Longitudinal Assessment of Metabolic Syndrome Risk and Cognitive Decline Following the Fukushima Daiichi Nuclear Power Plant Accident: A Comprehensive Review

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1. Introduction

After the Fukushima nuclear accident, the increase in thyroid cancer cases detected through thyroid ultrasound screening is estimated to be driven by overdiagnosis rather than radiation exposure. Long-term evacuation, temporary shelter living, loss of livelihoods, and the dissolution of local communities inflicted severe secondary heart burdens. In addition to radiation-induced cancer, metabolic syndrome and dementia have drawn significant attention in the aftermath of the Fukushima disaster. While numerous studies in South Korea have examined thyroid cancer risks in response to nuclear accidents, research on metabolic syndrome or dementia remains lacking. This review synthesizes findings on dementia and metabolic syndrome (MetS) among Fukushima evacuees, highlighting their interconnected pathological mechanisms and providing actionable insights for future nuclear disaster management.

2. Methods and Results

We reviewed recent representative studies that analyzed changes in dementia [1], cognitive function, and MetS [2] using data from the Fukushima Health Management Survey.

2.1 Epidemiology of Dementia

Comparing the periods before and after the compound disaster, the number of dementia patients showed a significant increase, rising from 96 out of 1,078(8.9%) to 235 out of 1,404 (16.7%) (P<0.001). In particular, the proportion of patients increased significantly in the late period (144 out of 766, 18.8%) compared to the early period of the compound disaster (91 out of 638, 14.3%) (P=0.023). The number of patients exhibiting behavioral and psychological symptoms of dementia (BPSD) increased significantly after the compound disaster (79.6%) compared to before (60.4%) (P<0.001). The HIDA group (agitation, irritability) increased during the early period of the disaster (P=0.013) but recovered to pre-disaster levels in the late period. The Psychosis group (hallucination and delusion) showed no increase in the early stage, but exhibited a significant increase in the late stage.

2.2 Non-Radiological Determinants of Dementia

This increase in dementia patients stemmed from heightened psychological stress due to earthquakes, tsunamis, and frequent evacuations, combined with reduced caregiving opportunities for the elderly caused by the decline of the young working population and a shortage of care facilities. Disruptions to daily routines caused by evacuation, environmental changes, loss of housing lifestyle patterns, and living in temporary shelters exacerbated these symptoms.

2.3 Epidemiology of MetS

Beyond radiation-induced cancer, MetS is one of the diseases of concern. According to one study, Fukushima Prefecture was divided into four zones (mountainous area, central area, coast area, evacuation area), and a health survey tracking the prevalence of MetS was conducted annually from 2008 to2017 on approximately 300,000 to 400,000 residents aged 40 to 74. Among the four areas, the prevalence ratio in the evacuation zone from 2012 to 2017 (after the accident) showed a significantly increasing pattern compared to before the accident. This pattern was also observed across males, females, and the age groups of 40-59 and 60-74. From 2008 to 2017, other areas also showed an increase in prevalence every year, but the increasing trend of MetS in the evacuation area was particularly significant.

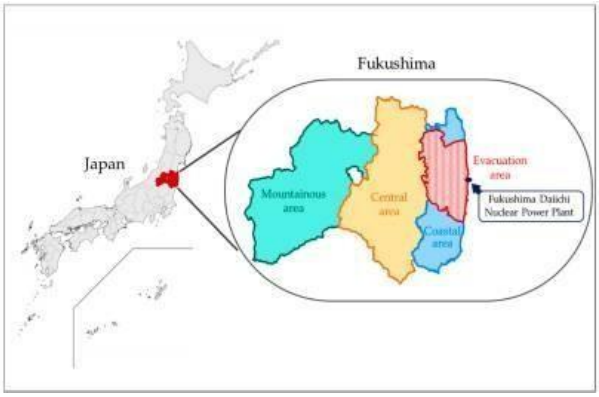


Fig. 1. Mountainous area, Central area, Coast area, Evacuation area in Fukushima Prefecture [2].

2.4 Non-Radiological Determinants of MetS

Lifestyle changes resulting from the disaster-such as lack of exercise and excessive juice consumption-are

primarily considered as contributing factors. Secondary factors include dietary changes caused by psychological stress, smoking, alcohol consumption, and sleep disorders. In the long term, the impact of MetS is estimated to be greater in males and the elderly compared to females and younger age groups, respectively.

2.5 Discussion

Dementia-related symptoms and MetS were noticeably more prominent in evacuated areas than in non-evacuated areas. Following the Fukushima nuclear accident, local residents within a 20 km radius of the plant, as well as designated high-radiation zones beyond it, were evacuated. In the wake of the Fukushima nuclear disaster, the prevalence of metabolic syndrome among displaced residents escalated from 16.2% in 2010 to 20.4% in 2017, exacerbating the burden of chronic conditions [2]. This upward trend is primarily linked to lifestyle disruptions and reduced physical exertion associated with evacuation, rather than ionizing radiation exposure. Furthermore, evidence suggests that these metabolic abnormalities, compounded by social alienation, precipitated accelerated cognitive deterioration and dementia within the elderly cohort [3]. As demonstrated by the Fukushima health survey findings [4], secondary health impacts-such as psychological stress and adverse effects on metabolic and cognitive functions resulting from mass population displacement and evacuation are as critical as direct radiation exposure. Consequently, addressing these secondary impacts has become a pivotal component of emergency preparedness planning for South Korea's nuclear power plants, which are located in densely populated areas with high reactor density. As a countermeasure to this, South Korea has established specific and phased resident evacuation criteria through the allocation of PAZ/UPZ zones, and is building an epidemiological model aimed at evaluating long-term health impacts on local residents near nuclear plants and emergency responders. In addition, an emergency medical health system must be established to prevent dementia and MetS caused by isolation stress following evacuation, and in terms of public communication, low-dose radiation health research based on localized epidemiological data is required.

3. Conclusions

It is presumed that environmental changes and psychological stress caused by relocation to evacuation areas are the main causes of dementia and MetS in relation to the Fukushima nuclear accident. Mental health intervention during evacuation and the establishment of a long-term healthcare system are essential. Further, low-dose radiation health research is needed.

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