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REVIEW

The impact of disaster on cognition in geriatric population

Özlem Önder[1*]

[1]Department of Neurology, Faculty of Medicine, Near East University. Nicosia / Cyprus
* Department of Geriatric Health Graduate School of Medical Sciences, Muğla Sıtkı Koçman University. Muğla / Türkiye

Abstract

Aging has become one of the predominant demographic issues of the 21st century both in Türkiye and globally. All countries face major challenges to ensure that the health and social systems are ready for the present development. Disasters are natural, technological, or human-induced events that cause physical, economic and social losses. Türkiye is one of the countries frequently face to the catastrophic natural disasters. During the disasters, geriatric population should be considered as being a particular vulnerable group of society. Geriatric individuals are usually more severely injured, have prolonged hospital stay, lower quality of life and have higher mortality during disaster and in post-disaster periods. However, studies on the cognitive effects of disasters are limited. It is clear that the data to be obtained from studies to be conducted in this field will be of even greater importance, if the increasing geriatric population is considered. Age, living alone, being less educated, having chronic diseases, and not working are known as being the the most related factors with cognitive decline due to the disasters. Stressful events such as disasters have short and long-term effects on different brain structures. In the literature, it can clearly be seen that the popular area for researches is the affected locations in brain due to disasters The impotance of better preparedness and community empowerenment that can improve the vulnerable populations, particularly the geriatric people with dementia, is known and more researches are needed.

Keywords: Disaster, cognition, aging, elderly, disaster gerontology

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Corresponding Author:
Özlem Önder
Email: ozlem.onder@neu.edu.tr

Introduction

Disasters are natural, technological, or human-induced events that cause physical, economic and social losses for all or certain segments of a society, interrupting and sometimes even stopping the normal flow of life. Natural disasters are ecological events that disrupt daily life and require assistance to eliminate their negative consequences; earthquakes, floods and storms are the most common examples of natural disasters. In terms of increasing technological developments, economic problems in large geographies, wars, disasters, increasing migration movements due to economic and social reasons, and disasters triggered by climate changes brought about by global warming, it is seen that the whole world is moving step by step towards an unstoppable crisis.

Türkiye frequently faces to the natural disasters, as floods in the Black Sea region, forest fires in the southern Aegean and Mediterranean regions, and earthquakes in different regions of the country. In Türkiye, which is defined as an 'earthquake country', all those disasters have had many physical, psychosocial, and economic impacts, both individual and societal, and these impacts will continue to occur.

Cognitive health issues caused by any disasters are even more neglected area. In the present article, the aim is to reveal what changes due to disasters and is known about the cognitive impairment after the different types of disasters all over the world.

Relationship Between Disaster and Cognition

Adaptation to Stress During Disaster

Despite the negative effects of natural disasters on communities, there are disaster survivors who can go through a natural recovery process without experiencing any psychopathological consequences. Stress is necessary for building and shaping the responses to environmental changes in progress throughout life, particularly between second pregnancy trimester and first two years of life, during the development of brain. However, prolonged or excessive activation of the stress response might have negative effects on brain structure and functions. According to the stress-adaptation model, the effects of a traumatic stressor may diminish over time as people are exposed to stress [1]. Although chronic exposure to stress can lead to negative outcomes such as cognitive dysfunction and depression, it is important to note that adaptation to low or moderate levels of acute stress can be developed and social behaviors can increase as a contribution of a properly managed post-disaster process. Many variables such as individual-specific personality, gender, age and genetic factors have an impact on cognitive and behavioral responses to disaster [2].

Risk Factors for Cognitive Impairment After Disasters

Some risk factors for dementia without an experience of disaster are seen as current risk factors for cognitive decline following a disaster. The most important risk factors for cognitive loss after a disaster are old age, living alone, being less educated, not working and having chronic diseases. These are the well-known main risk factors for geriatric population regardless of disasters. Apart from these, low-income level is also known to be an important risk factor, and it is also known that cognitive loss may occur in individuals with low education level but high-income level due to easy access to bad habits, such as alcohol misuse and drugs [3].

It is possible to reduce cognitive loss by maintaining the pre-disaster social support after disasters. It is emphasized that those living in a community with strong ties defined as social capital will be less exposed to social isolation after a disaster and thus cognitive loss can be prevented easily. The relationship between experiences of disaster and the deterioration of dementia symptomatology is demostrated with comparing geriatric populations who lost their homes after disaster to those didn't lose or experienced less severe damage. Those who lost their homes are seen as more suffered from cognitive and social support losses than the ones who had able to have their own houses [4].

The impact of social connections on both health and social resilience appears to be critical to sustaining the wellbeing of older people affected

by disasters. Older people living in south-eastern Australia have experienced bushfires and COVID-19 in speedy succession, and living in rural areas means they face limited access to support services and the risk of social isolation. Women living in this region, with chronic diseases and the geriatric population who interpreted their own health status as worse experienced the effects of both bushfires and the pandemic at an increased rate compared to the others [5].

In another study conducted after the flood disaster in Japan in 2018 demonstrated that geriatric victims who continued to live in their own homes independently in most of their daily living activities, with or without any care support, were at risk of cognitive decline due to the disaster. They presented two hypotheses to explain that result; one is that there would be a cognitive dysfunction did not surface before the disaster and the second is negative effects of the disaster as a result of severe depression, social isolation and lack of physical activity on cognitive functions [6].

The Most Impaired Cognitive Domains After Disasters

Neuropsychological studies have documented that the significant impairments in cognitive functioning after acute stress reaction are attention, working memory, and verbal memory functions [4,7]. Recurrent memory thoughts related to disaster period and increased arousal levels in post-disaster period have been hypothesized to interfere with ongoing cognitive processing. It is assumed that these interventions cause memory impairments in working memory and attention in cognitive functions. Although working memory impairment within the first 4 weeks following the disaster appears to greatly increase the likelihood of positive identification of Post-traumatic Stress Disorder (PTSD), it does not appear to contribute to verbal memory [7].

Disaster-related traumatic experiences are linked to exacerbation in dementia and to working memory loss in geriatric population without dementia. Predicted mechanisms include post-traumatic stress disorder, depression, reduced social participation and social isolation accompanying loss of place of residence [8]. The level of cognitive functioning of the elderly living in temporary apartments after the Great East Japan Earthquake was monitored and found that 36% of the elderly living in the disaster area had lower cognitive functioning. This rate is higher than the prevalence of dementia in Japan, which is 14%, and they stated that this increase is due to rapid changes in living conditions, loss of families, relatives and friends, loss of daily activities such as farming and fishing, and separation from families and neighbors. A more pronounced deterioration in cognitive and behavioral symptoms is observed in people with dementia living in temporary housing. It is emphasized that ischemic stroke, post-traumatic stress disorder (PTSD) and depression, which increase in frequency after disasters, more frequently in men, may contribute to this deterioration [9].

Which Brain Areas Are Significantly Affected Due to Disasters?

Stressful events such as disasters have both short and long-term effects on the brain. In experimental animal studies, acute and chronic stress-induced microstructural brain changes were observed in prefrontal regions and microstructural changes occurred in white matter density, especially in the cingulum and uncinate fasciculus, was revealed in a human study [10]. It was reported as the effect of chronic stress in posttraumatic stress disorder in the long term and the effect of acute stress in survivors of a disaster in the short term. In neuroimaging studies conducted to evaluate the “early-term” effects 3 months after the disaster and “long-term” effects 1 year after the disaster, significant changes were observed in the right anterior cingulum, both uncinate fascicles, left superior longitudinal fascicle and left thalamus [11].

The uncinate fasciculus, which plays a role in emotional processing, is a major white matter system connecting limbic regions, including the orbitofrontal cortex and amygdala, and anterior temporal cortices. Through this pathway, neural responses of the orbitofrontal cortex are preferentially amplified during extinction, together with those of the amygdala, and

voluntary regulation of emotions is achieved. As a result of the secretion of corticosteroids as an acute stress reaction, it is observed that the white matter density, which increased in the early period in the left uncinate fascicle, regressed at the end of the first year [12]. This change indicates that there is a need for a new emotional regulation for disasters that cause an intense stress factor such as earthquakes. When individuals with post-traumatic stress disorder are compared with individuals who have been exposed to disasters but are psychiatrically well, it is emphasized that exposure to disaster itself has a detrimental effect on neuropsychological performance, as there is data showing that both groups have memory impairment but there is no significant difference [13]. With this idea, concepts such as 'earthquake brain' or 'flood brain' have been put forward due to the effect of disaster exposure [14]. Within the framework of this concept, the interest in examining the effects of disaster exposure on neuropsychological functions by comparing them with unexposed controls is increasing day by day. The most important information obtained from the studies is that there was no difference in verbal or visuospatial memory in individuals with PTSD compared to controls exposed to earthquake [15]. Compared to controls who were not exposed to the earthquake, both groups were found to have lower performance in visuospatial memory tests. These results are presented as preliminary evidence suggesting that the factor affecting neuropsychological functioning is the exposure to the disaster itself rather than the presence of PTSD [16].

Emotional Changes Following Disasters and Effects on Cognition

Acute Effects of Post-Traumatic Stress Disorder on Cognition

The processing of facial emotions reflects a specialized aspect of cognitive functioning related to trauma exposure that has received less attention. A systematic review of social cognition studies in PTSD has reported mixed findings in the processing of threatening expressions such as anger, fear, and sadness [17]. Accuracy and sensitivity in the interpretation of facial expressions of fear, sadness and anger were found to be reduced in people with PTSD compared to war-exposed controls [18]. Compared to non-earthquake-exposed controls, it was suggested that earthquake-exposed individuals, including those with and without PTSD, rapidly develop emotional facial expressions that express increased sensitivity to potentially harmful situations, and thus may be able to generate an adaptive response to the disaster in a short time [19].

Earthquake survivors with current PTSD symptoms had worse scores in attention, verbal memory and verbal fluency performance in the animal naming test compared to those with a history of PTSD and healthy controls [20]. When the demographic characteristics of these three groups were analyzed, it was noteworthy that there was a significant difference in terms of lack of preschool education in the PTSD group and the level of parental education was also lower in this group, although the duration of education was similar [21]. It seems possible to prevent possible cognitive loss that may be encountered in case of disaster by increasing the level of education in individuals and their parents, contribution to cognitive reserve and positive contribution to the development of the prefrontal lobe through education starting in early childhood.

Chronical Effects of Post-Traumatic Stress Disorder on Cognition

Decreased hippocampal volume and progressive cortical thinning as a result of chronic PTSD and changes in dopaminergic pathways resulting from long-term exposure to airborne pollutants have been associated with Alzheimer's disease [22,23]. Neuroimaging studies have shown that disaster victims with chronic PTSD face an increased risk of Alzheimer's disease as a result of faster hippocampal volume loss, decreased cortical thickness and increased beta-amyloid accumulation [24]. In studies conducted on September 11th World Trade Center attack survivors, it was shown that the risk of dementia increased as an effect of PTSD and long-term exposure to airborne pollutants. In early period examinations, it was revealed that there was a limited relationship between the duration of

being in the debris field and the level of cognitive loss in relation to the high neurotoxin contained in the debris [25]. In addition, when these individuals were evaluated in terms of APOE-ε4 allele carriage, which is an important risk factor for Alzheimer's disease, it was observed that there was a weak association between the long-term presence of allele carriers in the debris field and Alzheimer's disease [26]. This association supports the increased negative effects of increased exposure to neurotoxins in dust on the development of Alzheimer's disease with the contribution of increased blood-brain barrier permeability for APOE-ε4 carriers [27].

PTSD has a common network that spreads from parietal to frontal cortex and includes limbic structures, different specific networks can be activated according to the type of stress and suggested that para-hippocampal gyrus, superior temporal gyrus, medial and superior frontal gyrus are effective for natural disasters. The fact that these structures play a key role in navigation suggests that there may be problems in the perception of familiar places damaged by the disaster and the perception of a new environment [28]. In addition, it was suggested that there may be problems in learning new spatial sequences in the peripheral field as a result of cerebral network changes caused by PTSD due to natural disasters, especially in the insula, lingual gyrus and frontal gyrus in the right hemisphere. These cerebral areas are related to different spatial abilities; the insula and lingual gyrus are involved in learning sequences in the navigation domain with specific and complementary contributions, the inferior frontal gyrus plays a role in the 3D perception of objects and letters, and the superior frontal gyrus plays a role in maintaining spatial orientation in working memory [29]. Bilateral hippocampus activation is required during the creation and use of a cognitive map, and the demonstration of the problem experienced by individuals with PTSD resulting from the L'Aquila earthquake in creating a cognitive map of a virtual environment is accepted as a result of hippocampal changes caused by PTSD [30].

Do Disasters Only Have Negative Effects or Do They Also Have Good Effects on Cognition?

In a navigation study investigating the topographic memory skills of disaster survivors and post-disaster residents, disaster survivors scored higher on the ability to learn a new path and needed fewer repetitions, and topographic memory was shown to selectively improve over visuospatial memory. However, once a path had been learned, there was good recall of the learned path information by both groups, and especially within the disaster survivor group [31]. This result suggests that exposure to environmental changes after a natural disaster may promote the acquisition of new topographic knowledge, but repeated topographic practice has no effect on the enhancement of topographic memory if pre-disaster familiarity is absent [32]. In the light of this information, considering the widespread cognitive and psychological effects of disasters throughout the population, the importance of close and careful follow-up of the cognitive functions of healthy geriatric individuals in addition to individuals with cognitive loss, who are known to have high vulnerability after disasters, has been clearly demonstrated.

Disaster preparedness is the most significant digit to reduce damages. However, disaster preparedness is predicted to be difficult for geriatric population with cognitive impairment. In disaster preparedness, there tends to be an emphasis on building shelters and supplies such as food, water and medicine, but studies demonstrated the importance of social networking. Building resilience to disasters depends not only on supporting the physical infrastructure, but also on strengthening social connections [33]. Social capital is defined as the resources that individuals and groups can access through their own social connections and it plays a critical role in the emergency response phase of disasters [34].

Studies to assess the cognitive status of individuals who are not able to maintain pre-disaster social capital against the effects of residential relocation on cognitive decline have found that moving to trailer-type housing, which

is vulnerable to frequent relocation, is also a risk factor for rapid cognitive decline, especially when random relocation leads to distance from neighbors and close family members. The hypothesis that low social participation, less frequent social contact and loneliness are associated with dementia is based on the 'use it or lose it' theory of brain plasticity. This theory suggests that daily participation in intellectual and social activities regularly stimulates the brain and, conversely, that inactivation of these functions leads to loss of cognitive abilities [35].

Discussion and Conclusion

Disasters are unexpected events that affect many people and cause many problems in addition to their devastating effects. Physical, emotional, and psychological health of individuals are significantly affected due to the disasters and they are resulted in high numbers of deaths, injuries, and economic losses. The vulnerability of geriatric population in disasters is revealed by many researches in the literature. Geriatric population, particularly the individuals with dementia, is of great importance during a disaster period being one of the most vulnerable groups in society due to the physical, psychological and cognitive negative effects besides the increased assistance needs that will occur as a result of the disaster. Awareness about the importance of post-intervention techniques and their easy applicable capacity in affected geriatric population is the main step for victims' recovery periods. Disaster-management strategies, as a multidisciplinary and multidimensional process, cover disaster preparedness, interventions during disasters and for post-disaster period, and follow-up activities for long-time period after disasters. It is important to understand not only the needs of geriatric people with dementia but also the caregivers' needs from their own perspectives. This information would help healthcare professionals assist in the development of intervention models of care to ensure both patients and caregivers' perceived needs are met. The present review has limitations on significant points for developing disaster-management strategies. Governments, healthcare professionals, epidemiologists, geriatricians and gerontologists must make efforts to diminish all negative impacts of disasters. For that reason, it is of great importance for all responsible to improve disaster management strategies with the contributions of multiple post-disaster studies.

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