not only direct radiation-related health effects but also long-term psychological and social consequences are important [20].

2.1. Postmemory of the Chernobyl Disaster

One of the components of postmemory shaping contemporary perceptions of the Chernobyl disaster is the empirical dimension. The maintenance of memory about these events, as well as the shaping of their perception among individuals who had no direct involvement in the accident, occurs, among other means, through educational materials. It has been indicated that the perception of radiation risk is shaped not only by scientific data, but also by social and communicative factors, leading to discrepancies between expert assessments and public perception [21,22].

A qualitative analysis of history textbooks intended for Belarusian and Ukrainian students revealed that the dominant discourse follows a postmemory strategy that marginalises these events. The Chernobyl disaster is often presented merely as a point on a timeline, and in some publications, it is entirely omitted [21]. It has been shown that such pedagogical approaches may lead to the “neutralisation” and suppression of difficult memories associated with the disaster, particularly among young people, in whom psychological effects of the Chernobyl disaster have been observed [23].

At the same time, annual commemorations and marches dedicated to the disaster and its victims are organised in Ukraine. The largest of these is the “Chernobyl March”, a recurring event involving concerts and numerous public speeches. This constitutes an example of the pragmatic dimension of postmemory, influencing the way it is shaped among younger generations and emphasising the human dimension of this tragedy [21].

2.2. Medicalisation and postmemory in Poland

The Chernobyl reactor accident had a profound impact on Polish society, becoming a major factor in shaping the medicalisation of fear and postmemory. The direct consequences of the disaster reached the country on April 28, 1986, when, in the morning hours, the monitoring station in Mikołajki recorded a background radiation increase of over half a million times normal levels. Within just an hour of these readings being transmitted, an emergency was declared by the Central Laboratory for Radiological Protection (CLOR) in Warsaw, and on the night of April 28–29, a population protection strategy was developed. The mass administration of stable iodine in the form of Lugol's solution was recommended to prevent the absorption of the radioactive iodine-131 isotope by the thyroid gland. Initially, the campaign targeted children and adolescents in 11 northeastern provinces, directly affected by the radioactive cloud, but just a day later, it was expanded to encompass the entire country [24].

In an interview years later, Prof. Zbigniew Jaworowski, the initiator of this action, admitted that from a medical standpoint, the mass administration of the preparation was unnecessary, as the contamination did not reach health-threatening levels. It has been noted that this decision was primarily driven by widespread panic, misinformation, and a critical lack of reliable data regarding the actual scale of the event [25]. From a sociological perspective, however, this nationwide intervention led to the immediate medicalisation of the crisis. Instead of remaining a purely physical problem, the radiation threat became a tangible biological experience, which permanently altered the public's attitude toward nuclear energy. A direct consequence of this was the suspension of the Żarnowiec nuclear power plant construction in 1989. The strength of the postmemory formed in this way is evidenced by the public reactions in 2014, when news of a reactor shutdown in Zaporizhzhia, Ukraine, triggered widespread media anxiety, reviving deeply rooted fears of a Chernobyl catastrophe repeat [24,25].

3. The Fukushima Daiichi disaster

The disaster at the Fukushima Daiichi nuclear power plant, triggered by a massive earthquake on March 11, 2011, highlights a completely different dimension of crisis medicalisation. At the time of the tremor, six boiling water reactors were operating at the site, half of which had already been shut down for maintenance. The remaining three, operating at full capacity, were properly shut down through the automatic insertion of control rods. The critical moment proved to be the arrival of a 10-meter tsunami wave, which easily overcame the defenses designed for six-meter waves. The influx of seawater flooded the rooms housing the motors powering the cooling pumps, leading to a total loss of emergency power.

Due to the lack of cooling and the decay heat generated by isotopes, the reactors experienced a drastic increase in temperature and pressure, ultimately resulting in core meltdowns. This cascade of events triggered a series of explosions: on March 12, a hydrogen explosion destroyed the upper part of the Unit 1 reactor building, and two days later, a similar explosion occurred in Unit 3. On the afternoon of the same day, a significant pressure drop was recorded in Unit 2, clearly indicating a containment breach and the subsequent release of radioactive compounds into the environment [26]. The scale of the accident and the mass evacuation forced the healthcare system to shift its priorities. Instead of treating the direct effects of radiation exposure, Japanese medical infrastructure was forced to address a rising wave of cardiovascular diseases, metabolic disorders, and anxiety conditions. In this way, it was primarily the trauma of displacement that underwent medicalisation, requiring physicians to manage the chronic health issues of a population that had lost their sense of stability overnight [20,27].

4. Comparison of the Fukushima Daiichi and Chernobyl Nuclear Disaster

Although both the Chernobyl and Fukushima nuclear disasters were classified as level 7 on the INES scale, they exhibited fundamental differences in their accident mechanisms, the specific radionuclides released, and the subsequent nature of environmental contamination. [28,29]. In Chernobyl, the RBMK (reaktor bolshoy moshchnosti kanalnyy) reactor suffered rapid core destruction, followed by a graphite fire, which resulted in the release of volatile radionuclides such as ^{131}I, ^{134}Cs, and ^{137}Cs, as well as less volatile fuel components, including ^{90}Sr and plutonium isotopes.

Conversely, in Fukushima, the disaster resulted from the loss of power and cooling caused by the earthquake and tsunami, which led to core meltdowns of three reactor units and the release of primarily volatile radionuclides into the atmosphere. Comparisons based on UNSCEAR data indicate that the releases of ^{131}I and ^{137}Cs from Fukushima amounted to approximately 7% and 10% of the releases observed for Chernobyl, respectively (Table 1) [26,29,30].

As a consequence of the different trajectories of these two disasters, the spatial extent of radionuclide deposition differed. For example, the area heavily contaminated with ^{137}Cs was more than ten times larger around Chernobyl than around Fukushima Daiichi. For deposition levels of 555–1480 kBq m^{-2}, it was 7200 km^2 and 495 km^2, respectively, and for deposition >1480 kBq m^{-2}, it was 3100 km^2 and 272 km^2, respectively (Table 2) [26]. Due to the geographical location, a significant portion of the radionuclides released at Fukushima was transferred to the Pacific Ocean, which limited the scale of land contamination. In both cases, ^{137}Cs is of key long-term environmental importance, but in Chernobyl and its surroundings, less volatile and fuel radionuclides played a more significant role. This resulted in a more complex pattern of environmental contamination [29]. As a result of the different accident conditions and the rapid implementation of protective measures in Fukushima, including evacuation of the population and food safety campaigns, the projected health effects in Japan were significantly lower than those observed or projected after the Chernobyl disaster [29,31].

Table 1. Comparison of the estimated amounts of radionuclides released into the environment during the Chernobyl and Fukushima Daiichi accidents, expressed in petabecquerels (PBq).

	Chernobyl	Fukushima Daiichi
^{133}Xe	6500	7300
^{131}I	1760	120
^{132}Te	1150	29
^{134}Cs	47	9

^{137}Cs	85	8.8
^{90}Sr	10	No data
^{95}Zr	84	No data
^{95}Zr	168	No data
^{106}Ru	73	No data
^{140}Ba	240	No data
^{141}Ce	84	No data
^{239}Np	400	No data
^{239}Pu	0.013	No data

Table 2. Comparison of the most heavily contaminated areas affected by ^{137}Cs around the Chernobyl and Fukushima Daiichi accident sites.

	Level of ^{137}Cs contamination	
	555 – 1480 kBq m^2	>1480 kBq m^2
Chernobyl	7200 km^2	3100 km^2
Fukushima Daiichi	495 km^2	272 km^2

5. Environmental consequences and radionuclide behaviour

5.1. Radioactive Particles and Fallout After Chernobyl Disaster

A prominent characteristic of the Chernobyl disaster was the release into the environment, in addition to volatile radionuclides, of so-called hot particles, including nuclear fuel particles and condensation particles formed in the destroyed reactor core during high-temperature processes. Microscopic and spectrometric studies showed that a substantial portion of the fuel particles had a composition similar to that of irradiated reactor fuel and contained, among others, radionuclides such as ^{90}Sr, 239Pu, as well as ^{95}Zr, ^{106}Ru [32–34].

The spatial deposition of fuel particles decreased with increasing distance from the reactor [34]. A significant fraction of fission products released from the overheated fuel were emitted into the atmosphere and partially condensed onto inert aerosol carriers. The resulting condensation particles had a lower activity concentration compared to nuclear fuel particles [32,35].

Radioactive particles derived from the fallout were found up to 250 km from the reactor mainly in the 0 to 1 cm soil layer, and the vertical distribution profile depended more on soil type and bioturbation than on the distance from the emission source itself. It was also found that this distribution pattern did not differ substantially with distance from the reactor.

A significant portion of ^{90}Sr and ^{137}Cs initially remained bound to low-solubility fuel particles, which limited their immediate mobility while allowing for the gradual long-term release of radionuclides into the environment [32,36]. The rate of disintegration and dissolution of fuel particles depended on geochemical conditions, primarily the pH and degree of environmental oxidation.

Studies conducted in the 30–50 km zone revealed that still in the 1990s, between 2% and 21% of ^{90}Sr activity was still associated with weathering-resistant fuel particles, and their dissolution was faster in soils with lower pH. In terrestrial environments, most fuel particles had already disintegrated, whereas in cooling pond sediments this process is much slower due to low oxygen availability and relatively high pH; therefore, a substantial portion of ^{90}Sr activity remains associated with fuel particles.

Current predictive models indicate that in drained sediments, the dissolution of these particles may take about 15–25 years, and in permanently flooded areas up to about 100 years [36–38].

5.2. Radioactive Particles and Fallout After the Fukushima Disaster

A characteristic feature of the Fukushima disaster was the predominantly atmospheric transport of radionuclides. The released radioactive material was dominated by volatile radionuclides, especially ^{131}I, ^{134}Cs, and ^{137}Cs, while the contribution of less volatile fuel components was significantly lower than in the Chernobyl disaster [29,39].

Model analyses indicate that approximately 13% of the released ^{131}I and 22% of ^{137}Cs were deposited on Japanese territory, while vast majority of the remaining fallout was deposited over the Pacific Ocean.

Land deposition was highly uneven and strongly dependent on meteorological conditions, especially rainfall and snowfall [39,40]. The highest levels of land contamination occurred not only in the immediate vicinity of the plant but also in a zone extending northwest of Fukushima Daiichi, as a result of several emission episodes between 12 and 23 March 2011, coupled with meteorological conditions [40,41].

Radioactive fallout from the Fukushima disaster was chemically and physically heterogeneous, and included both relatively mobile forms and persistent particles that gradually underwent transformation under the influence of environmental processes [42,43].

6. Conclusion

This study comprehensively examined the key phenomena related to nuclear science that resulted from the accidents and its subsequent environmental contamination. A cross-disciplinary academic review of the literature, including educational materials, was conducted, providing a representative overview of both radiological data and sociological shifts in public perception over the last four decades.

This study highlights a profound divergence between radiological findings and collective public concern, a gap that is actively driven by the process of medicalisation. The findings indicate that many issues related to nuclear energy are perceived through the lens of the Chernobyl accident and other nuclear incidents. Moreover, as long as environmental contamination remains measurable, and some radionuclides can persist in the environment for up to one hundred years, the associated medical discourse will continue to generate persistent negative emotions, even among individuals who had no direct contact with these events While the medicalisation of fear defined the Polish response to Chernobyl, the Fukushima disaster has primarily demonstrated a medicalisation of displacement, and this transition reinforces a simplified and often distorted public understanding of nuclear incidents

To effectively bridge the division between empirical facts and societal beliefs, researchers must proactively engage with the underlying socio-medical mechanisms that shape these narratives to facilitate a transition toward energy dialogues that prioritize objective radiological data over the legacy of historical trauma.

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