



# Identifying and Describing Impact of Disasters on Non-Communicable Diseases: A Systematic Review

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(Received 12 Jul 2020; accepted 21 Oct 2020)

## Abstract

**Background:** Patients with non-communicable diseases are vulnerable to disasters. This is a systematic review describing the impact of disasters on non-communicable diseases.

**Methods:** A systematic review was conducted using PRISMA standards. Relevant articles published from 1997 to 2019 collected by searching the Scopus, PubMed, Science Direct, databases. We specifically examined reports describing NCDs and including the key words “non-communicable disease and Disasters”. NCDs included cardiovascular, respiratory, diabetes, cancer and mental health diseases.

**Results:** Of the 663 studies identified, only 48 articles met all the eligibility criteria. Most studies have shown the impact of all natural disasters on non-communicable diseases (39.8% n=19). The largest study was the effect of earthquakes on non-communicable diseases (29.2% n=14). For the NCDs targeted by this research, most of the included studies were a combination of four diseases: cardiovascular disease, respiratory disease, diabetes and cancer (44% n=21). Followed by cardiovascular disease (14.6% n=7), chronic respiratory disease (12.5% n=6), diabetes and cancer (6.2% n=3) and mental health (12.5% n=6).

**Conclusion:** The incidence of disasters affects the management of treatment and care for patients with NCDs. Specific measures include a multi-part approach to ensuring that patients with non-communicable diseases have access to life-saving services during and after disasters. The approach of the health system should be expanded from traditional approaches to disasters and requires comprehensive planning of health care by policy makers and health professionals to develop effective strategies to enable patients to access medical, therapeutic and diagnostic services in natural disasters.

**Keywords:** Disasters; Non-communicable diseases; Systematic review

## Introduction

We live in a world in 21<sup>st</sup> century that is continuously affected by emergency situations, often associated with highly serious consequences to local

and regional health. An increase has been observed in the rate of non-communicable diseases



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among recent examples that can refer to devastating storms and floods in USA, Australia, and Pakistan; earthquakes in Haiti, Japan and New Zealand; and conflicts in Syria (1). Non-communicable diseases (NCDs) such as cardiovascular disease, diabetes, cancer, mental health and chronic lung disease are a major threat to global public health (2-4). As the main cause of death and disability in 65.5% of mortality and about 50% of disability-adjusted living worldwide (1, 5, 6). In other word, 26.6 million deaths worldwide from NCDs in 1990, and its increase to 34.5 million in 2010 (5, 7). The annual death toll from non-communicable diseases is rising from 38 million in 2012 to 55 million in 2030 (4, 8-11). Global economic burden of NCDs, as estimated in 2010, was 6.3 trillion US dollars with an increase to 13 trillion US dollars in 2030 (12). Disasters can damage the basic infrastructure of public health and the necessary social protection systems for vulnerable populations. Disasters also affected people with NCDs, including loss of medicines, interruption of regular medical treatment and damage to hospitals (13-15). Patients suffering from non-communicable diseases e.g. respiratory, cardiovascular diseases, cancer and diabetes are among vulnerable groups in critical conditions, who face different problems following natural and man-made disasters (15).

Lung problems is the major cause of diseases and casualties resulted from natural disasters and respiratory damages are known as the main cause of death in various kinds of natural disasters, where a large amount of harmful suspended particles are released in the air (16).

Statistics on different diseases show that at the time of disasters, there have been an increased number of admissions by hospitals of patients with at least one chronic disease. As an example, in Sichuan earthquake, 47% of patients with hypertension and 24% of patients with diabetes constituted the highest rate of city hospitals admissions (17). Hurricane Katrina was an experience where it was observed that as health crises, patients with non-communicable diseases are in need of promoted crisis preparedness and response programs (18). This leads to indirect mortality and high complications up to 70%-90%, primarily due

to the exacerbation of life-threatening conditions and chronic diseases (19). Due to the large-scale disasters, non-communicable diseases are expected to cause significant health problems. Therefore, with development of anti-hazard measures such as earthquake-resistant construction, early warning can directly reduce the mortality of patients with non-communicable diseases and injuries caused by hazards. In unexpected disasters, preparedness to care for a vulnerable population is far more important than for healthy people (20-22). After disasters, inadequate care, resources, and lack of continuity of care for chronic diseases such as cardiovascular diseases, asthma, diabetes, renal diseases led to increased symptom exacerbation that resulted in increased morbidity and mortality among these populations (23). However, non-communicable diseases have received little attention from human-rights organizations in the acute phases of crisis and emergencies and there is a need to refocus disaster systems for the 21<sup>st</sup> Century (1). Generally speaking, there are few studies on the impact of emergencies e.g. natural disasters on non-communicable diseases, and it inevitably a need to improve the level of awareness and understanding of such patients with regard to their access to healthcare services during disasters. (24, 25).

Despite its significance and the critical role of the impact of disasters on patients with non-communicable diseases and the exacerbation of their symptoms, there are not enough studies on this issue (26). Manuals and instructions during disasters and crises often on communicable diseases such as Aleppo boil, measles, cholera and diarrhea; and considering authors 'research and literature reviews, there are limited number of studies on the management of non-communicable diseases in emergencies (27).

Management of patients with chronic diseases during emergencies such as natural disasters and crises require the formulation of an appropriate rescue manual (28). In consideration of the above-discussed, a systematic review on management of NCDs during disasters, and identifying and defining disaster impacts on it, for the purposes of reducing damages to patients and providing their

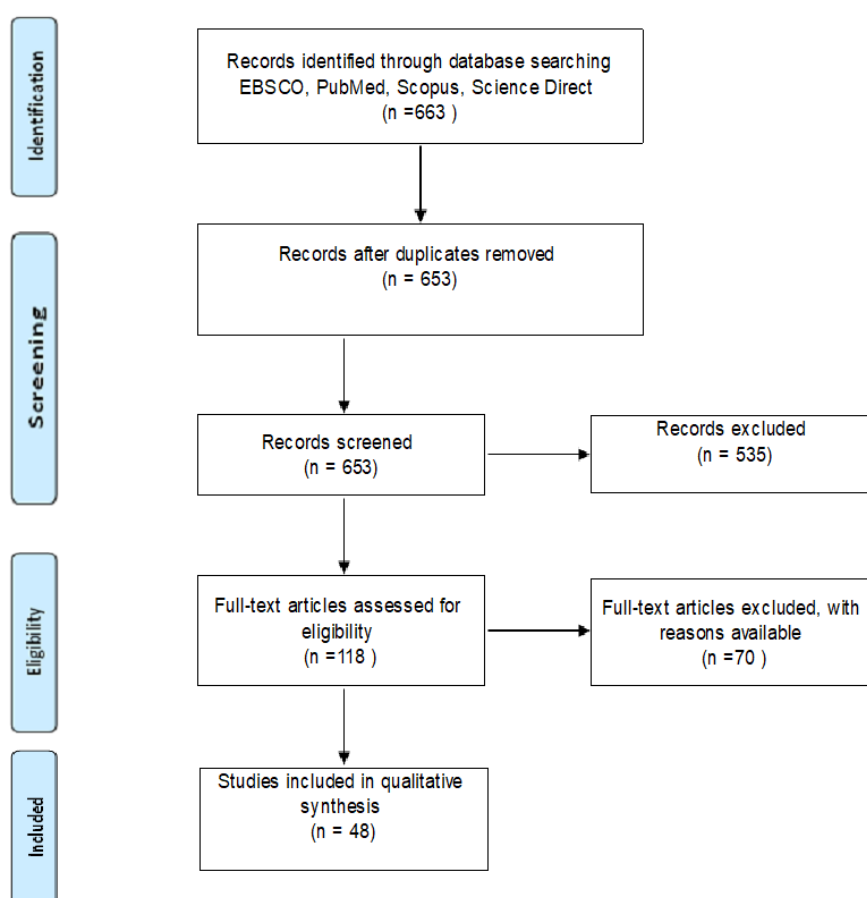
needs during and after disasters seem effective. Following the global increase in disasters and everyday increase in the number of people suffering from chronic diseases, there is a basic need to improve preparedness and emergency response to patients with chronic diseases during disasters.

Therefore, this study aimed to provide a systematic review in terms of identifying and defining the impacts of disasters on NCDs.

## Methods

### Research plan and Registration

This systematic review has been submitted to the International Prospective Register of Systematic Reviews (<https://www.crd.york.ac.uk/prospero/>) (Registration Number: CRD 42020164032). The review methods were guided by the PRISMA statement on systematic reviews, and the steps involved are shown in a PRISMA flow diagram (Fig. 1).



**Fig. 1:** Screening chart of the extracted studies in the systematic search in data banks for impacts of disasters on NCDs

### Eligibility Criteria

#### Inclusion criteria

An article was included in this review if all of the following were applicable:

1. Relevant articles published in accredited scientific and research journals

2. The abstract and text was written in English
3. Studies described impact of disasters in patients with NCDs

#### Exclusion criteria

An article was excluded from this review if any of the following was applicable:

1. Studies with inaccessible abstracts
2. Articles lacking required quality to be included in the study
3. Studies that described only infectious disease or injuries

### ***Quality assessment***

The researchers evaluated the quality of the selected articles based on valid checklists by type of study. Quality assessment of the observational studies such as cohort and cross-sectional articles was carried out by strengthening the reporting of observational studies in epidemiology check list (STROBE). Based on this checklist, studies obtain a score ranking from 0 to 34. Quality assessment of the experimental studies was carried out by transparent reporting of evaluations with nonrandomized designs (TREND). Based on this checklist, studies obtain a score ranking from 0 to 59. Quality assessment of the Qualitative studies was carried out by critical appraisal skills programme (CASP). Based on this checklist, studies obtain a score ranking from 0 to 10. Quality assessment of the systematic review and meta-analyses studies was carried out by preferred reporting items for systematic review and meta-analyses checklist (PRISMA). There are 27 items in this checklist. Each paper is reviewed in terms of these 27 items and marked either as implemented or not-implemented. If an item is not observed in a paper, it will be rated ZERO, and if the subject item is mentioned in the paper, it will be rated ONE. When items are not as distinct, the unclear parts will be repeated several times until a precise interpretation is ultimately reached and a valid evaluation of the study is made.

### ***Information Sources***

#### ***Databases used to search for sources***

The title and abstract of the remaining papers were independently investigated by two members of the research working group based on the inclusion and exclusion criteria. We reviewed articles electronically and through the following data banks: Scopus; Web of Science; PubMed; Clinical Key; Ovid Medline; Ovid EMBASE; CINAHL; EBSCO; Cochrane library; PsycINFO including articles from 1997 to 2019. In addition to these databases, we used websites of organizations such as: CDC, WHO, and FEMA. We also used disaster and chronic disease related published books.

### ***Literature search strategy***

The search was limited to the English language and was made for articles related to the topic using the following search terms: “non-communicable diseases” AND “disasters”, “non-communicable diseases OR chronic illness”, “disaster OR crisis” on all databases. The key words used in the search strategy were types of disasters, impact of disasters, disaster preparedness for individuals with chronic diseases, health practitioners and chronic diseases in a disaster, disasters and chronic diseases, health outcomes for chronic disease individuals after a disaster. The search strategy for NCDs terms is presented in (Table 1).

The search was made on the international databases including PubMed, Scopus, EMBASE, CINAHL, EBSCO and Clinical Key in the title/abstract field and on the Web of Science in the topic field, from 1997 to 2019. We selected relevant articles according to the inclusion and exclusion criteria in order of the title, abstract, and text. The gray literature was not actively searched, because they usually do not portray the whole picture of the results and when fully published the results may change substantially. Also, we chose key terms and developed a search strategy based on the National Library of Medicine “Medical Subjects Headings (MeSH)”.

**Table 1:** Classification of NDCs based on their subsets

<i>Type of Disease</i>	<i>Classification</i>
Cardiovascular	'Coronary artery disease', 'Myocardial Infarction', 'peripheral arterial disease', 'Ischemic heart disease', 'congenital heart disease', 'deep vein thrombosis' or 'pulmonary embolism', 'Hypertension', 'Blood Pressure'.
Chronic Respiratory Disease	'asthma', 'chronic obstructive pulmonary disease', 'COPD', 'Chronic lung diseases', 'lung disease' or 'pulmonary hypertension'.
Diabetes	'Diabetes Mellitus', 'Hyperglycemia'.
Cancer	'Malignant tumors' or 'neoplasms'.
Mental Health	'Behavior Problems', 'Depression', 'Mental Disorder', 'Mental Health Disorder', 'Psychological Disorder', 'Anxiety', 'Psychiatric Illness'.

### *Study Selection*

The WHO states that NCDs, also known as chronic diseases, are not transmitted from person to person. In addition to the 4 main types of NCDs (cardiovascular diseases, cancers, chronic respiratory diseases, and diabetes). In addition to the importance of mental illnesses that are considered non-communicable diseases, we added in addition to the four main diseases in this study. We also included all natural and manmade disasters in the study. This phase of the study was conducted in three sections. First, duplicate studies were deleted. Second, the title and abstract of the remaining papers were independently investigated by two members of the research working group based on the inclusion and exclusion criteria. When disagreement occurred, the opinion of a third reviewer was sought. Finally, the screened studies were selected based on the full text and independently by the researchers. Moreover, the reference lists of included studies were searched again for additional relevant articles.

### *Data extraction*

Data were extracted by researchers separately from a researcher-made checklist. This checklist includes the title of the article, Authors, the year of publication, study design, the type of NCDs, the type of disaster, the country.

### *Data Collection*

In our primary search, 663 studies were gathered. Of these, 10 were identified in two or more databases. Removal of the additional entries of the same articles left 653 unique studies. Examination of the abstracts identified 535 studies that did not fit the inclusion criteria described in the next paragraph. The remaining 118 studies were read in full, and a further 70 studies excluded, with reasons for each exclusion recorded. This gave 48 studies included in qualitative synthesis. (Fig. 1).

### *Results*

Initially 663 potentially relevant articles were identified. After re-assessment the titles, 10 articles were excluded due to repetition and 653 articles included the screening. After a title and abstract review, 535 articles were excluded based on exclusion criteria and 118 articles selected for full text review. After the full text review, 70 articles were excluded based on exclusion criteria. Finally, 48 papers were included in our systematic review. The process of selecting studies in the PRISMA flowchart is described in Fig.1.

Of the 48 articles, most of the included studies were conducted in USA (39.6% n=19) and Japan (25% n=12). The basic features of included studies are presented in Table 2.

**Table 2:** Articles used in impacts of disasters on NCDs

<i>Authors</i>	<i>Year of Publication</i>	<i>Study Design</i>	<i>Type of Disease</i>	<i>Type of Disaster</i>	<i>Location</i>
Robert et al.(24)	1997		Cardiovascular	Earthquake	USA
KikukoMori et al.(29)	2007	Quantitative Qualitative	Diabetes and Res- piratory Disease	Earthquake	Japan
Aldrich et al.(30)	2008	Qualitative	Combination of Four Diseases	All Natural Disas- ters	USA
Uscher et al.(31)	2009	Quantitative	Combination of Four Diseases	All Natural Disas- ters	USA
Ardalan et al.(32)	2010	Qualitative	Combination of Four Diseases	Earthquake	Iran
Korteweg et al.(33)	2010	Systematic Review	Combination of Four Diseases	All Natural Disas- ters and Manmade Disasters	USA
Ng et al.(34)	2011	Longitudinal Study	Diabetes	Flood	UK
Bethel et al.(25)	2011	Experimental	Combination of Four Diseases	All Natural Disasters	USA
Robinson et al.(35)	2011	Experimental	Respiratory Dis- ease	All Natural Disas- ters	Australia
Kim et al.(36)	2011	Systematic Review	Mental Health	Earthquake	Japan
Bandyopadhyay et al.(16)	2012	Experimental	Respiratory Dis- ease	All Natural Disas- ters	Japan
jiao et al.(37)	2012	Cohort	Cardiovascular	Hurricane	USA
demaio et al.(27)	2013	Systematic Review	Combination of Four Diseases	All Natural Disas- ters	Denmark
Ito et al.(38)	2013	Quantitative	Cardiovascular	Earthquake	Japan
Kobayashi et al.(39)	2013	Cohort	Respiratory Dis- ease	Earthquake	Japan
Matsumoto et al.(40)	2013	Systematic Review	Mental Health	Earthquake	Japan
Poopola et al.(41)	2013	Systematic Review	Mental Health	All Natural Disas- ters	USA
Funayama et al.(42)	2013	Quantitative	Mental Health	Earthquake	Japan
Kang. (43)	2014	Cross-Sectional	Combination of Four Diseases	All Natural Disas- ters	Korea
Ko et al.(44)	2014	Quantitative	Combination of Four Diseases	All Natural Disas- ters	USA
Nakayama et al.(45)	2014	Experimental	Respiratory Dis- ease	Earthquake	Japan
Owens et al.(26)	2014	Qualitative	Combination of Four Diseases	All Natural Disas- ters	USA
Lami et al.(46)	2014	Cross-Sectional	Combination of Four Diseases	Mass gathering	Iraq
Hunt et al.(47)	2015	Qualitative	Combination of Four Diseases	Earthquake	Japan



Khader et al.(48)	2015	Systematic Review	Combination of Four Diseases	Storm, Flood, Cyclone	Jordan
Pourhosseini et al.(49)	2015	Qualitative	Combination of Four Diseases	All Natural Disasters	Iran
Rayn et al.(50)	2015	Systematic Review	Combination of Four Diseases	Hurricane, Flood, Cyclone	Australia
Harada et al.(51)	2015	Systematic Review	Mental Health	Earthquake, Nuclear Accidents	Japan
Yoo et al.(52)	2016	Qualitative	Combination of Four Diseases	All Natural Disasters	Korea
Murakami et al.(53)	2017	Systematic Review	Combination of Four Diseases	Earthquake	Japan
Koenig et al.(54)	2017	Systematic Review	Combination of Four Diseases	All Natural Disasters and Mass gathering	USA
Slama et al.(28)	2017	Systematic Review	Combination of Four Diseases	All Natural Disasters and Manmade Disasters	Canada
Man et al.(55)	2018	Systematic Review	Cancer	All Natural Disasters	Australia
Becquart et al.(56)	2018	Quantitative	Cardiovascular	Hurricane	USA
Verna et al.(57)	2019	Qualitative	Cancer	All Natural Disasters	Italian
Nakhle et al.(58)	2019	Cohort	Cardiovascular	Hurricane	USA
Ryan et al.(19)	2019	Quantitative	Combination of Four Diseases	All Natural Disasters	USA
Ryan et al.(59)	2019	Quantitative	Combination of Four Diseases	All Natural Disasters	Australia
Nguyen.(60)	2019	Quantitative	Respiratory Disease	Hurricane	USA
Lawrence et al.(61)	2019	Cohort	Respiratory Disease and Cardiovascular	Hurricane	USA
Allweiss.(62)	2019	Systematic Review	Diabetes	All Natural Disasters	USA
Satoh et al.(63)	2019	Quantitative	Diabetes	Earthquake	Japan
Gohardehi et al.(64)	2019	Systematic Review	Diabetes and Cardiovascular	All Natural Disasters and Manmade Disasters	Iran
Aloisio et al.(65)	2019	Quantitative	Respiratory Disease	Earthquake	Italian
Prohaska et al.(66)	2019	Systematic Review	Cancer	All Natural Disasters	USA
Gichomo et al.(67)	2019	Qualitative	Combination of Four Diseases	All Natural Disasters	USA
Kloner et al.(68)	2019	Systematic Review	Cardiovascular	Earthquake	USA
Makwana et al.(69)	2019	Systematic Review	Mental Health	All Natural Disasters and Manmade Disasters	India

For the NCDs targeted by this research, most of the included studies were a combination of four

diseases: cardiovascular disease, respiratory disease, diabetes and cancer (44% n=21). Followed

by cardiovascular disease (14.6% n=7), chronic respiratory disease (12.5% n=6), diabetes and cancer (6.2% n=3) and mental health (12.5% n=6).

Of the 48 articles, (39.6% n=19) focused specifically on all natural disasters, (29.2% n=14) on earthquake, (10.5% n=5) on hurricanes, (8.5% n=4) on natural with manmade disasters, (4.2% n=2) on hurricanes with flood, (2% n=1) on flood, (2% n=1) natural disasters with mass gatherings, (2% n=1) on only mass gatherings and (2% n=1) earthquake with nuclear accidents.

The design of most studies was systematic review article (35.4% n=17), (23% n=11) quantitative article, (18.8% n=9) qualitative article, (8.4% n=4) cohort and experimental articles, (4% n=2) cross sectional and (2% n=1) longitudinal study.

In a literature review, people with NCDs, compared to those with good physical health, show significant ill health consequences.

### ***Cardiovascular Disease***

Patients with chronic diseases are vulnerable in disasters. Disregarding medical care for patients with cardiovascular diseases during and after disasters may cause the worsening of symptoms and signs including hypertension, cardiac arrest and even death.

Natural disasters including earthquakes are of the main stress factors in patients with cardiovascular diseases that can cause an increase in mortality rate (70). The impact that natural disasters have on patients with cardiovascular diseases may persist for weeks and even months after the outbreak, such as Hurricane Katrina (38).

The disruption of access to medical care, drug shortage, not maintaining a healthy diet, loss of patients' medical records, destruction of transport routes, and disaster-related environmental stressors cause the worsening of symptoms and signs in patients. In the occurrence of natural disasters like earthquakes, the worsening of symptoms and signs in patients with cardiac arrhythmias and heart failure persists for six months since the beginning of incident (71).

Moreover, some studies have discussed the increasing rate of cardiovascular diseases including

congestive heart failure, acute heart attack and atrial fibrillation after disasters (37).

### ***Chronic Respiratory Disease***

Patients with chronic respiratory diseases suffer from the worsening of symptoms and signs of disease including the shortness of breath (29, 35). After the incident, there is an increase in hospital admissions and hospitalization rates for patients with chronic respiratory diseases such as asthma and COPD (16). Natural disasters including floods, earthquakes, hurricanes, etc. affect adversely the clinical consequences in patients with chronic respiratory diseases. Therefore, following natural disasters, admission and hospitalization of these patients and their hospital care is essential (39).

Among the most important causes of worsening respiratory signs in patients with chronic respiratory diseases are: disruption of access to medical care, lack of access to medicines, crowd, lack of respirator masks, oxygen and nebulizers, increased allergens and dust, destruction of transport routes, stress, poor diet and exposure to cold weather (16, 29, 35, 39, 60).

Among the major problems of these patients in need of CPAPs like ventilators, is that they face problems following the incident and power cut; hence, a communication support system like generators is required to be available and planned for these patients (45).

Elevated levels of allergens after disasters are another cause of worsening respiratory illness (72). Studies related to chronic respiratory diseases in disasters confirm the fact that such patients are among high risk groups after disasters.

### ***Diabetes***

Following incidents and disasters, patients with diabetes are also among high risk and vulnerable groups affected by disruptions in medical care during and after disasters, impacts that persist for months after the incident.

Inadequate nutrition, lack of access to medication, lack of insulin, limited physical activity, loss of medical records, loss of insulin kits, lack of access to laboratory measures, lack of awareness of pa-



tients and health care workers are the most important causes of disease exacerbation in patients with diabetes (34, 62, 63).

### **Cancer**

After disasters, patients with cancer face transport disruption, destruction of chemotherapy and radiotherapy clinics, hospitals and doctors and medicines. Reducing access to care and treatment in these patients can continue for up to 1 year, based on the experience of Hurricane Katrina (73).

Damage to infrastructure, support systems, communication and information systems, patient's refrain from treatment adherence, destruction of hospitals, destruction of radiotherapy, laboratory and paraclinical departments cause disruption in medical care of patients with cancer (55).

### **Mental Health**

Most patients with mental disorders had higher rate of hospitalization following the worsening of their symptoms, change of residence, loss of their family members, and loss of their job after disasters (40). Shortage of some drugs, especially antidepressants and anticonvulsants, causes many problems for these patients (36).

Depression, anxiety, sleep disorders, PTSD, alcohol dependence, emotional instability, hopelessness, Suicidal thoughts and fear were the most common disorders (69).

Being in the denial phase after disasters leads to increased stress, anxiety, fear and other maladaptive reactions. In Man-made disasters, fear, suspicion, paranoia, obsessive thoughts and suicidal ideation are the most common problems for these patients (69).

### **Discussion**

Natural and man-made incidents and disasters affect the management and medical care of patients with chronic diseases. Such impacts lead to the worsening of symptoms and signs of the disease and even death. The most important causes of exacerbation in these patients following disasters include loss of medical care, lack of access to medicine, poor nutrition, lack of awareness of patients

and medical staff, transportation disruption, lack of laboratory facilities, destruction of medical centers, and loss of medical records, Exacerbates stress and anxiety and sleep disorders (53, 54). Lack of proper care and treatment, even for a short time, puts at risk patients with NCDs.

Patients with cancer, it can exacerbate the disease and increase the risk of death. In patients with cardiovascular diseases, it leads to heart attacks, hypertension, pulmonary embolism and acute MI and death.

In patients with chronic respiratory disorder, it exacerbates symptoms and increases hospital admissions and increases the need for ventilators and oxygen therapy.

In patients with diabetes, symptoms for example diabetic ketoacidosis, hypoglycemia, increased mortality, and especially in insulin-dependent patients occurred following disasters.

Symptoms such as anxiety, fear, depression, PTSD, suicide, emotional instability, and frustration are seen in patients with mental disorders.

The effects of disasters in patients with non-communicable diseases require continuous evaluation, even for months after the crisis. Follow-up helps reduce the effects of disasters on patients.

It is vital to create plan and useful strategies in emergencies situation before a disasters occurs. Adequate access to medicines and medical care, improving the level of cooperation between national and international agencies in the field of public health, appropriate response of the emergency team in emergencies, preservation and management of patient information and records, integration of non-communicable diseases in policy Instructions and guidelines in critical situations, self-care training for patients in disasters, training of health care workers, the existence of an emergency evacuation plan for patients with chronic diseases, and the provision of psychiatric interventions help reduce the effects of disasters on patients.

## Conclusion

Disasters and incidents affect the management and medical care of patients with chronic diseases; therefore, health and medical systems require a change in traditional approaches to disasters. Improving emergency preparedness for preplanning and providing self-care training to patients is essential. Safe and correct patient identification during disasters and provision of timely services and relief can reduce the impact of disasters on diseases.

## Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

## Acknowledgements

This article is extracted from a PhD thesis on health in emergency and disaster with COI: IR.UMSU.REC.1398.228, Urmia University of Medical Sciences by the research center for social factors effective on health. We extend our special thanks to supervisors and advisors collaborated in this research.

## Conflict of interest

The authors declare that there is no conflict of interests.

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