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Nuclear Emergency and It's Psychological Effects- A Short Review

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Abstract

Nuclear power plants produce heat powered by nuclear energy to boil water into steam which later turn the turbine generators to generate energy. Nuclear power does not produce carbon emissions since it depends on uranium as its fuel rather than fossil fuels to generate heat. There is major potential in the construction of consequential effects nuclear reactors, where the lifetime of nuclear waste can be shortened to hundreds of years rather than the current timescales of hundreds of thousands of years. Although nuclear power plants require significant investment to construct, they offer low operating costs and a lengthy lifespan. As a result, they are extremely cost-effective. The majority of the carbon dioxide emissions related with nuclear power plants occur during construction and fuel processing, not just during energy generation. However, radiation is frequently feared and poorly understood. This is worsened in the case of a nuclear detonation. Most people do not plan for or know how to respond to this sort of disaster. The writings on the psychological impact of the nuclear accidents at Three Mile Island in 1979, Chernobyl in 1986, and Fukushima in 2011 has been compiled in this review of the literature. Nuclear disaster survivors are more likely to experience PTSD, depression, and anxiety. After a nuclear disaster, mental health issues are more common among disinfection laborer's, residents nearest to the nuclear power plant, and survivors.

Keywords: Nuclear Emergency, Radiation, Nuclear, Accident, Psychological

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1. Introduction

Nuclear energy is produced by the binding energy stored in the centers of atoms to keep them together. The energy is released when atoms undergo a process known as fission in which extra binding energy splits apart into heat and radiation. A neutron collides and divides with a uranium atom during a process called nuclear fission which then producing a tremendous quantity of energy in form of heat and radiation [1]. A divided uranium atom typically releases more neutrons. The process keeps repeating again as these neutrons keep crashing into more uranium atoms. This is known as a nuclear chain reaction. In nuclear power plant reactors, this reaction is regulated tocreate the required quantity of heat. The reactor's heat is dissipated by a coolant fluid, usually water. Once steam is created from this heat, it may be utilized to power turbines that produce energy. Reactors have mechanisms that accelerate, halt, or shut down the nuclear reaction and the heat it creates to ensure that it occurs at the optimum speed. Control rods, which are generally comprised of neutron-absorbing materials such as silver and boron, are typically used for this [2]. Nuclear power reactors have shown to bea dependable, constant, low-carbon energy source with a high energy density. Nuclear energy is also a possible replacement for fossil fuel-based sources because to its extended working life, minimal maintenance costs, and load-following capacity [3]. All countries have a common interest in securing sustainable, low-cost energy supplies with minimal impact on the environment. Therefore, many consider nuclear energy as part of their energy mix in fulfilling policy objectives [4]. After 30 years of the devastating nuclear accidents at the Chernobyl power plant in the Ukraine in 1986 and at Fukushima, radioactive material was spilled, resulting in fatalities, illnesses, and the poisoning of land and water. An uncontrolled power outage that overheated the fuel rods in the reactor's core occurred in the Chernobyl incident because of a combination of human error and a control rod design defect. When the hot fuel rods split, they combined with the coolant water. This results in a massive volume of high-pressure steam that lifts the cover off the core. A steam explosion caused bythe damage released radioactive fission products into the atmosphere [5]. Radioactive material was widely dispersed into the atmosphere during the Chernobyl nuclear plant disaster in 1986 [6]. The catastrophe caused significant social and psychological devastation in the lives of people who were impacted, as well as massive economic losses throughout the region. Large regions of the three nations were polluted with radioactive elements, and radionuclides released by Chernobyl were detectable in all northern hemisphere countries [7].

Fukushima on the other hand, a 9.0-magnitude earthquake followed by a tsunami caused the nuclear catastrophe at the Fukushima Daiichi Nuclear Power Plant on March 11, 2011. It was a category 7 nuclear accident following the 1986 Chernobyl disaster [8]. Radioactive elements were released into the environment because of the Fukushima nuclear catastrophe [9]. Most radionuclides (more than 80%) were carried offshore and deposited in the Pacific Ocean during the Fukushima nuclear disaster, eventually polluting food and water supplies[10]. Nuclear and radiation technology, which is one of the most important sources of energy, has applications in medical, non-destructive testing, well logging, and agriculture. As a result, this technology is critical to national progress and economy. However, nuclear catastrophes can have far-reaching consequences. Radiation, in particular, has biological and psychological consequences on the human body. As a result, in the event of such an accident, a highly qualified professional must respond quickly. Countries that are advancing their nuclear technology and applying it in numerous industries are building nuclear emergency response planning systems in line with the worldwide standards set by the International Atomic Energy Agency [11]. Most people do not plan for or know how to respond to this sort of disaster. Preparedness, more than any other part of a reaction, has the potential to save more lives in this situation. As every aspect that affects risk perception is present in a nuclear explosion scenario, the public's sense of danger triggers tremendously powerful emotions. The radioactive material might then pollute the land and groundwater nearby. Some serious health issues for the local population as well as other creatures may result from this and it would be necessary to evacuate all communities. Despite the fact that most scientific evaluations have rated nuclear energy generation as safe as coal-powered generation, societal skepticism of nuclear power has hindered its advancement. Previous nuclear catastrophes such as nuclear meltdown in Chernobyl and Fukushima has leave a negative stigma on us. The main goals to prepare for nuclear emergencies is to safeguard persons, society, and the environment by helping to build efficient countermeasures against radioactive risks posed by sources. Besides, it is important to take all practicable measures to prevent nuclear accidents and to counteract their consequences if they occur. Therefore, this review discussed the (a) types of radiation emergencies, (b) the public awareness, (c) alert and notification system as an early preparation for nuclear emergencies. As every aspect that affects risk perception is present in a nuclear explosion scenario, the public's sense of danger triggers tremendously powerful emotions. Therefore, early emergency preparedness plan has the potential to save more lives in this situation. Nuclear disaster has been affected the survivors mental and psychological for long period resulting to be a horrible nightmare for their entire life. The International Atomic Energy Agency (IAEA) defines a nuclear and radiation accident as an event that has resulted in significant consequences to people, the environment and the facilities. This paper will review the mental health impact of nuclear accident survivors of the three major nuclear power plant accidents which are the Three Mile Island (TMI,1979), Chernobyl (1986), and Fukushima (2011). These disasters have caused severe destruction from every aspect [12]. On March 28, 1979, the Three Mile Island (TMI) Nuclear Power Plant (NPP) accident occurred near Harrisburg, Pennsylvania, US. The International Nuclear and Radiological Event Scale (INES) has classified TMI as a level 5 "accident with repercussions." TMI persists the most severe nuclear disaster in US historical record, with a partial meltdown with in Unit 2 reaction chamber. Even though no direct health effects mostly from accident's radiation were revealed, the TMI disaster negatively affected nuclear power's image as a guaranteed energy resource. The accident appears to have the greatest impact on the mental well-being of the plant workers and the citizens residing in the TMI territory [13 - 15]. During April 26, 1986, the Chernobyl Nuclear Power Plant accident/ took place in former Ukrainian Republic of the Soviet Union. About 300,000 citizens have migrated, and more than 600,000 victims were registered as medical emergencies and recovery employees (also known as "liquidators"). The INES classified the Chernobyl NPP accident as a level 7 which mean major accident. The worst impact on public health in this instance were those on mental health [16]. Subsequently, On March 11, 2011, the Fukushima Daiichi NPP accident took place. INES also registered this NPP as a level 7. Throughout the northern part of Japan, in the Tohoku region, a massive earthquake with a magnitude of 9.0 appeared. All the NPP's cooling systems were disrupted by the earthquake and followed with the major impact of tsunami, which several explosions within the plant's structures. In May 2012, 164,845 people in total were evacuated. Contrary to Chernobyl, Fukushima did not experience any acute radiation-related fatalities or acute radiation syndrome occurrences [17]. The purpose of this essay is to describe how nuclear disasters affect mental health. The most typical post-nuclear disaster psychological recurrences, such as post-traumatic stress disorder symptoms (PTSD), depression, and anxiety, will be discussed, along with the hazards and potential treatments that may contribute to the success of these scenarios.

2. Types of Radiation Emergencies

Emergency situations involving radiation can result from mishaps involving radiation material or from deliberate activities intended to harm others, such as terrorist attacks. Radiation crisis can occur as a result of unintentional act such as nuclear power plant accident and intentional acts which involving nuclear weapons for war purposes. In nuclear reactor, uranium is its main fuel. The uranium is converted into little ceramic pellets before being placed into sealed metal tubes known as fuel rods. An assembly of fuel is typically made up of over 200 of these rods. Depending on its power level, a reactor core generally consists of a few hundred components. The fuel rods are submerged in water within the reactor vessel, which serves as both a cooling medium and a moderator. In order to sustain the chain reaction, the moderator plays its part to slows down the neutron produced by fission energy. The heat produced by fission converts water into steam that powers a turbine and generates carbon-free energy [18]. The biggest issue that may arise when a nuclear plant sustains damage. This damage occurs when the nuclear core that houses the uranium fuel and fission products may get destroyed which allows radioactive elements to escape into the atmosphere. However, accidents involving nuclear power plants can occur in an abnormal way due to significant changes in parameters and unique features because of the accident type and magnitude [19].

On April 26, 1986, the most catastrophic nuclear accident occurred at the Chernobyl nuclear power plant in Ukraine. It is the only nuclear accident in commercial nuclear power history to result in radiation deaths [20]. Several factors, including reactordesign difficulties and a weak safety culture, contributed to a failed safety test, which resulted in two explosions, a week-long fire, and the discharge of a huge amount of radioactive material. The site and surrounding regions have been cleaned up continuously after the catastrophe [21]. To prevent future hazardous material escapes, a concrete dome was quickly constructed over the damaged reactor. This was a short-term solution that was subsequently substituted by the New Safe Confinement structure,which was finished in July 2019 [22]. According to United Nations (UN), nuclear weapons are the most fatal weapons in the world [23]. Nuclear weapons are the most lethal, brutal, and indiscriminateweapons ever invented. They are unlike any other weapons in terms of the degree of damage they produce, as well as their particularly persistent, spreading, genetically harmful radioactive fallout. Long-term catastrophic impacts can ruin an entire city,possibly killing millions and endangering both natural environment and the lives of future generations. The hazards of such weapons originate from the fact that they exist. Throughout the history, nuclear weapons have been utilized twice in warfare which is inthe bombing of Hiroshima and Nagasaki.

3. Communication strategy

One of the most crucial elements of emergency management in a nuclear or radioactive emergency is effective public communication since it reduces risk, supports the deployment of preventive measures, and lessens panic. A communication plan identifies significant problems, target audiences, appropriate messaging, and communication actions to deliver the intended information. A communication plan might be general or tailored to a particular radiation situation [24]. As a result, it may be conceivable to have numerous plans, one for each probable form of disaster or one overall approach that will be modified to specific emergency scenarios. Nuclear detonations are difficult to comprehend, imposing, and disastrous—and a lack of understanding about the issue makes it impossible for people to feel in control. The future is unpredictable, the scenario is unexpected, and the hazard is created by humans. All of these things combine to make communications during a radiation emergency extremely difficult. While it will always be forced and disastrous, pre-incident educationcan help boost the public's impression of control and familiarity. Emergency planners, public information officers, community leaders, and emergency and first responders should effectively communicate how some preparedness for a nuclear explosion scenario is critical to survival [25]. People will likely rush from danger if there is no pre-incident awareness, important information, or preparatorymeasures, potentially subjecting themselves to deadly radiation doses that can be prevented by simply taking a shelter. In order to effectively spreading the preparedness information, it is important to communicate in an easy, non-technical language that public can understand and translatable. Therefore, focusing on the action itself helps the public to understand the information given allowing them to make more wise decisions. Preparedness campaigns should contain information about the communication techniques that emergency personnel and responders will incorporate to contact the public. Campaigns should explain the many emergency siren tones, the reasoning behindthem, and the need of acquiring a hand-crank radio.

4. Alert and Notification Systems

Proper planning, early warnings, and responsive signals benefit members of an impacted community by giving important safety messages to safeguard them in any situation. An early warning and notification of nuclear catastrophe is crucial to notify those who lived in the impacted area to immediately take action in order to avoid deaths and injuries caused by a radiation blast. The public should always be informed about the approaching danger that has triggered the emergency alert through a warning message. The warning message should be informed in two parts: a descriptive of the predicted occurrence and an explanation of how it will threaten people's safety [26]. People can understand the motives of protective actions if a hazard is clearly explained such as immediately taking shelter in nearby building and close down car windows as the risk is in the air. Moreover, warnings must also include its location as the level of hazard is linked to its closeness. Warnings must specify the whereabouts of those who are not atharm and those who are at harm in the nuclear disaster, and it need to do so in ways that are easily understood by those who are targeted to receive the message. In order to be effective, warning messages must have a consistent style throughout all of their messages as well as within them [27]. A warning messageencourages the formation of correct perceptions if the information it gives is consistent with previous publicly issued advisories. The timeframe of public response must also be addressed in the subject of public warnings. It is critical to notify warning receivers of the amount of time remaining before impact so that they can take precautionary measures. Besides, warnings should be short and informative as it will give a hard time for the public to remember the warning information if they only listen to it once.Furthermore, a warning message will be most effective if it is delivered repeatedly and consistently, and when it enters the informal communication channels driven by the warning confirmation process occurring within the danger region population. Thus,authorities can increase adherence to the preventive measures advised which are most likely to effectively safeguard a vulnerable population by directing the warning recipients' description of the issue.

5. Psychological Effects

After several research and review of papers, the mental health consequences of the nuclear disruption show the arising prevalence of Post-Traumatic Stress Disorder (PTSD), depression and anxiety. These three major psychological effects on the survivors will be discussed in turn regarding to its risk factors.

5.1. Post-Traumatic Stress Disorder (PTSD)

Throughout disaster-related occurrences, level of stress frequently reaches their highest point, stay high for a while but then drop significantly [28]. Hypervigilance, avoiding triggers from the stressful event, flashbacks, and nightmares are some long-lasting signs of stress. Years after the horrific situation, these signs may continue to concern some individuals. Following a nuclear accident, PTSD symptomatology rates range from 33.2% to 59.4% within the first year [29-30].

A nuclear catastrophe does not actually impact everybody in a form. The psychological results are determined by both personal and disaster-related parameters. Elevated concentrations of PTSD were linked to personal factors like social isolation as well as having a previous history of mental or physical health issues. Following a nuclear disaster, those who had been subjected to prejudice or racist remarks experienced higher levels of post-traumatic stress and symptoms that lasted longer. PTSD was also linked to worries about one's welfare and lost employment [31]. Both one year after the accident and 18 years later, stronger radiation exposure had been related to worse PTSD symptoms. Staying near to the nuclear reactor that was having issues causes more tension than staying close to a nuclear plant which is operating normally, despite the absence of existing radioactive contamination. Citizens who should leave their residences because of a nuclear disaster seem to be more highly probable to meet the requirements for an official PTSD diagnosis and have a higher prone to having post-traumatic stress response illnesses. Due to their place, the strains of moving, and their anxiety about upcoming nuclear occurrences, survivors are at a higher risk of radiation exposure [32].

5.2. Depression

Additionally, tends to be more severe following a nuclear disaster. According to studies, in the first year following a nuclear accident, between 21.1% and 66.8% of individuals encounter symptoms of depression, and between 7.1% and 23.3% of people fit the criteria for such a full diagnosis of major depression. A persistent sense of sadness and loss of interest are symptoms of depression, a mood disorder. Clinical depression, also known as major depressive disorder, affects quality of life, assuming, interact and can lead to numerous of emotional and physical issues [33]. Radiation exposure and closeness to nuclear power plants are linked to depressive symptoms. Increased levels of symptoms of depression and higher depression rates were proven among those who inhabited nearest to the nuclear reactor. Acute radiation sickness (ARS) from Chernobyl increased the risk of depressive disorder in waste disposal workers compared to those who did not experience ARS. A higher received amount of radiation from the outside was specifically linked to more symptoms of depression, a formal diagnosis of depression, and the severity of the depression. In comparison to a control group of non-clean-up workers from the same region, more Chernobyl clean-up workers experienced depression and suicidal ideation after the disaster, and this trend persisted perhaps 18 years after the tragedy [33]. Although less researched in the literary works on nuclear disasters, suicide attempts are frequently addressed in the context of depressive episodes. Other researchers reported that 8.9% of state workers were deemed to be at "risk for suicide" two years after the Fukushima nuclear accident. With rates of 9.2% and 4.1%, respectively, Chernobyl employees were more likely to experience thoughts of suicide than a comparable majority of non-employees from Chernobyl area. The nuclear disaster had an effect on rates of attempting suicide and death by suicide in addition to raising suicidal ideation [34].

5.3. Anxiety disorder

Nuclear disasters cause anxiety affected to other conditions in addition to post-traumatic stress disorder and so its symptomatology. These include semi anxious symptomatology, generalized anxiety disorder, and health anxiety. Study on anxiousness and nuclear disasters has a strong emphasis on anxiety related to radiation exposure and the potential health risks of radioactive contamination. A feeling of fear, dread, and unease is known as anxiety. You might start to perspire, become agitated and tense, and experience rapid heartbeat. Greater anxiety is linked to home destruction from the nuclear disaster but also having to leave one's home after the tragedy. Generalized anxiety syndrome rates were higher among those who were relocated to temporary accommodation. Additionally, survivors were discovered to experience more radiation anxiousness than non-evacuees [35].

Since radiation exposure poses continuing health consequences, anxiety following a nuclear disaster is distinct from anxiety following other accidents. The stress is continuous because of potential future threats from radiation exposure instead of being a separate source of stress brought on by the tragedy. Thyroid cancer and other cancers, worries about the next generation, food and land pollution, and gene mutations are prevalent worries from radiation exposure. There is more psychological distress among those who believe there is a severe chance of radiation exposure. Radiation worries lessen as time goes on following the nuclear accident [34]. Low levels of psychological distress are observed in people with higher levels of psychological wellbeing and family protection. Personal strategies revealed remarkable improvement in mental wellbeing, such as cognitive reappraisal work experience, behavioral management, and relaxation training. Numerous of the population-level initiatives put in place to lessen radiation exposure actually make people feel more anxious. Over than half of the study people involved fell into low or under-threshold side effect clusters in all three tragedies, despite the fact that the patterns of effects on mental health outcomes varied. The proximity-estimated exposure to radiation level and stigma have been the prevalent causes of mental quality of care across the three disasters. Our results demonstrate the long-term effects of such catastrophes, and our findings will contribute to a thorough understanding of the effect of the worst nuclear accidents in history on the affected individuals' mental health.

6. Conclusions

The likelihood of a catastrophic accident at a nuclear facility resulting in the release of huge amounts of radiation into the environment has always been considered to be negligibly low. Even in the scenario of a significant release into the surrounding environment, quick and efficient countermeasure implementation can minimize the radiological implications for the people and the ecosystem. However, some radiation health implications may appear immediately or within a few days while others may take years to emerge. Radiation exposure can cause mild symptoms such as skin reddening tosevere ones such as skin irritation, acute radiation syndrome (ARS) and even death. Therefore, the ability to handle nuclear emergencies requires a strong cooperation from multiple service units in the nuclear facility. All three authorities, state, and central— will play a critical role in ensuring off-site officials respond appropriately to any potential radioactive effects in the public domain and inform the public of the safety measures to be taken.

From this review, it will be concluded the adverse psychological and mental outcomes associated throughout a nuclear destruction. The research from the three major accidents which are TMI, Chernobyl and Fukushima determined that the evacuees have higher levels of PTSD, depression and anxiety. Contrary to the people and residents who lives far away from the nuclear power plant and do not experience a massive nuclear explosion. Following a nuclear disaster, government actions that provide the populace with reliable information sources lessen public anxiety about radiation exposure. A few of the precautions taken to lessen the risk of radiation in the impacted areas, though necessary, actually cause stages of psychiatric distress to rise. Research could be done to determine if there are any practical ways to lessen the increase in psychological distress brought on by the required radiation countermeasures. Future research ideas include technologically based interventions, like mobile support programmers, which are economical ways to reach sizable populations in dispersed locations.

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