

**RISKS TO RESPONDERS' SAFETY AND MITIGATION STRATEGIES DURING  
RESCUE WORK IN NATURAL DISASTERS: A SCOPING REVIEW**

By

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## TABLE OF CONTENTS

PLAGIARISM DECLARATION .....	1
ACKNOWLEDGEMENTS .....	2
TABLE OF CONTENTS.....	3
LIST OF TABLES .....	5
LIST OF FIGURES .....	6
ABBREVIATIONS.....	7
PART A: LITERATURE REVIEW .....	8
Background.....	9
Aim .....	13
Search strategy .....	13
Literature Review.....	14
Natural disasters and emergencies.....	14
Factors affecting the health and safety of EMS.....	16
General health and safety risks EMS .....	16
Health and safety risks specific to natural disasters .....	19
Poor management of resources .....	21
Health and safety outcomes.....	22
Accidents and injuries.....	22
Violence at work .....	24
Musculoskeletal disorders .....	24
Fatalities .....	25
Adverse health outcomes on mental health.....	26
Adverse health outcomes of radioactive exposure .....	28
Adverse health outcomes associated with chemical risks .....	28
Adverse health outcomes related to biological risks .....	30
Preventative measures .....	30

Communication and coordination at the international level .....	31
Emergency policies .....	31
Organisational measures: Safety and health management.....	32
Summary and conclusion.....	38
References.....	40
<b>PART B: MANUSCRIPT IN ARTICLE FORMAT .....</b>	<b>57</b>
Abstract.....	59
Introduction .....	60
Methods .....	61
Search strategy and eligibility criteria.....	62
Results.....	62
Discussion.....	73
Conclusion .....	74
Limitations.....	75
Acknowledgements.....	75
Declaration.....	75
References.....	76
<b>PART C: APPENDICES .....</b>	<b>80</b>
APPENDIX 1: Instructions for authors.....	81
APPENDIX 2: Research protocol.....	82
APPENDIX 3: HREC approval letter .....	101

## LIST OF TABLES

Table 1 Summary of scoping review research articles.....	66
Table 2. Proposed timeline .....	93
Table 3. Budget .....	94

## LIST OF FIGURES

<b>Figure 1:</b> Results of article search, screening and review.....	63
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## ABBREVIATIONS

COVID-19	Coronavirus Disease
EMS	Emergency Medical Services
HIV	Human Immunodeficiency Virus
PHE	Public Health Emergency
PPE	Personal Protective Equipment
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
PTSD	Post-Traumatic Stress Disorder
WHO	World Health Organization

## **PART A: LITERATURE REVIEW**

## Background

The International Federation of Red Cross and Red Crescent Societies (IFRC) defined a disaster as “a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community’s or society’s ability to cope using its resources. Though often caused by nature, disasters can have human origins.” (1). The term “disaster” has long been used in a manner that is incorrect and misleading. As highlighted in the definition, a hazard can only become a disaster once it affects society negatively or destructively (1). Hazards are natural, whereas disasters are not, for example, volcanoes, typhoons and earthquakes, whose occurrence is not triggered by human beings. A disaster often occurs due to the interaction between hazardous disasters and human societal activities. For instance, deforestation may lead to landslides and the increasing rate of agricultural activities may lead to desertification (2). Regardless of the decisions taken by human beings, natural disasters will still occur (2).

Several countries are not prone to natural disasters; however, that does not imply that they are exempt from natural disasters (3). Every natural disaster type has a different effect on humans, such as Earthquakes can cause buildings to collapse and wildfires can cause the ignition of buildings. In many countries, the most common or prominent natural catastrophes usually occur floods, tropical cyclones, severe thunderstorms, tornadoes and drought. These natural catastrophes typically lead to structural damage to infrastructure and loss of lives (4).

Natural disasters frequently occur across the world and threaten the lives of many. A few mentionable natural disasters that have taken place in the last 20 years include Hurricane Katrina in the US Gulf Coast (2005), Cyclone Nargis in Myanmar (2008), Great East Japan Earthquake and Tsunami (2011), and Hurricane Sandy (2012). Such disasters had severe and long-term effects on the affected population’s safety and community health (4-6). The negative health impacts of natural disasters could impact directly (for example, mortality) or indirectly (for example, famine and infectious diseases) (5, 7). Because of natural disasters, the health issues are compounded by the loss done to the healthcare system, water and food, infrastructure of sanitation, and displacement of affected communities (8, 9). According to the World Health

Organization (WHO), numerous needs can be anticipated, such as search and rescue and medical assistance; however, responding to these areas during and after the disasters put the responders and rescuers safety at risk (10).

The primary purpose of emergency medical services (EMS) is providing immediate medical care to the people who need it the most with the general preamble of improving a better quality of life for the communities they serve (11). EMS responders and professionals are commonly trained to work on typical day-to-day emergencies throughout their cities and communities. Natural disasters present emergency scenarios that represent significant challenges to EMS professionals in serving their purpose effectively, mainly influenced by numerous factors that include physical factors (injuries and physical barriers), mental factors and psychological states, and interpersonal factors. Emergencies can be so widespread and dangerous that local EMS may lack the needed resources (that is, funds, expertise, equipment and personnel) to respond safely and effectively. Irregular and unpredictable working hours; fatalities; high responsibility for the lives of people; violence at work; severe time pressure; as well as handling numerous injured people all represent hazards that have the potential result in serious emotional overstrain in EMS professionals(48,49). An experience of a situation that is life-threatening or results in serious injury or represents a threat to the physical integrity of an individual; Natural disasters represent events that are highly likely to be potentially traumatic resulting in EMS professionals experiencing profound feelings of revulsion, horror, helplessness, despair and grief (21, 46, 48). The Diagnostic and Statistical Manual of Mental Disorders (DSM) provides a detailed definition of post-traumatic stress disorder (PTSD) identifying the qualify criteria of a traumatic event which needs to be met (50).

Despite the lack of adequate resources, responders are not hesitant execute their duties as been trained to do, that is, go to attend to an emergency scene prepared to provide immediate medical assistance and save lives. When the local health organisation's capabilities and resources are overwhelmed by a natural disaster, responders have come from other areas and other national or international health organisations to assist in the affected area. Skilled support personnel are involved in specialised tasks, for example, removing debris and fixing utilities and transport (1). However, neighbours and other volunteers may be present at the scene of the disaster to offer some assistance. Other concerned individuals as well as organisations donate equipment, supplies and food (12)

One of the characteristics of natural disasters is that the response stages change quickly. There is always an underlying presence of risk with natural disaster response. This risk can be familiar or unfamiliar, depending on the nature of the disaster (13). Moreover, recent natural disasters have created many safety and health problems, including apprehension, for emergency responders in those countries that have been

affected (14, 15). The safety officers and health specialists responsible for enforcement and regulatory rule compliance must ensure EMS responders are safe while working and performing their functions during natural disasters. However, this is not an easy task as it is difficult to predict natural events and be fully prepared and anticipate the dangers, impacts, and far-reaching consequences on individuals or populations safety and well-being (16). Similar to previous natural disasters, like Hurricane Katrina (2005), the tsunami in the Indian Ocean (2004), wildfires in Australia (2009), Haiti earthquake (2010), and the floods in Pakistan (2010), the effects on the population and civilisation in affected countries were overwhelming and immediate (17-20). Every time EMS responders take action against these kinds of natural disasters, they put their safety aside and risk their lives to perform the rescue activities (21). While the complete elimination of threats is not possible, strategies can be implemented to for the management of the involved risks manage to as well as ensure the disaster EMS workers and all other personnel involved in the disaster response. The safety plan should meet the responders' safety and health needs at every phase of disaster work (13).

There are different types of healthcare responders. This research will only focus on the EMS responders because of the service they provide, they are among the first to arrive at the scene and the nature of their work is high-risk. EMS are more exposed to factors because they are generally the first responders and may not know the disaster's exact situation and extent. EMS responders are highly susceptible to these risks in the case of a natural disaster posing health and safety risks.

The "Emergency Medical Service" or "EMS" refers to a person, body, or organisation equipped, staffed and dedicated to offering: (a) emergency medical care; (b) transport of the ill or injured; or (c) inter-health facility medical treatment (22). Emergency care or emergency medical care refers to "the evaluation, care and treatment of an injured or sick person in an emergency care situation and the continuation of treatment and care during the transportation of such person to or between health establishments" (22). In this regard, an emergency care situation can be contextualised as the situation or circumstance during which an injured or ill person requires emergency care. EMS personnel usually offer emergency medical care. To transport a sick or injured person during the medical care situation, the EMS personnel or paramedics typically use an ambulance.

The WHO indicated that public health security is threatened by pandemic-prone and epidemic diseases (23). These diseases are likely to result in high morbidity and mortality levels and they have severe adverse impacts on the economies of the regions they affect at the community level up to the global level (24). African countries have experienced such diseases like Lassa fever, meningococcal meningitis, yellow fever, influenza, Marburg and Ebola viruses and cholera epidemics (24). One of the deadliest epidemics that has been reported in the 21<sup>st</sup> century is the outbreak of the novel coronavirus disease of 2019 (COVID-19) in mainland China which was declared, by the WHO, a public health emergency (PHE) (25).

To contain the outbreak of the novel coronavirus, medical support teams were dispatched by the National Health Commission of the People's Republic of China (NHCCPRC) to support medical care in Hubei Province and in the city of Wuhan (25).

There is a need to understand a wide range of physical, mental, as well as interpersonal factors affecting the health and safety of EMS responders during their response work. EMS responders are of paramount importance during emergency care situations. Activities of disaster response are classified into five groups: disaster recognition, disaster notification, mobilisation, response as well as demobilisation (11). The EMS are essential during all phases of response to a natural disaster, with notable critical roles including on-scene treatment, mass-casualty triage, communication, evacuation, patient transport coordination, and patient tracking (11). Also, EMS personnel are involved in leadership roles during their response to natural disasters, and they may be a part of the command staff, including being regarded as significant stakeholders of national or regional assets (11).

During some major natural disasters, the prolonged duration of operations has required response organisations to implement measures of sustainability that are unfamiliar (26). Numerous hazards that are caused by natural disasters may not be apparent until well after the end of disaster response operations (26). There is a lack of clarity in understanding the factors that influence EMS responders' safety (27). Therefore, to identify these factors, a scoping review of published research will be conducted. This research aims to characterise the available literature, thereby showing areas of saturation and areas requiring focus. Therefore, the objective of this review is to map the available evidence to provide an overview of factors that influence

the safety of disaster EMS responders and identify areas/factors that need further attention.

### Aim

This study aimed to identify factors that affect EMS responders' health and safety in natural disasters and provide information to mitigate harm in future natural disasters.

### Search strategy

A three-step search strategy, as recommended by Aromataris *et al.* (28) and similar to that of a standard systematic review, was employed to identify all literature in a systematic and exhaustive manner as follows:

1. A search of pre-identified databases (chosen for relevancy, to include PUBMED, MEDLINE, google scholar, SCOPUS, African-Wide, and National ETD (grey-literature) was undertaken to gather titles and abstracts on studies relating to implementation in natural disaster settings and EMS safety. All text was then analysed to identify keywords. Index terms were abstracted and reviewed for relevancy, as were medical subject headings (MeSH), where appropriate.
2. Keywords and index terms identified in step 1 were used to search all databases for appropriate studies.
3. Reference lists from all studies identified in step 2 were reviewed to identify additional studies.

Inclusion criteria:

- Articles published between 2000 and 2020
- Articles pertaining to natural disasters and EMS responder safety
- Articles that outline interventions to mitigate health and safety risk of EMS in natural disasters
- Both review and original research articles
- Articles need not be directly related to healthcare
- Grey literature

Exclusion criteria:

- Articles published prior to 2000 and after 2020
- Articles were screened by assessing the title and the abstract. The full-text manuscript of screened articles was evaluated to determine eligibility.

Data from studies meeting eligibility criteria were extracted and charted for analysis. The following fields were extracted for the study, where applicable:

- Author(s)
- Year of publication
- Complete citation
- Source origin/country of origin
- Resource-level of the study setting
- Aims/purpose
- Study population and sample size
- Methodology
- Description of disaster type
- Description of disaster magnitude
- Health and safety risks to EMS responders
- Interventions to mitigate the health and safety risks to EMS responders

Results were then classified under main conceptual categories and summarised using charts, tables, and maps.

## **Literature Review**

### **Natural disasters and emergencies**

This research explores factors determining EMS's health and safety concerning 'emergencies' and 'natural disasters'. The occurrence of emergencies is more frequent than that of disasters; though they require an immediate and appropriate response, they may result in a disaster, particularly when emergency response fails. The WHO defines an emergency as "... a state in which normal procedures are suspended and extra-ordinary measures are taken in order to avert a disaster" (29).

On the other hand, a disaster is identified as "...an occurrence disrupting the normal conditions of existence and causing a level of suffering that exceeds the capacity of adjustment of the affected community" (29). Natural disasters are a natural event

(forest fires, hurricanes, seismic events, floods) that adversely affects human activity, property or life with the level of suffering exceeding the capacity of the community that is affected (30). There is a consensus in literature with regards to the effect of disasters as they are viewed as having the potential to simultaneously affect numerous people and engendering a vast array of stressors which include the threat to human physical integrity and life, profound loss, ongoing hardship, community and social disruption, bereavement, and exposure to death and dying (31-33).

The prevalence of natural disasters is noted to cover a broad scope. According to the reviewed literature, approximately 75% of Earth's population live in areas prone to natural disasters. The occurrence of natural disasters is noted to be increasing since the year 1900 (34). With the increase in the global population, increased pressure on natural resources, as well as the exacerbated global warming, the prevalence and severity of negative effects of natural disasters are predicted to increase (35).

Events resulting from the Earth's natural processes that are likely to cause disasters and emergencies can be categorised into biological (insect infestations and epidemics), geological events (volcanic eruptions, tsunamis and earthquakes) and hydro-meteorological events (avalanches, landslides, vegetative fires, drought, extreme temperatures, windstorms and floods) (36). The most frequent disasters, based on data from 1998 to 2017, are noted to be floods (accounting for 43% of the total), volcanic activity (1%), wildfires (4%), drought (5%), landslides (5%), extreme temperatures (6%), earthquakes (8%) and windstorms (28%) (37). Of all the natural disasters, 91% resulted from heatwaves, storms, floods, drought and other extreme weather events (37). Historically extreme weather events pose the most significant health and safety risk to the general global population and the EMS that attend to them. However, in 2020 COVID-19 caused the greatest number of fatalities among the general population and the EMS across the globe (38). Knowledge of the prevalence of natural disasters is useful in allocating limited resources for the identification and mitigation of health and safety risks that afflict EMS. Given the prevailing situation and the predicted trend, EMS's importance cannot be emphasised enough (39-41). As a result, their safety and health are of the utmost importance.

## **Factors affecting the health and safety of EMS**

Given the nature of their work, EMS are extremely prone to health and safety issues caused by natural disasters. As noted in the literature, EMS face numerous health and safety hazards and are often unavoidable (27). Furthermore, EMS often does not face a single and isolated hazard but rather tend to face a combination of risk factors that are complex and highly dynamic and unpredictable (27). There are general factors that affect EMS's health and safety in any emergency, including physical and psychological overstrain. Furthermore, some factors are uniquely associated with natural disasters. Additionally, there are risk and safety factors caused or worsened by poor management of resources (13). The following subsection discusses the factors that affect EMS workers' health and safety in general and specifically in the occurrence of natural disasters.

### General health and safety risks EMS

#### *Physical overstrain*

EMS work is often physically demanding characterised by short breaks, working overtime and long shifts. EMS professionals are particularly exposed to the risk of developing musculoskeletal disorders (MSDs) that are a result of work tasks that are psychologically and physically demanding (42). The following are the risks of musculoskeletal disorders and injuries to which EMS workers are exposed to (42):

- working under extreme time pressure;
- being exposed to whole-body vibrations when travelling on poor roads,
- wearing heavy protective equipment;
- prolonged time doing sedentary activity (like driving an ambulance); and
- the musculoskeletal system being overexerted from frequent moving and lifting objects, dead bodies as well as patients (such as extrication of patients, stretchers or specialised rescue equipment) as well maintaining incorrect postures for the prolonged time periods.

Evidence from prior research identified that EMS personnel noted the main strain they faced in their work to involve carrying as well as lifting people and things (43). Ambulance drivers were noted to perform tasks which go beyond just driving ambulances as they also exercise the functions EMS workers (44). EMS professionals

frequently work on their own, having to move people who are sick from one point to another. Whole-body vibrations caused by travelling on bumpy roads, high physical workloads and sedentary activity all represent factors that pose the risk of musculoskeletal disorders.

### *Emotional overstrain*

The ability of EMS workers to avoid negative stressors within their working environment significantly reduced when they attend to 'critical incidents', which refer to incidents that are sufficiently disturbing to threaten to overwhelm or to overwhelm individuals' usual coping methods. Irregular and unpredictable working hours; fatalities; high responsibility for the lives of people; violence at work; severe time pressure; as well as handling numerous injured people all represent hazards that have the potential result in serious emotional overstrain in EMS professionals (45, 46). The psychological burdens that EMS worker face may also be associated with moral dilemmas in situations which involve decisions of balancing the safety and health of the EMS worker and the health and safety of others. In some instances, EMS professionals may be confronted with public expectations that are unrealistic, including circumstances where the potential benefit of intervention are outweighed by the health and safety risks (47).

Among EMS professionals, diagnosed mental illness or symptoms of mental illness may be a result of the strong feelings and impressions they bear in situations where they are faced with destruction as well as despair, suffering, pain, injuries and death of the victims of disasters (48). EMS workers have the burden of responsibility for other people's lives, confronted with immense psychological demands, and the impression that any failures or errors could result in the death of someone and result in feelings of guilt that are challenging to cope with (49). The time that EMS workers spend attending to a natural disaster scene is significantly correlated with the extent to which psychological consequences are severe at a later date (49).

The Diagnostic and Statistical Manual of Mental Disorders (DSM) provides a detailed definition of post-traumatic stress disorder (PTSD) identifying the qualify criteria of a traumatic event which needs to be met (50).

Traumatic events can include the following:

- An experience of a situation that is life-threatening or results in serious injury or represents a threat to the physical integrity of an individual;
- circumstances involving the witnessing another person's injury, death, or threat their physical integrity;
- an event where an individual experiences helplessness, intense shock or fear after the event.
- circumstances involving receiving the news of serious injury or death of close associates or family members that is unexpected;

Natural disasters represent events that are highly likely to be potentially traumatic resulting in EMS professionals experiencing profound feelings of revulsion, horror, helplessness, despair and grief (21, 46, 48). Excessive stress is likely to result in PTSD, and severe symptoms of burnout and depression. Increased levels of stress in EMS workers are noted to be associated with levels of professional and personal preparedness that are low (51, 52).

The diagnosis of PTSD is based on numerous diagnostic criteria that are met for a minimum period of a single month (50). The symptoms of PTSD need to disrupt an individual's functioning in their private or professional lives characterised by dissociative states over periods which range from seconds to days with the afflicted individuals behave like they are experiencing the traumatic event again; recurring distressing dreams; and constantly recollecting the traumatic event. The individual afflicted by PTSD avoid anything associated with the trauma and may further suffer psychological distress that is intense in situations when they are confronted by elements that are symbolic or reminiscent of the traumatic event (50). These challenges are commonly paired with emotional numbness, which may include detachment of feelings or reduced participation and interest in everyday life (53). Symptoms of PTSD also include persistent increased arousal resulting in concentration problems, irritability, nightmares and difficulties falling asleep (48, 53).

Often times, mental health problems are accompanied by depression which results in individuals feeling 'low' for the majority of the day, bringing a loss of pleasure or interest the majority of daily activities. This depression may also be associated with other symptoms which include recurrent thoughts of suicide and death, fatigue, feelings of

worthlessness, concentration problems, psychomotor agitation (restlessness), insomnia or hypersomnia and weight loss (46, 54, 55).

The work of EMS professionals is characterised by the requirement to be emotionally empathic and suppress emotions while working; confrontation with death and dying; severe time pressures as well as high workload, factors that present risk burnout. Burnout can be defined as a “long-term reaction to occupational stress” and may be characterised by three factors as follows (56):

- depersonalisation: individual’s loss of compassion and concern for their environment;
- reduced personal accomplishment: believing the diminishing of one’s competencies;
- emotional exhaustion: feeling ‘empty’ due to contacts with others, emotional fatigue.

EMS workers who suffer from burnout often complain of exhaustion that is paired with absences due to recurrent short-term sickness, reduced motivation (demoralisation and loss of interest), reduced efficiency and heightened tension which result in suboptimal performance at work (27, 57-59).

#### Health and safety risks specific to natural disasters

Supporting the population’s vaccination, recovering dead bodies, providing medical assistance and rescuing survivors include some of the principal responsibilities of EMS professionals in response to the occurrence of natural disasters (27). Specific risks that EMS workers are exposed to are associated with the general devastation of infrastructure and communication lines; destruction of electrical installations; collapsing buildings and other structures; and significant devastation of their working environment (48, 60, 61). Circumstances of natural disasters also require that EMS professionals operate in confined spaces, at the risk of serious injury by aggressive animals, falling debris or being trapped (61-63).

Oftentimes, natural disasters involve flooding (resulting from tsunamis, windstorms and rainstorms) and the risks related include exposure to water-spread vector-borne diseases and drowning (63). The spread of water-borne diseases is noted to occur particularly when the EMS workers or population affected directly come into contact

with water that is contaminated with viruses, bacteria or other microorganisms in high concentrations. Examples include situations where EMS professionals need to work in contaminated surface water and when sewage gets into the supply of drinking water (63). Typical water-borne diseases include shigellosis, rotavirus, parasitic diseases, hepatitis E, hepatitis A, typhoid fever, cholera and diarrhoea (21, 63).

The likelihood of vector-borne diseases spreading occurs in natural disasters involving flooding or requiring the erection of field camps to cater for disaster victims and there is poor waste management. Pooled and stagnant water represents a mosquito breeding site and the nutrients in poorly managed waste also attract disease-carrying rodents. Mosquitoes often carry and spread diseases like West Nile fever, St Louis encephalitis, dengue and malaria. Rodents' excrement likely contains large quantities of leptospira, thereby facilitating the spread of leptospirosis (63).

EMS workers are at risk of being afflicted by infectious diseases through contact with survivors and particularly, infected wounds. These infectious diseases include those transmitted through droplet infection (for example, COVID-19 and tuberculosis); blood-borne diseases such as Human Immunodeficiency Virus (HIV) as well as hepatitis B and C; and those transmitted through smear infections (gastrointestinal diseases). The majority of tuberculosis infections, gastrointestinal illnesses and blood-borne illnesses in natural disasters are associated with EMS workers' contact with dead bodies (21, 64, 65).

EMS workers providing medical services in natural disasters are at risk of asthmatic and respiratory issues. Natural disasters like landslides, wildfires and earthquakes result in significant amounts of smoke, dust, ash and gas. All these emissions cause pulmonary as well as eye irritation and asphyxiation in the severest of circumstances. Furthermore, oftentimes the by-products from burning material are carcinogenic (33). Vegetative fires, erupting volcanoes and fires resulting from the secondary effects of natural disasters lead to heat stress, burn and possible skin injuries. The likelihood of transportation accidents is also increased by the air pollution caused by ash and gas released from volcanic eruptions, dust from collapsed buildings, and smoke from fires (33).

When attending to natural disasters, EMS employees are confronted with the increased risk of needle-stick injuries as well as the exposure to bodily fluids and blood

in pre-hospital health care and providing medical assistance to victims. There are four diseases that are of primary concern in these situations and they are hepatitis C, hepatitis B, HIV and, more recently, COVID-19 (66, 67). When coming into contact with dead bodies or survivors in instances of the occurrence of natural disasters in areas where tuberculosis is widespread among the population, EMS professionals need to take into serious consideration the possible transmission of infection. Tuberculosis particularly prevails in developing nations in Africa as well as Asia (24). Tuberculosis may be transmitted when EMS professionals physically interact with infected individuals who talk, sneeze, spit or cough, resulting in the emission of tuberculosis bacillus into the air or when EMS professionals handling dead bodies breathe in residual air from the chest cavities of infected bodies (65).

#### Poor management of resources

Cooperation at international, national, local and organisational levels is of the utmost importance in attending to all types of emergencies, subject to their scale. The absence of immediate and precise information on the real situation at the scene of a natural disaster as well as the unpredictability of unfolding events are inherently part of EMS work. However, poor cooperation amongst various groups and authorities attending to disaster emergencies enhances the risk of exposure to the health and safety of EMS professionals.

The poor management of resources leads to issues of inappropriateness, insufficiency and lacking regarding:

- preparedness plans;
- training;
- communication and information dissemination after, during and before the natural disaster;
- the coordination of all groups of attending to a particular natural disaster, considering the specific tasks they are assigned, the different communication systems used, or the language they understand;
- protective clothing and personal protective equipment; and
- post-disaster support.

Various groups attending to emergencies, inclusive of EMS workers, may use radio systems which are incompatible, leading to a breakdown in communication resulting in significant adverse effects, increasing the difficulties faced by disaster managers in maintaining control over the scene of a disaster, share the necessary safety information and utilise the forces at their disposal effectively (13). The lack of a standard communication system and their poor management may result in confusion among the groups attending to a disaster, leading to severe safety issues among EMS responders (13). Incompatibility of channels for the dissemination of information and the lack of a common language has adverse effects, particularly in the case of cross-border collaboration.

### **Health and safety outcomes**

EMS responders are vulnerable to numerous risks simultaneously, and the consequences for their health as well as safety are likely to be manifold. Multiple EMS workers are afflicted by injuries and accidents and other harmful effects on their health in executing their jobs. These health and safety outcomes have deteriorating effects on the physical as well as psychological well-being of EMS workers. Identifying the health and safety outcomes of natural disaster hazards on EMS workers. The most common consequences faced by EMS workers, based on the review of relevant literature, include fatalities; musculoskeletal disorders; violence at work; injuries and accidents; mental health issues; negative effects on radioactive exposure; adverse effects of the exposure to harmful chemicals; and adverse effects of biological contagions. Understanding EMS workers' health and safety outcomes from exposure to natural disaster hazards help identify preventative measures and resolutions.

#### Accidents and injuries

Non-fatal accidents and injuries are common in EMS workers as a result of natural disasters. Approximately a fifth of non-fatal injuries and accidents are noted to require a leave of work of 10 days or more (68). More extended periods off work are noted to prevail in older EMS personnel (68). Most EMS workers were injured or involved in manually moving or carrying objects and victims (69). Similarly, works of research identify the common injuries incurred by EMS workers while they were lifting, carrying, or handling people and material and falls, trips and slips; and being struck by falling,

flying or moving objects (70-72). Repetitive or strenuous movements and overexertion are the most common causes of occupational accidents that befall EMS workers in attending to natural disasters.

Complicated tasks that divide workers' full attention are also noted to reduce their ability to balance and control body movement while moving, consequently exposing them to injury (73). Slip, trip and fall (STF) accidents present the most common accidents for EMS workers and other hospital workers, within the hospital setting as a result of liquids contaminating floor surfaces (74). The reviewed literature noted that within the USA's hospital environment the occupation that is most exposed to STF injuries is in emergency medical/transport services (74). Accidents requiring sick leave of three days or more that were caused by STF accidents were noted to constitute a significant component of work-related accidents among emergency workers; including paramedics/ambulance drivers (73, 74).

Full-time EMS employees are identified as suffering at least five times more injuries than those with more time off work (70). These results are also echoed in the literature that identified a significant correlation between occupational injuries and time at work by EMS workers attending natural disasters (60, 75, 76). Additionally, it is noteworthy that there is a positive and significant correlation between age and the incidence of STF accidents as older EMS workers were injured at work more often than younger personnel (74). Furthermore, the additional weight of personal protective equipment (PPE) was a factor that significantly contributed to some accidents (77). The personal protective equipment that is required when attending to natural disasters impairs functional and postural balance of EMS professionals significantly (43). This represents a dilemma and a gap in current research and practice because PPE is necessary; however, it can impede EMS workers attending emergencies caused by natural disasters.

EMS workers' most commonly injured body parts were identified to include the back and lower extremities because of STF accidents due to tears, dislocations, strains, and sprains (74, 78). Additionally, STF accidents were often noted to cause multiple injuries and fractures compared to other accidents types (74). Furthermore, injuries of the back and lower extremities to EMS workers during natural disasters are mainly due to excessive exertion needed in transporting and handling people, PPE and other

heavy work equipment (79). The reviewed literature also noted that most EMS personnel accidents resulted from stretcher mishaps, particularly in moving heavy patients (43).

### Violence at work

Violence at work is also identified as another outcome of EMS workers' exposure to health and safety hazards resulting from natural disasters. The occurrence of injuries and fatalities resulting from the assault of EMS personnel was noted to be more frequent for the US EMS than other medical services (80). EMS personnel are commonly identified as prone to or targets of violence (81).

The forms of violence that EMS professionals most commonly face in their work include sexual assault, physical abuse, intimidation, sexual harassment, and verbal abuse. Prior research found that EMS workers were substantially exposed to the risk of violence at work as they perform their day-to-day routine, revealing that physical violence or verbal occurred commonly in encounters with patients (81). Pre-hospital care providers are identified as making up most EMS professionals who are the targets of violence (80-82).

### Musculoskeletal disorders

EMS workers come to work prepared for strenuous physical labour, which entails carrying heavy patients, routinely carrying heavy cases and bags, Electrocardiography, EKG monitor/defibrillators, suction units and other heavy equipment they need for attending to medical emergencies. Hence, EMS personnel's work involves carrying heavy loads that have adverse effects on their musculoskeletal system. The incidence of musculoskeletal disorders (MSDs) was noted to be higher among EMS workers who are deployed during natural disasters (27, 77). Increased frequencies of EMS personnel absence from work, longer lengths of absence from work and increased numbers of sick-leave days for up to 30 months after the occurrence of the disaster reflects the increase in the incidence and prevalence of the occurrence of MSDs (83). When the EMS personnel who were previously attending to natural disasters were compared to those who were not involved, the frequency, incidence and prevalence of absence from work were found to be increased, however, not in the duration of absences and number of sick days (83).

MSDs are the main rationale behind early retirement as a result of ill health among EMS workers, particularly ambulance workers (84). Cervical spine injuries were identified as the predominant problem resulting in early retirement (84). Male ambulance employees commonly suffer from musculoskeletal issues related to upper back, lower back and neck pain (84). Back issues are a frequently noted health complaint among EMS technicians. The increased risks of back problems among EMS technicians exhibit an association with job tasks involving patients' transportation, low satisfaction with the current assignment, and lower general levels of physical fitness (84, 85).

### Fatalities

A major outcome of the exposure of EMS workers to the hazard of natural disasters is fatalities. The majority of EMS responders' deaths are identified as resulting from operational activities in response to emergency disasters. The majority of EMS deaths are noted to be a result of medical problems, stress and overexertion (27). It is also worth noting that well-trained career EMS professionals were least likely to die while attending to natural disasters compared to volunteer EMS workers with less training (64). The literature universally identified the training to have a significant and positive relationship with EMS workers' health and safety (61, 86).

EMS personnel are vulnerable to work that is physically strenuous and has adverse effects on their hearts' activity. Emergency alarms signal the start of immense exertion and brusquely terminate sedentary activity. During the periods of attending to medical emergencies caused by natural disasters, maximal heart rates are recorded, wearing heavy protective equipment and exposure to extreme conditions heavily strain the heart, triggering cardiac overexertion fatalities (87). Previous diagnosis of peripheral arterial disease, carotid stenosis, hypertension and current smoking also represent significant risk factors resulting in the fatality of EMS workers (87-89).

Furthermore, EMS personnel's age was also linked to fatalities caused by sudden cardiac death (90). Pertinent literature reported that EMS workers 40 years and older succumbed to sudden cardiac death more often than those younger. On-duty fatalities of EMS personnel due to cardiovascular issues were identified as common in individuals involved in alarm response, ambulance duty and training. Other common

causes of EMS personnel deaths resulting from natural disasters include falls, vehicle-related accidents and violence at work (27, 91).

### Adverse health outcomes on mental health

Issues relating to the EMS workers' psychological traumatising has been gaining scientists' attention for about three decades. Prior studies noted that disorders of a psychosomatic nature are among the leading reasons for sick leave amongst EMS workers (92). Most EMS professionals may experience stress without resulting in mental disorders that are diagnosable but rather result in numerous symptoms which include physical reactions (racing heartbeat, pain, fatigue, tension), cognitive reactions (memory loss, lack of concentration, disorientation), and psychosocial reactions (being distant, distrust, avoiding socialising, isolation) and emotional reactions (emotional numbness, helplessness, guilt, anger, shock) (21, 48, 93).

EMS workers involved in the rescue response in hurricane Katrina and the Fukushima disaster noted to have experienced several symptoms of stress within days of the incident, which included disturbing as well as vivid images of the victims, edginess, feelings of inadequacy, tension, over-anxiety and insomnia (94, 95). EMS personnel also reported that their perceptions of security changed. The EMS personnel's ability to work was momentarily reduced. Alternative research showed that 15% of EMS personnel who attend to major natural disasters seek medical care for emotional issues during and up to a year after the occurrence of the disaster, in comparison with the overall population EMS seeking similar help constituting, and excluding all those not involved constituting only 4% (96). Insomnia and depression were identified as greater among nurses involved in providing EMS during the COVID-19 outbreak than colleagues not involved (97).

Factors that increase the likelihood of severe stress reactions in EMS personnel during natural disasters include existing psychological disorders, lack of training, high self-expectations, prior traumatic experiences, seeing severe injuries or death for the first time, a lack of belief in the operation and other major life stressors (98-101). Social factors such as low levels of social support; the lack of bonding or solidarity within EMS working groups and teams; the lack of information on emergency medical situations; as well as poor leadership also increase EMS personnel's stress levels (102). Nevertheless, some works of research indicated that EMS personnel are

regularly noted to have high levels of hardiness, a trait that serves the purpose of moderating the negative effects that trauma has on their mental health (103).

Typically, stress reactions are supposed to dissipate within a month after experiencing the traumatic event (53). Various coping mechanisms are developed by EMS professionals handle events that are stressful (104). An example, is pretending as if the stressful event is not real and distancing themselves from the scene, EMS professionals are able protect themselves from negative feelings that may emerge as a result of identifying themselves with disaster victims which would have negative impact of developing stress reactions that are traumatic (48). Nevertheless, in instances of symptoms lasting more than a single month post-disaster, there is the possibility that individuals develop PTSD, stress reaction that are acute or mental health problems that are severe such as anxiety depression and burnout (45, 48, 53).

Academics in prior research identified EMS professionals as being at a higher risk of developing PTSD despite whether they are exposed to major natural disasters or not. The likelihood of developing PTSD for emergency medical staff was noted increase due to numerous factors which include having personally experienced childhood sexual/physical violence, severe accidents, and the sudden death of loved ones (53). The incidence of PTSD in EMS personnel attending to disasters is noted to be highly correlated with the recollection of a personal experience of seeing human remains or a perceived threat to life (49, 53). The prevalence of PTSD after a natural disaster was noted as highest for EMS workers who performed uncommon tasks for their profession and this suggests that the greatest risk of PTSD is for EMS personnel with the least experience and training for disaster scenarios.

Occupational stress among EMS workers (support services, pathologists and medical practitioners, paramedics, emergency staff, ambulance drivers) is a result of the stress factors, which include the following:

- Inadequate or poor management/supervision, lack of specialised personnel insufficient salary, lack of recognition, lack of involvement in decision of making policy, inadequate support by supervisors/management;
- Experiencing emergencies that are unfamiliar/new, decisions that are on-the-spot and critical, performing duties in situations that are dangerous, frequent changes from activities that are boring to ones which are demanding;

- Public abuse and unnecessary call-outs, negative attitudes of other healthcare personnel towards EMS, constant scrutiny at emergency scenes by the public and by relatives of disaster victims (105).

A leading factor that contributes to EMS professionals experiencing excessive stress is a lack of preparedness. Prior research notes a lower prevalence of psychopathology following natural disasters among highly trained and experienced EMS workers than EMS workers with less training and experience (98, 99). Prior research thus suggests that knowledge and experiences reduce the stress faced by emergency workers in situations of natural disasters.

#### Adverse health outcomes of radioactive exposure

Adverse health and safety outcomes to EMS workers were noted due to radioactive exposure from the Fukushima incident caused by a tsunami. Acute radiation syndrome (ARS) was diagnosed with EMS personnel involved in the Fukushima disaster (106). Radiation exposure is noted to succumb from radiation exposure related issues like malignant neoplasms, cardiovascular diseases, leukaemia injuries, and poisoning (107).

Numerous works of research mention uncertainties concerning studies of the effect of radiation on emergency personnel, which must be considered when predicting mortality after exposure (108). Prior research noted that that the latent period for induction' of solid cancers due to radiation exposure is less than ten years (109). The exposure to low levels of radiation is noted to result in temporal chromosomal aberrations, with indications of unstable chromosomal abnormalities occurring up to a period of six years after harmful radiation exposure (110). In the case of the Fukushima incident, workers exposed to ionising radiation developed mental health issues, leukaemia, cardiovascular disease, and posterior subcapsular cataracts (106).

#### Adverse health outcomes associated with chemical risks

Numerous works of research carried out assessments of the effects of contamination from and exposure to dangerous combustion products and hazardous materials. Considering, the prevalence of inconsistencies amongst previous research on the uncertainties related to information about exposure that is available, the significant

impacts to the health of EMS personnel that related to chemicals, particularly those attending to fires, including the following:

- Acute effects for instance chemical pneumonia and asphyxiation may lead to death and other serious health effects, as a result of being exposed to substances that are dangerous; these include, sulphur dioxide phosgene, carbon monoxide and ammonia (111);
- Respiratory disorders like bronchial hyper-responsiveness, chronic lung dysfunction, emphysema, shortness of breath and asthma respiratory irritation, persistent cough, and non-malignant respiratory diseases leading to deaths (112);
- Headache, eye irritation, dizziness and nausea (113);
- Asbestosis (114);
- Benign neoplasm (115);
- Skin disorders, for instance chloracne, injuries resulting from corrosive material such as acid coming into contact with skin, and other symptoms arising from situations involving being exposed to substances such as dibenzodioxins including 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), polychlorinated dibenzofurans and polychlorinated biphenyls (116, 117);
- Reproductive disorders resulting from being exposed to materials that are hazardous to the human reproductive system (118, 119);
- Changes in biochemical and blood parameters (87).

Numerous works of research on epidemiology primarily discuss respiratory disorders EMS professionals experience when attending to natural disasters resulting in explosions and buildings collapse. The effects of dust and other chemicals released are noted to result in or triggered persistent coughs that develop after being exposed, coupled with severe respiratory symptoms requiring medical leave; vocal cord dysfunction; granulomatous pulmonary disease or sarcoidosis; asthma, and pulmonary symptoms (120-122). Furthermore, these respiratory symptoms are noted to increase over time, potentially having long-term or lifetime effects (120). Scientific studies on the long-term effects of exposure to various chemicals and dust for EMS personnel remain primarily unexplored; consequently, there is the need for further research and continued monitoring.

### Adverse health outcomes related to biological risks

Prior research identified that EMS personnel are exposed to a higher risk of acquiring biological contagions in their work. More specifically, EMS workers were noted to be at a higher risk of transmission of hepatitis C or B and HIV frequently due to exposure to body fluids or blood as a consequence of needle stick injuries (65). Approximately 600 000 to 800 000 such incidences occur in the US yearly among over 9 million health workers (123). The reviewed literature also noted that three people would become HIV-positive for every 1,000 injuries from needles used on people with HIV beforehand, representing an incidence rate of approximately 0.3% (124). Factors that determine the risks of injuries needle-stick include inadequacies in ambulances, inadequate disposal boxes, inefficient disposal of used injection material, an insufficient number of or overfilled disposal boxes at emergency/disaster sites or hospitals (70, 124).

A more recent study noted that EMS workers were highly vulnerable in comparison to the general population exposed to the COVID-19 virus. The factors that determine the exposure of EMS workers to COVID-19 were noted to include the lack of proper PPE, inadequate sanitary material, inadequate patient containment facilities and a general lack of resource capacity (125, 126). Hence, the importance of appropriate resource management is apparent in securing EMS workers' health and safety from being exposed to any contagious illness or disease.

### **Preventative measures**

This section discusses general and specific measures of prevention that can be applied to mitigate and reduce EMS workers' exposure and effects of health and safety hazards encountered in attending to natural disasters. Formal legislative instruments regulate the health and safety obligations of employers in most countries. For example, Europe is controlled by the Framework Directive 89/391/EEC (127). However, due to EMS work's nature, exemptions to these regulations often apply for special emergency services like the fire brigade, armed forces, and the police. Nevertheless, it is a must that EMS workers' health and safety should be protected, and secondary and primary preventive measures should be applied whenever possible.

## Communication and coordination at the international level

Coordination with effective communication and is essential when responding to major natural disasters as well as good information exchange among different occupational groups and authorities. Also critical is the development of a multichannel communication system for the management of disasters. To ensure that all stakeholders involved in disaster control and management have access to the same information, it is important that the use identical channels of communication (128). Several communication channels that are integrated are critical for natural disaster warning systems so that the population can be warned parallel through sirens, cell broadcast, television, radio and social media (129). Additionally, stations for broadcasting warning signals should be built strong enough to withstand major natural disasters and the establishment of multiplicative systems is necessary to ensure that disaster warning signals can still be broadcast after one or more broadcasting station has been destroyed (130). Alternative to traditional communication techniques, satellite-based systems for communication that are now cost-effective must be established and utilised (131). It is also necessary to establish a standard working language, particularly in the instance of shared activities involving different countries, as well as standardised method for the interpretation of monitored data. Safety in emergency and crisis scenarios would also be further enhanced through the development of joint drills and standard training among varied organisations as well as varied emergency personnel, perhaps from other countries.

## Emergency policies

Another preventative measure is the institution of emergency policies. Examples are the Council Directive 96/82/EC, extended by Directive 2003/105/EC in Europe. In accordance to these directives, the term “major accident” refers to “an occurrence such as a major emission, fire, or explosion resulting from uncontrolled developments in the course of the operation of any establishment covered by this directive and leading to danger to human health and the environment, immediate or delayed, inside or outside the establishment, and involving one or more dangerous substances” (132). The application of this edict is compulsory in all countries within the European Union for the prevention as well as limitation of industrial and natural disasters that a major. The directives’ requirements include establishing safety management systems, the

assessment risk of hazards to facilitate the identifying protective measures that are appropriate, emergency planning (off-site and on-site), land-use planning, plans for public information, public authorities' notification of the occurrence of accidents, implementing prevention policy for a major accident. The EU directive does not address the health and safety of EMS workers as an independent topic. However, several references concerning the directive's application in EU member countries are in place, accompanied by the general practice codes for responding to emergencies of accidents involving hazardous materials (132). The EU also has 10 May 2010 Council Directive 2010/32/EU designed for the prevention of sharp injuries in hospitals and the healthcare sector in general.

Responses to traffic accident emanating from natural disasters should also be governed by adequate and suitable safety legislation and policies. These policies include developing training programmes that are multidisciplinary and the preplanning strategies for traffic control to ensure that EMS professionals are aware of mutual agreements with varied authorities (including armed forces, police, fire-fighters) and other jurisdictions in transport accident cases. It is also critical that policies for disaster management have an element of multidisciplinary coordination and communication (133). For example, in the US are the "slow down and move over" laws designed mandate that people move over when passing an EMS vehicle on the road-side or the scene of an accident (134, 135).

#### Organisational measures: Safety and health management

Prior research suggests that safety management cycle should be followed when protecting EMS responders (12). It is important that those charged with the responsibility of ensuring the health and safety of EMS professionals should, at all times, responsible for safeguarding EMS workers must always assess whether the benefits of EMS are sufficient considering the health and safety risks involved (12). The process managing risk can be distilled into the following steps:

1. **Gathering information:** Data concerning the specific capabilities and number of EMS professionals available for the management and control disaster of a disaster, potential hazards posed by the disaster to EMS personnel, and data on the exposure to hazards as well as the actual injuries of EMS workers at the disaster scene.

**2. Decision making and analysis of alternatives for action:** alternative actions are compared, there is the need to plan the moment that disaster operations turn into recovery operations. Furthermore, it is necessary to determine the PPE required by various EMS personnel, and anticipation of any other kind of resources for additional safety required for disaster control and management.

**3. Taking Action:** On taking action, it is essential the communication related safety and risk equally reaches all entities involved in the operations for disaster, and the implementation of safety measures should be done. Therefore, strategies that are effective are essential for providing medical care for the mental and physical health of EMS responders as well as equipping them with appropriate and adequate PPE. Additionally, there should be logistic solutions established for the provision of the appropriate PPE.

The reviewed literature emphasised that to coordinate EMS workers' activities in an efficient manner, the most appropriate leadership style is authoritarian as it works best when applied in circumstance the require instructions that are rapid and precise (136). On the other, cooperative leadership is suitable during standby as it best enhances the motivation of EMS professionals in that situation (136). To ensure efficiency of operations during natural disasters it is essential that EMS professional be properly prepared for such situations. There is the need to identify and assign management tasks, roles of EMS organisations/teams/workers, available personnel and technical resources and available equipment to the appropriate workers/teams/organisations before the commencement of disaster, ensuring that the efficiency of disaster management and control efforts is at its highest. The strategic planning as well as implementation of standard procedures as well as systems which were previously tested enhances the likelihood of disaster management and control to be successful (137).

In previous literature, ensuring that the number of EMS professional at a scene is limited to the minimum number of personnel that is necessary and the prompt release of those that are no longer needed at the scene are identified in previous literature to be of great importance (138). Through doing this, the exposure of EMS personnel to hazards presented by natural disasters is kept at an absolute minimum. Creating "protective-action zones" that are a function of the source of a disaster site and the

intensity of the phenomena that results from the disaster represents an effective strategy that limits the exposure of the public and EMS personnel to potential hazards (138). Approach of the disaster site by EMS personnel follows specific instructions on how to operate within a specific zone.

Preventative measures at the organisational level must also embrace good organisation of work. This may include considering task/job rotation whenever possible to reduce the exposure of EMS professionals to overstrain and task/job-related risks. The literature also identified the initiation of comprehensive programmes for the prevention of STF accidents within hospitals and this represents another example of preventative measures at an organisational level that would be beneficial to ensuring the health and safety of EMS personnel (73, 74).

#### *Risk assessment*

The assessment of risk must abide by a set of general principles and take into consideration, all the possible risks that EMS professional may be exposed to. For instance, the assessment of risk at the scene of a disaster should consider the possibility of domino effect; for example, whether current events may have further effects, danger or damage; if structures that are collapsed pose the risk of fires, electrocution and short-circuits, fires may lead to explosions (136). While looking for possible risks, all near-accidents and accidents need to be seriously considered. The development of preplanning on this basis must foresee the probable requirements for response as well as establish the preventive measures necessary (139).

Health and safety risks for EMS workers should be balanced with the possible benefits of emergency medical interventions (140). It is essential that EMS workers follow the employers' directives, reasonable care of others and themselves should be taken, co-operate with their employer, and act responsibly and sensibly in line with their employer's control and command. EMS workers must not execute their duties in a reckless manner (47).

#### *Training*

EMS personnel need to be need to be knowledgeable the all the risks to their health and safety that they may be exposed to in the execution of their professional duties and responsibilities as well as the consequences that come with those risk and the

possible measures for preventions. EMS professionals should also have knowledge on the reaction of their bodies on exposure to various psychological, biological, chemical or physical hazards, which cannot be avoided in their line of work, as well as the prompt deployment of possible protective measures (64). The training that EMS personnel receive must address issues concerning the physiological symptoms of exposure to hazardous materials; the specificity of functioning while under tremendous stress as well as pressure, appropriate decontamination procedures, proper manual handling, proper selection, maintenance, care, and use of PPE (43).

EMS professionals should also be prepared for and instructed on how to operate in different disaster circumstances before they actually occur (12). The development of and dissemination of standardised procedures for operations associated with these various circumstances is also advised and identified as a good practice in prior literature (12, 64). It is also recommended that developing joint drills and standardised training procedures for EMS personnel from various professional groups be mandatory procedure (12, 137). Additionally, specialised training equipment, for instance, tools for simulation, can aide the process of learning and the making of decisions in real situations, especially in events that present multiple risks (137).

Training may also be useful in helping EMS professionals to cope within violence at work, given that they are at a high risk of encountering violence at work (80, 81). The fatal or severe injury of an EMS worker adversely affects the people they are working with, resulting in the significant impairment of their response at the scene of an emergency. Evidence from prior research identified the prevalence of abusive behaviour (such as psychological harassment) within the EMS teams, groups and organisations, similar to any other work environment (141, 142). EMS professionals need training on how to handle situations like these. The development of procedures for training EMS personnel is critical and abided by strictly to ensure that injuries as well as accident are prevented, which as prior research shows, occur frequently during training (80, 81).

### *Vaccination*

Vaccination represents an adequate as well as essential preventative measure made available in scenarios where EMS personnel workers may be at risk of contracting diseases that are water-borne (rotavirus, typhoid fever, cholera), hepatitis B or

exposure to biological agents, such as instance smallpox, tularaemia botulism and COVID-19 (21, 66, 126). EMS workers should be vaccinated against biological contagions.

### *Personal Protective Equipment*

Consider the given risks, EMS personnel utilising specific personal protective equipment is important for the prevention of adverse health effects they may be exposed to. The selection of PPE should be appropriate for the typical duty assignments to specific EMS personnel groups, nature of the disaster being managed or controlled and hazards at the disaster scene (77). An example is that EMS personnel attending to wildfires, characteristically, they need protection against thermal risks and the appropriate PPE they use includes specialised footwear, thermal personal protective clothing, helmets, breathing masks, oxygen tanks and so forth. In the scenario of exposure to harmful elements (nuclear radiation, by-products of fire, or chemical), EMS personnel should be provided with the appropriate respiratory protective equipment, including, eye protection caps, shoes, suits, and protective gloves (77, 125).

Prior literature also noted that protecting against substances that pose numerous hazards (for example, both toxic as well as flammable) for EMS personnel. The PPE that EMS responders are equipped within the daily routines are typically not sufficient or suitable in the event of major natural disasters (143). Consequently, the EMS responders in question or parties/individuals assigned with the responsibility of disaster management and control must ensure the selection of appropriate alternative or additional PPE. Performance, specific properties, combinations with other PPE, adjustment and fit must all be taken into consideration when selecting PPE. In the assessment and monitoring of hazards at the scene of a disaster, risk evaluation frequently is only possible by sight given that more detailed and complex and detailed evaluation is impossible (143). There is the need for the selection of the appropriate PPE for a disaster; ensuring its availability at the scene, and EMS personnel should be familiar with its proper use.

It should also be considered that infected victims of a disaster need PPE for the protection of others (such as surgical masks) (126). Nevertheless, the isolation of infected individuals may be necessary for some instances to effectively curtail the

spread of particularly contagious infections (125). The use of PPE such as gloves are essential ensure an antiseptic and clean working environment as well as the protection of EMS personnel from any infection. However, the use of PPE may have some adverse effects; for example, healthcare workers, police and medical staff, due to their frequent use of latex gloves, are especially prone to developing latex allergies.

### *Ergonomic equipment*

To ensure EMS workers' health and safety, it is essential to use ergonomic equipment that reduces the strain on EMS personnel as well as the risks that they are exposed to. This equipment includes mobile apparatus used for carrying bodies or any other equipment necessary. When administering emergency medical care and rescuing people from tall and large structures there is also the possibility of utilising equipment such as lifts (79). To address the issue of strain on the musculoskeletal systems of EMS personnel caused by travelling on poor roads in ambulances transporting first aid kits in backpacks instead of bags when walking over long distances to scenes of disasters or emergencies can be use as well as vibration-reducing seats in ambulances (44, 77).

Any low-emission, low-noise and explosion-proof equipment must be taken into consideration. To reduce the risks of infection, EMS professionals need to be equipped with syringes that incorporate safety features for the prevention of injuries from needlesticks (124). Such a measure should be complemented with special disposal boxes that facilitate the safe disposal of in which sharp objects or needles can be disposed of safely during special training and after use at the scene of disasters.

### *Prevention of mental health problems*

To aid EMS workers with coping with the emotional issues involved in their work, psychological preparedness exercises should be initiated. The possible measures of prevention include the following:

- Boosting the internal locus of control of EMS personnel may aide in the execution of their duties without consequently impairing their mental health. The ability of EMS personnel to cope with stress reactions after and during traumatic events are significantly determined by their self-image, self-confidence and self-esteem.

- Gathering exhaustive data on the nature of the disaster, which other EMS personnel are at the scene, where injured people are at the time, how many are injured, how many people are dead, and whether there are survivors. Data on the conditions at the disaster site should also be exhaustive (13, 144).
- Adverse stress reactions can be buffered by experiencing feelings of safety as well as trust safety. Consequently, social support from colleagues, family as well as having a good personal network are important as they aide EMS personnel to better handle traumatic experiences in their past (144).
- At the scene of the disasters, emotional and mental strain can be reduced by well-coordinated teamwork and the support of colleagues providing feelings of belonging and security. Given the EMS personnel who have worked in disaster scenarios in the past have at a reduced risk of developing mental health issues, EMS teams should be composed a mix with highly-experienced personnel offering enhanced social support to less-experienced personnel (54, 144).

Training in cognitive-behavioural techniques, relaxation techniques and stress management for operating and decision-making under pressure enhance the ability of EMS personnel to handle challenging stresses and emotions (48, 145). Previous works of research indicated that training on simulated EMS response may significantly reduce responders' stress-related anxiety and physiological stress reaction levels (the mean arterial pressure and lower pulse) (137).

Some studies also suggest that improving psychological characteristics including psychological resilience, hardiness, as well as coherence may aide EMS professionals in coping with traumatic and difficult scenarios (93, 137) . In the workplace, these features may be enhanced by goal orientation, trust, good leadership, shared values, collective identity, and team cohesion (102).

### **Summary and conclusion**

The research findings from the literature review identified that EMS workers are exposed to numerous factors that determine their health and safety due to natural disasters. Based on the reviewed literature, the outcomes of the health and safety hazards from natural disasters that EMS workers are exposed to help understand the factors determining EMS personnel's health and safety in attending natural disasters. Additionally, the reviewed literature identified preventative measures consisting of

communication and coordination, emergency policies and organisational measures designed to eradicate or limit exposure to and adverse outcomes from EMS workers' exposure to health and safety hazards resulting from natural disasters.

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## **PART B: MANUSCRIPT IN ARTICLE FORMAT**

# **RISKS TO RESPONDERS' SAFETY AND MITIGATION STRATEGIES DURING RESCUE WORK IN NATURAL DISASTERS: A SCOPING REVIEW**

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## **Abstract**

**Introduction:** Emergency medical services (EMS) who attend to natural disasters are at a high risk of experiencing numerous psychological and physical conditions that adversely affect their health and safety as well as their ability to serve their purpose. This study aimed to identify factors that affect EMS responders' health and safety in natural disasters and provide information to mitigate harm in future natural disasters.

**Methods:** A scoping review was conducted to identify literature published between 2000 and 2020 relating to EMS responder safety in natural disasters according to a predetermined search strategy. Titles and abstracts were first screened, whereafter full texts were reviewed and extracted.

**Results:** In total, 49 articles were identified and 22 articles were ultimately included. The findings from the research identified numerous factors and outcomes that affect the health and safety of responders attending to disasters. These could be categorised into mental and psychological issues (PTSD, suicidal ideation, depression) and physical issues (environmental, infectious, and traumatic conditions).

**Conclusion:** Numerous health and safety hazards befall responders attending to natural disasters and the variability of their incidence commands case-specific prevention and mitigation strategies. There is poor monitoring of factors affecting the health and safety of responders as well as their consequences, making current mitigation and prevention strategies ineffective. Enhanced surveillance and reporting systems should be developed and implemented to inform and improve mitigation strategies.

## Introduction

Natural disasters are common occurrences across the globe and they represent a major hazard to the health and safety of the communities they affect (64). Natural disasters are identified as naturally occurring events that can be a result of numerous factors. These include biological, meteorological, climatological, hydrological or geophysical phenomenon which severely disrupts the normal operations of society inflicting environmental, economic material and or human losses exceeding the ability societies or communities to cope given the resources available (36). The most common natural disasters across the world are floods, tropical cyclones, severe thunderstorms, tornadoes and drought, often resulting in the loss of lives and significant infrastructural damage (4). It is also worth noting that the prevalence of natural disasters is closely related to climate change, with evidence suggesting that with increasing surface temperature at a global level, there is the likelihood of an increase in the prevalence of natural disasters as well as the severity of their effects (34). The ongoing climate change is noted to increase the prevalence of cyclones, floods, wildfires and droughts, adding to the urgency of measures to mitigate against the negative consequences of natural disasters (35).

Emergency medical services (EMS) have the purpose of providing immediate medical care to the people who need it the most with the general motive of providing a better quality of life to the communities they serve (11). Natural disasters present emergency scenarios that represent significant challenges to EMS professionals in doing their jobs effectively. These challenges are mainly influenced by numerous factors that include physical factors (injuries and physical barriers), mental factors and psychological states, and interpersonal factors (27). Fatal and non-fatal injuries to EMS attending to emergency scenarios are a common occurrence across the globe and they are noted to account for more than 31 days of lost work time on an annual basis (68). Often emergency situations caused by natural disasters may be so widespread and hazardous to the extent that the local EMS resources are not adequate to effectively address the prevailing emergencies (21). Despite the lack of adequate resources, responders are not hesitant execute their duties as been trained to do, that is, go to attend to an emergency scene prepared to provide immediate medical assistance and save lives. Natural disasters present factors that pose as unique and significant risks to the health and safety of EMS professionals and numerous works of literature have

discussed these factors. The safety of EMS is important during disaster response because if they get injured/ill, the whole disaster response is affected and there is no one to manage the situation (63). Consequently, investigating the factors affecting the health and safety of EMS in the literature is crucial for informing policy and mitigation.

According to previous the work of Jolley *et al.* (146), “a scoping review is a preliminary assessment of the potential size and scope of available research literature. It aims to identify the nature and extent of research evidence (usually including ongoing research)”. The purpose of a scoping review in the view of this study was to provide a description of existing literature and other sources of information. Scoping review results commonly focus on the range of identified content and assessment of a quantitative nature is commonly limited to a count of the number of sources addressing or reporting on a particular phenomenon. The aim of this study was to identify the most important factors that affect the health and safety of EMS responders in natural disasters, as well as provide information to mitigate factors to harm in future natural disasters.

## **Methods**

The scoping review was informed by a protocol developed *a priori* to predefine the study’s objectives and methodology. All steps of the protocol, including screening, inclusion, and charting, were done independently by one reviewer, and only the inclusion and exclusion of titles, abstracts and full-text were done by two reviewers. A three-step search strategy, as recommended by Aromataris *et al.* (12) and similar to that of a standard systematic review, was employed to identify all literature in a systematic and exhaustive manner as follows:

1. Identifying synonyms in studies that were found in an initial search of a database include: Medline via PubMed Google Scholar, Scopus, African-Wide, and National ETD (grey-literature)
2. Synonyms identified in step 1 were used to search all databases for appropriate studies. All text was then be analysed to identify keywords. Index terms were abstracted and reviewed for relevancy, as were medical subject headings (MeSH), where appropriate.
3. Reference lists from all studies identified in step 2 were reviewed to identify additional studies.

## **Search strategy and eligibility criteria**

A search of pre-identified databases (chosen for relevancy, to include Medline via PubMed Google Scholar, Scopus, African-Wide, and National ETD (grey-literature)) was undertaken to gather titles and abstracts on studies relating to natural disasters and EMS safety. The relevant literature was searched using identifiable search terms such as “prehospital”, “emergency medical services”, “natural disasters”, “earthquakes”, “landslides”, “tsunamis”, “volcanoes”, “avalanches”, “floods”, “extreme temperatures”, “wildfires”, “cyclones”, “storms” and “epidemics”. The full search strategy is attached in the appendices. The literature that was selected in this study was in line with certain inclusion and exclusion criteria.

The inclusion criteria were as follows:

- Articles published between 2000 and 2020, in English
- Articles pertaining to natural disasters and EMS responder safety
- Articles that outline interventions to mitigate health and safety risk of EMS in natural disasters
- Both review and original research articles
- Articles need not be directly related to healthcare
- Grey literature

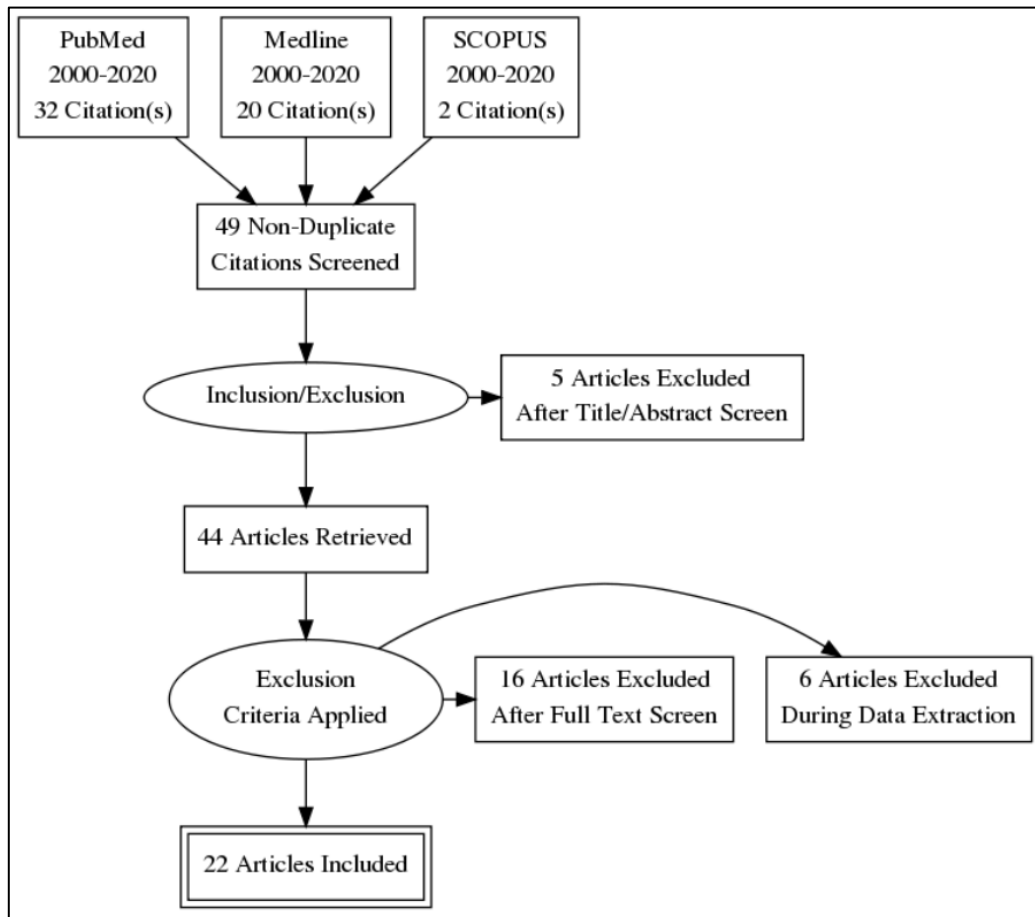
The exclusion criteria were as follows:

- Articles published prior to 2000 and after 2020
- Articles that did not pertain to EMS provider safety in natural disasters (for example, EMS safety during day-to-day operations or during disasters that are man-made).

## **Results**

The results of the initial article search produced 49 potential sources, which were in line with the inclusion criteria. Articles that were not journal articles or grey literature were removed as well as duplicate sources. After application of the exclusion criteria and screening of the abstracts of the remaining articles, a second author reviewed the results to verify relevance. The entire selection and extraction process resulted in 22

articles being selected for the scoping review. Figure 1 illustrates the article selection and extraction process. Table 1 is a summary of the research articles included in this research.



**Figure 1:** Results of article search, screening and review.

Of the total research articles, 10 were reviews and the remaining 12 were original research studies. The majority of the studies originated from the USA, comprised of nine articles (21, 27, 48, 60, 147-151), four studies were from China (49, 53, 55, 152), and two were from Taiwan (54, 61). The most common natural disasters that were addressed by the majority of the studies comprised earthquakes (32, 46, 49, 53-55, 61, 153, 154) and floods (32, 63, 151).

### **Risks affecting the health and safety of EMS**

The reviewed studies acknowledged the prevalence of general health and safety risks to include physical overstrain (21, 27, 32, 46, 48, 60, 61, 63, 147, 151, 153-155) and

emotional overstain (27, 45, 48, 49, 53-55, 76, 148-150, 155) which affect EMS professionals in their day-to-day operations as well as in the cases of natural disasters. Additionally, the research review identified studies that explored factors affecting the health and safety of EMS, the general devastation of infrastructure and communication lines; destruction of electrical installations; collapsing buildings and other structures; and significant devastation of their working environment (21, 32, 48, 60, 61, 63, 153).

EMS professionals in natural disasters are forced to work in confined spaces exposing them to the risks of being seriously injured. The research articles also identified the prevalence of floods as presenting a risk to the safety of EMS workers who coming into direct contact water that is contaminated, with viruses, bacteria or other microorganisms in high concentrations. Examples include situations where EMS professionals need to work in contaminated surface water and when sewage gets into the supply of drinking water. Other research articles also identified that EMS professionals are susceptible to infectious diseases through getting in contact with infected victims of disasters (27, 32, 33, 63, 151, 156). EMS were also at the risk of respiratory issues as a result of working in conditions of natural disasters with high levels of air pollution (32, 61). The majority of studies identified the poor management of resources as a major risk factor affecting health and safety (21, 32, 49, 53, 60, 63, 148, 149, 154).

### **Health and safety outcomes**

The health and safety outcomes to EMS exposed to the risk factors identified were fatalities and injuries (21, 27, 32, 46, 48, 60, 61, 63, 147, 151, 153-155); musculoskeletal disorders (27, 48); violence at work (27, 149); mental health issues (27, 45, 49, 53-55, 76, 148-150, 155); negative effects of harmful chemicals and biological contagions (27, 33, 63, 148, 151, 156).

### **Interventions to mitigate risks**

The works of research in this review identified preventative measures designed to safeguard the health as well as safety of EMS in natural disaster situations. The preventative measures that were identified in the reviewed literature included

communication and coordination (86, 152, 154); standardised emergency legislation policies (54, 60, 63, 148, 153); better provision and management of resources (21, 46, 147, 154); better understanding of factors contributing to health hazards, improving awareness and preparation based on those findings (21, 46, 48, 49, 53-55, 60, 153); early warning systems, advanced surveillance systems, appropriate planning, mitigation strategies education and training; PPE, minimal health and safety measures (21, 27, 32, 45, 46, 48, 49, 53-55, 60, 61, 63, 76, 147-151, 153-155); and psychopharmacologic and psychotherapeutic interventions (27, 45, 48, 49, 53-55, 76, 148-150, 155).

**Table 1 Summary of scoping review research articles**

	Author	Year	Study Type and (Sample Size)	Country of Study	Natural Disaster	Main Findings	Interventions	Limitations
<b>1</b>	Chambers <i>et al.</i>	2020	Qualitative Research (N = 11)	USA	Hurricanes	Hurricanes were noted to negatively impact the availability of staff, processes of transfer and disposition as well as consumption of resource.	Pre-disaster planning and preparation; surplus supply of staff and resources; flexibility of EMS function during the disasters.	Qualitative data was of a retrospective nature and the interviews were subject to recall bias. Small sample size to provide rich data.
<b>2</b>	Kc <i>et al.</i>	2019	Systematic review	Nepal	Earthquakes	Technical skills of responders, social stigma, governance, and the socio-economic status of the affected nation were identified as critical influencing factors to health and safety.	Understanding the variables that contribute to injuries. Utilising some collective or specific measures targeted at the aforementioned factors influencing EMS health and safety. Capacity building for preparedness; good governance.	Small sample size. Prior access to conceptual framework limited respondents' abilities to generate new expert opinions. The generalisability of results beyond Nepal is limited.

3	Ma <i>et al.</i>	2020	Survey (N = 519)	Taiwan	Earthquake	Risk factors associated with PTSD were noted to include personality characteristics of anxiety, perfectionism and introvert tendency.	Pre-event planning; broad realisation of risks may improve the mental outcomes of disaster rescuers	Disproportionate sex ratio possibly resulted in biased results. Limited generalisability of the data due to the homogeneous characteristics of the sample. Issues relating to delayed onset PTSD were not addressed because the administration of questionnaires for the survey was done four weeks after the occurrence of the earthquake.
4	Coelho <i>et al.</i>	2020	Systematic review	USA	COVID--19	EMS health hazards associated with COVID-19 identified issues associated with compliance, information-driven fears, disgust, hypochondriasis, social isolation, and fear of the unknown.	Preventive and therapeutic interventions.	Unclear whether quality criteria for selecting studies were predetermined in the review protocol.
5	Wu <i>et al.</i>	2018	Survey (N = 414)	Taiwan	Earthquake	Hazards reported included worsened respiratory or new symptoms, including coughs, rhinorrhea or nasal congestion and chest tightness.	Enhanced training and preparation of personnel; therapeutic interventions.	Cross-sectional design limited the ability to explore the relationship between exposures and outcomes.

6	Wang <i>et al.</i>	2016	Survey (N = 70)	China	Earthquake	After the earth an estimated 21.4% the research responded noted reported suicidal ideation. Risk factors included the interaction effect between work-family conflict. and job burnout	Discretion is crucial in the management of the local workforce, particularly, concerning work-family balance and long work hours.	A relatively small sample size limited the significance of the results. Potential recall bias to the retrospective nature of the research.
7	Holcer <i>et al.</i>	2015	Systematic review	Croatia	Floods	Hazards to the safety and health of EMS reported included risks of injury, infection as well as disease resulting from exposure to chemical, radiological and biological contaminants as well as varied pathogenic microorganisms.	Establishing early warning systems, enhanced surveillance systems, improving the forecasting of flood, and appropriate planning, education and legislation.	Methods for article selection not clarified. Inadequate summaries of the included studies.
8	Schenk <i>et al.</i>	2017	Survey (N = 337)	China	Earthquake	Risk factors for clinically significant PTSD included getting injured during the disaster, falling ill, disconnecting from family and friends and experiencing water shortage	Adequate support before and during deployment, evaluation of EMS before deployment to assess risk ort, pressure management strategies	Possible selection bias is given that the response rate to internet questionnaire subject computer literacy level, access to a computer and concerns of providing sensitive information over the internet. Relatively small size limiting the statistical significance of the results.

9	Erhing <i>et al.</i>	2011	Survey (N = 267)	Pakistan	Earthquakes	Mental and mental and emotional problems were noted to appear up to 24 months after the earthquake. Problems included earthquake-related PTSD, anxiety and depression. The levels of PTSD symptom exhibited an association with female gender, low social support, work-related stressors, past traumas and severity of the earthquake experience	Enhanced training and preparation of personnel; therapeutic interventions.	The research was based on Western mental health concepts and assessment instruments and their applicability to non-Western is debatable. Limited range of predictor variables.
10	Khankeh <i>et al.</i>	2011	Qualitative Research (N = 29)	Iran	Earthquakes	Physical violence. The lack of planning, poor resource management at an organisational level, insufficient coordination in the provision of healthcare services during disasters, as well as the manner in which international relief initiatives contribute were the most significant hurdles.	Proper pre-event planning and public education. The managers of health services need to coordinate, in advance, to ensure the appropriate utilisation of international aid in through improved communication with foreign and local constituents.	Relatively small sample size hence data collection was based on few individuals or cases selected using purposeful sampling. Hence the generalisability of the research findings to cases with different environmental, cultural, and economic characteristics was limited.
11	Migl & Powell	2010	Review	USA	Various	The most significant factors affecting the health and safety of EMS include a lack of resources, unusual practice settings, a lack of familiarity with the situation.	Maintaining a state of professional readiness for emergency response and planning for and practice emergency response. Enhanced communication and coordination. Vaccination	The reliability of the summary provided in the literature review was subject to the methods used to estimate the effect in each of the primary studies.

12	van der Velden <i>et al.</i>	2012	Qualitative Research (N = 51)	Haiti	Earthquake	Health hazards during the earthquake were noted to include death and injuries, post-disaster health issues were noted to include event-related PTSD and coping self-efficacy.	Ensuring good team functioning, recognition and job satisfaction. Post-disaster health problems can be prevented by enhancing or restoring protective factors.	Cross-sectional design limited the ability to explore the relationship between exposures and outcomes. Potential recall bias to the retrospective nature of the research.
13	Aitken <i>et al.</i>	2009	Survey (N = 59)	Australia	Tsunami	EMS personnel deployed to disasters noted a lack of personal comfort, clinical care and logistic support.		The cross-sectional design limited the ability to explore observed associations
14	Berkowitz	2012	Systematic review	USA	Various	Factors causing health risks include long work hours resulting in health problems related to sleep deprivation.	Policies and legislations regarding work-hour limitations should be reviewed.	Protocol for article selection not clarified. Inadequate summaries of the included studies.
15	Garbern <i>et al.</i>	2016	Systematic review	USA	Various	PTSD and depression were noted as the most common and prevalent health hazards. Physical health outcomes included falls, fractures, burns respiratory, gastrointestinal, as well as diseases, and dermatologic, insect bites, heat stroke, and other traumatic injuries. Physical violence against responders.	Strategies for the mitigation of risks and enhanced surveillance systems.	The reliance on mostly case-based research and retrospective nature of this research represented limitations for the research. Furthermore, search for research articles was only limited to full-length English articles a single database (EMBASE) leaving out numerous articles that were relevant.
16	López-Ibor	2006	Systematic review	USA	Various	Symptoms of psychological issues including obsessive ruminations, high arousal level, blunting of responses,	Preventive and therapeutic interventions.	Protocol for selection of articles not identified. Quality of the underlying research articles not outlined.

						avoidance of stimuli, difficulties in remembering and flashbacks.		
17	Benedek <i>et al.</i>	2007	Systematic review	USA	Various	EMS experienced numerous physical as well as mental health effects as a result of work-related exposures.	Psychopharmacologic and psychotherapeutic interventions, based on evidence, for psychiatric disorders and PTSD reactions were identified.	Methodological limitations of the analysis and quantitatively interpreting replies to a narrative survey and open-ended questionnaire.
18	Paterson <i>et al.</i>	2018	Systematic review	USA	Floods	Health hazards from floods were noted to include fatalities from drowning, accidents, electrocution, hyperthermia, gastroenteritis, infections of the skin and soft-tissue as well as zoonotic noncommunicable disease.	Planning for the removal of people from areas prone to floods and flood mitigation schemes and; preventive and preparedness measures as well as more rigorous techniques of examining identified measures.	Protocol for article selection not clarified. Quality of research articles upon which the research was based.
19	Osofsky <i>et al.</i>	2011	Survey (N = 1056)	USA	Hurricanes	The major health and safety effects were traumatic experiences, posttraumatic stress, and depression	Adequate pre-event planning; Early attendance of reports of symptoms of anxiety or depression; provision of mental health services to all responders.	Limited representativeness of the sample. Limited generalisability and exploration of associations as a result of the study's cross-sectional design. Lack of accurate determination of population size due to the fluidity of the EMS workforce.
20	Wang <i>et al.</i>	2011	Survey	China	Earthquakes	Post-disaster suicidal ideation found to be associated with work engagement, work-family	Discretion in the management of the workforce, particularly	The self-rated Davidson Trauma Scale was used to classify PTSD in this study and psychiatric

						conflict, PTSD and depression, daily work hours, job burnout, and bereavement.	regarding long working hours and work-family balance.	comorbidity outside of PTSD was not assessed in this sample.
21	Suk <i>et al.</i>	2020	Systematic review	Europe	Earthquakes , flooding	Health risks included death and illness from infectious disease outbreaks resulting from exposure to contaminated floodwater or surface water after floods, living conditions after occurrence of the disaster and exposure to animals' excrement. Voluntary and inexperienced responders were noted to be particularly prone as they may not be aware of potential health risks.	Incorporation of measures for the control and prevention infectious disease prevention and control measures into response planning as well natural disaster preparedness. Education and communication of health risks prior as well as during the occurrence of natural disasters	Limited number of databases from which articles were extracted (MEDLINE and EMBASE).
22	Gerhart <i>et al.</i>	2020	Experiment (N = 10)	USA	Fire	Negative outcomes were noted to include heat stress, selective attention and total mood disturbance, which resulted in negative safety and health outcomes. Working for extended periods of time in humid and hot environments represents psychophysiological hazard to health and safety of EMS	Regulations on work hours should be reviewed to limit time exposed to the hazardous environment; better PPE.	Limited subject population to only a rural population and a relatively small sample size limiting the generalisability of the research findings. The participants were exposed to the hot environment for relatively short periods of time, offering limited time for detecting the adverse physiological and psychological effects of exposure.

## Discussion

EMS responders who attend to natural disasters experience numerous psychological and physical conditions; these conditions range from minor injuries to chronic mental issues and fatalities. The health and safety outcomes from the hazards to which EMS professionals are exposed during natural disasters depend highly on the role and preparation of the responders as well as the nature of the natural disasters.

The majority of the research articles in this review focused on mental issues, including post-traumatic stress disorder (PTSD) and depression. Previous research on the subject of psychological hazards including PTSD, suicidal ideation and depression in responders varied greatly regarding the prevalence and the determinants. The prevalence of PTSD, suicidal ideation and depression among responders in this research was noted to be between 2% to 57% (27, 45, 48, 49, 54, 55). Despite any responder being at the risk of PTSD, suicidal ideation and depression, some responders were more vulnerable than others and subject to risk factors including low social support; peri-traumatic dissociative experience; recent major life events pre-disaster; neurotic personality type; avoidant, distancing, or negative coping styles (45, 49, 54, 55). Additionally, higher rates of the prevalence of PTSD, suicidal ideation and depression were noted in non-professional or voluntary EMS responders (49). The research findings suggest support that it is more intensive to be at the disposal of professional and non-professional responders. Given the high degree of variation in prevalence as well as the development of mental health issues in EMS responders who attend to natural disasters, suggests an individualised approach to addressing issues of PTSD, suicidal ideation, depression and other mental health issues that affect EMS professionals.

Regarding physical health risks and outcomes among responders attending to natural disasters are less explored in literature and the incidence of numerous injuries and illnesses is largely unknown because of inadequate surveillance systems and under-reporting (27, 63). The findings from this review revealed that the physical ailments that affect responders during natural disasters could be categorised into environmental, infectious, or traumatic. Environmental ailments as a result of exposure to particular conditions unique to the setting of the disaster which include heat stroke (27, 155), insect stings and bites (27, 48), and dermatologic conditions from heat and

dirty water, heat exhaustion (48, 151). Infectious diseases that responders contract commonly include gastrointestinal (27, 151), respiratory, and vector-borne infections (48). Infections are also commonly resulting from unsanitary conditions and overcrowding (27, 151). Infectious and environmental conditions are easily preventable by teaching environmental awareness specific to disaster settings (32, 63, 154), wearing appropriate personal protective equipment (PPE) (155), implementing vector control measures (48), providing adequate sanitation and water (63), and hygienic practices (32). Injuries included crush injuries, sprains, stabs, lacerations, fractures, burns and falls during early relief efforts involving search and rescue operations were also identified (63).

The implications of the health and safety hazards that EMS are exposed to during natural disasters is may impede them from executing their primary purpose of delivering emergency medical care. Further, there is a lack of understanding of how these factors may impact the overall functioning of the emergency response and further research is needed, not only to better elucidate mitigation tactics, but also to understand the broader implications of the adverse outcomes experienced by EMS providers. The suggested preventative measures represent the means of effectively minimising the adverse effects of EMS' exposure when responding to natural disasters.

Despite only two studies discussing deliberate violence that is directed at EMS responders, it is an increasingly common occurrence. Prior research noted that violence against responders has been on the rise in developed countries and particularly common in conflict zones like Pakistan, Sudan, Afghanistan, Syria and South Sudan, where they account for more than a third of all violent attacks (27). EMS responders are increasingly targeted on the road when they are travelling from one place to another. The implications of these attacks are the increased incidence of injuries and fatalities amongst EMS and the significantly reduced ability for them to provide emergency medical services where they are needed, especially during disasters.

## **Conclusion**

In summary, there is a general agreement across literature concerning the factors affecting the health and safety of EMS when attending the emergency situations during

natural disasters. The factors that affect the health and safety of EMS workers in natural disasters are fairly simple and straight forward and their prevalence is widespread while mitigation against them are commonly noted to be suboptimal. Evidence to support the most effective measures is also lacking, especially in LMICs. Additionally, there is agreement across literature that the leading preventive measure to limit exposure of EMS to health and safety risks during natural disasters was noted to be better management of resources at the disposal of EMS authorities.

The outcomes from this review aid in the understanding of factors determining EMS personnel's health and safety in attending natural disasters and the development as well as the implementation of mitigation measures and plans for post-disaster care. Looking forward, it is necessary that enhanced monitoring of the health and safety outcomes of responders attending to natural disasters is of the utmost importance and this is possible through the use of more sophisticated reporting and surveillance systems. Further research is recommended to utilise more accurate and detailed data from these systems to investigate the antecedents and consequences of health and safety hazards faced by responders in natural disasters and develop better strategies to ensure the health and safety of responders.

### **Limitations**

The limitations of this research included limited geographical coverage due to the exclusive usage of the English language in conducting the searches for the research articles. This limited the coverage of the research to articles of other language covering geographical locations of interest to the research.

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## **PART C: APPENDICES**

## **APPENDIX 1: Instructions for authors**

### **Prehospital and Disaster Medicine Journal: Instructions for Authors**

The Prehospital and Disaster Medicine journal was selected for publication of this research as the recommendations made in the study are applicable to an international audience, and open access is available.

**The instructions for authors for this journal can be found through the following link:**

**<https://www.cambridge.org/core/journals/prehospital-and-disaster-medicine/information/instructions-contributors>**

## **APPENDIX 2: Research protocol**

### **Factors that influence EMS responder health and safety during rescue work in natural disasters: A scoping review.**

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## **ABSTRACT**

The consequences of natural disaster have major impacts on societies, properties, and population life. Earthquakes, floods, storms, cyclones, tsunamis, wildfires, and extreme temperatures are examples of natural disasters. Natural disasters are often categorised as emergencies since they demand urgent intervention due of their influence on people's health and safety, which then affects the regular operations of working infrastructure, disrupts regular daily activities and represents a threat for people in affected areas.

An EMS responder's life or health could be at risk of exposure to several threats and hazards following the occurrence of natural disasters. These hazards can involve physical, chemical, ergonomic, biologic, radiologic, psychological, and behavioural health hazard. In addition, there is need to improve the disaster plans so as to prepare rescuers before disasters, advise them about how to act through the disaster and provide guidance on how to perform the essential activities after a natural disaster as part of ensuring the safety of EMS responders.

Factors that influence the safety of the EMS responders have not yet been clearly identified and understood. As such, a scoping review of the published research will be executed to identify and contextualize these factors. Through a scoping review, areas of saturation and areas requiring focus will be unearthed. This will add value to the existing literature regarding the subject matter, while at the same time contributing new knowledge.

Therefore, this scoping review aims to identify the key factors influencing the safety of the EMS responders during the execution of their rescue work in natural disasters. This research will utilize the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) for the scoping review process.

## INTRODUCTION

The International Federation of Red Cross and Red Crescent Societies (IFRC) defined a disaster as “a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community’s or society’s ability to cope using its own resources. Though often caused by nature, disasters can have human origins.”(1) The term “disaster” has long been used in a manner that is incorrectly and misleading. As highlighted in the definition, a hazard can only become a disaster once it affects the society in a negative or destructive way (2). Hazards are natural whereas disasters are not, for example: volcanoes, typhoons and earthquakes, whose occurrence is not triggered by human beings. A disaster often occurs as a result of the interaction between hazardous disasters and human societal activities, for instance; deforestation may lead to landslides, and the increasing rate of agricultural activities may lead to desertification (2). Regardless of the decisions taken by human beings, natural disaster will still occur(3) .

Several countries are not prone to natural disasters and every natural disaster type has a different effect on humans such as Earthquakes can cause buildings to collapse and Wildfires which can cause in the ignition of buildings However, that does not imply that these countries are exempt from natural disasters (4). In many countries, the most common or prominent natural catastrophes that usually occur are floods, tropical cyclones, severe thunderstorms, tornadoes and drought. These natural catastrophes usually lead to structural damage to infrastructure and loss of lives (5).

Natural disasters occur daily across the world and threaten the lives of many. A few mentionable natural disasters that have taken place in the last 20 years include Hurricane Katrina in the US Gulf Coast (2005), Cyclone Nargis in Myanmar (2008), Great East Japan Earthquake and Tsunami (2011), and Hurricane Sandy of the United States East Coast (2012). Such disasters had serious and long-term effects on the affected population's safety as well as community health (6). The negative health impacts of natural disasters could impact directly (e.g., mortality) or indirectly (e.g., famine and communicable diseases) (7). As a result of the impacts of natural disasters, the health issues are compounded by the loss done to the healthcare system, water and food, infrastructure of sanitation, and displacement of affected

communities (8). According to the WHO, many needs can be anticipated such as search and rescue, and medical assistance, however, responding to these areas during and after the disasters put the responders and rescuers safety at risk(9). The EMS arrive quickly to perform essential rescue work that needs to be done to return the security, safety, and normalcy to the affected communities (10). However, those responders and professionals are only trained to work typical day to day emergencies which occur throughout their cities and communities (11).

In a natural disaster situation and the different types of a natural disaster can cause different types of factors such as physical factors and injuries, mental factors and psychological state, and interpersonal factors which may affect their career and job. Emergencies can be so widespread and dangerous that local EMS may lack the needed resources (that is, funds, expertise, equipment and personnel) to respond safely and effectively. Despite the lack of adequate resources, responders are not hesitant execute their duties as been trained to do, that is, go to attend to an emergency scene prepared to provide immediate medical assistance and save lives. When the local health organisations capabilities and resources are overwhelmed by a natural disaster, responders come from other areas and from other national or international health organisations to assist in the affected area. Skilled support personnel are involved in specialized tasks, for example, removing debris and fixing utilities and transport (12). However, neighbours and other volunteers may be present at the scene of the disaster to offer some assistance. Other concerned individuals as well as organisations donate equipment, supplies and food (4). Responders must therefore try to efficiently cater for all the concerned citizens and organizations, tasks and actions, supplies and resources, telecommunications, as well as every individual's safety (13). One of the characteristics of natural disasters is that the response stages change quickly. There is always an underlying presence of risk with natural disaster response. This risk can be familiar or unfamiliar depending on the nature of the disaster (14). Moreover, recent natural disasters have created a multitude of safety and health problems, including apprehension, for emergency responders in those countries that have been affected (15). The safety officer and health specialists responsible for enforcement and regulatory rule compliance must make sure responders are safe while they are working and performing their functions during natural disasters. However, this is not an easy task as it is difficult to predict the

occurrence of natural events and to be fully prepared and anticipate the dangers, impacts, and far-reaching consequences on individuals or populations safety and wellbeing (16). As in previous natural disasters, such as the tsunami in the Indian Ocean (2004), Hurricane Katrina (2005), wildfires in Australia (2009), earthquake on Haiti (2010), and the floods in Pakistan (2010), the effects on the population and civilization in affected countries were overwhelming and immediate (17). Every time emergency responders and rescuers take action against these kinds of natural disasters, they put their personal safety aside and risk their lives to perform the rescue activities (18). While the threats can never be eliminated, strategies can be implemented to manage the risks involved, and ensure the safety of the disaster responders and all other personnel involved in the disaster response. The safety plan should meet the responders' safety and health needs at every phase of disaster work (19).

There are different types of healthcare responders. This research will only focus on the Emergency Medical services (EMS) responders because they must arrive at the scene first and their high-risk work nature. EMS are more exposed to factors because they are the first responders and do not know the exact situation and extent of disaster. If there is any kind of outbreak, there are chances that EMS may face the outbreak too. Because EMS reach there and guide the control room regarding the situation and then the control room provides specific instructions regarding the event.

The "Emergency Medical Service" or "EMS" refers to "a person, organisation or body that is dedicated, staffed and equipped to offer: (a) emergency medical care; (b) inter-health facility medical treatment; or (c) transport of the ill or injured" (10). Emergency care or emergency medical care refers to "the evaluation, treatment and care of an ill or injured person in an emergency care situation and the continuation of treatment and care during the transportation of such person to or between health establishments" (10). In this regard, an emergency care situation can be contextualized as the situation or circumstance during which an injured or ill person is in need of emergency care. The EMS personnel usually offer emergency medical care.

To transport an ill or injured person during the medical care situation, the emergency medical services personnel or paramedics usually make use of an ambulance.

The WHO (2014) indicated that public health security is threatened by pandemic-prone and epidemic diseases (20). These diseases are likely to result in high morbidity and mortality levels and they have severe adverse impacts on the economies of the regions they affect at the community level up to the global level (20). African countries have experienced such diseases like Lassa fever, meningococcal meningitis, yellow fever, influenza, Marburg and Ebola viruses and cholera epidemics (21).

One of the deadliest epidemics that has been reported in the 21<sup>st</sup> century is the novel coronavirus disease or COVID-19 (20). The outbreak of the novel coronavirus disease of 2019 (COVID-19) in mainland China which was declared by the WHO to a public health emergency (PHE) by the WHO or COVID-19 (22). In order to contain the outbreak of the novel corona virus, the National Health Commission of the People's Republic of China (NHCPRC) dispatched medical support teams to support with medical care in Hubei Province and in the city of Wuhan (22). There is need to understand a wide range of factors and their different type such as physical-, mental-, interpersonal, which can affect the safety of Emergency Medical Service Responders during their response work.

Emergency Medical Service Responders are of paramount importance during the emergency care situations. Response activities are generally classified into five categories, namely; disaster recognition, disaster notification, mobilization, response, and demobilization (20). The emergency medical services are very essential during all phases of response to a natural disaster, with notable key roles including: on scene treatment, mass-casualty triage, communication, evacuation, coordination of patient transport, and patient tracking (23). In addition, EMS personnel are also involved in leadership roles during their response to natural disasters, and they may be a part of the command staff, including being regarded as significant stakeholders of national or regional assets (24).

During some major natural disasters, the prolonged duration of operations has required response organisations to implement measures of sustainability that are unfamiliar (25). Numerous hazards that are caused by natural disasters may not be apparent until well after the end of disaster response operations (12). There is a lack of clarity of understanding the factors that influence the EMS responders safety (3). Therefore, to identify these factors a scoping review of published research will be conducted. This form of research aims to characterize the available literature thereby

showing areas of saturation and areas requiring focus. The objective of this review is therefore to map the available evidence to provide an overview of factors that influence the safety of disaster EMS responders and identify areas/factors that need further attention.

## **MOTIVATION**

Every year natural disasters kill around 90 000 people and impact close to 160 million people worldwide (21). Natural disasters include earthquakes, tsunamis, volcanic eruptions, landslides, hurricanes, floods, wildfires, heat waves and droughts. They have an immediate impact on human lives and often result in the destruction of the physical, biological and social environment of the affected people. This subsequently has a longer-term impact on their health, well-being and economic status. When disasters strike, the affected communities depend on emergency response systems and their responders. Due to the significance of emergency response systems and their responders, nations must take every measure to protect emergency workers' safety from health risks inherent in their work and disaster response. The safety of the healthcare worker is a major component of disaster management and response.

In recent years, workplace safety has come into the spotlight as an important topic that needs to be addressed, especially in healthcare (5). While various dangers in the workplace permeate all fields of work, with healthcare personnel being no exception. EMS responders are at increased risk during natural disasters. Internationally, there is limited research or guidelines when noting the factors that influence the EMS responder's safety in natural disasters. Therefore, a base-level understanding of what has been reported is needed, as well as the identification of additional factors that require more attention. This scoping review will provide an overview of all the research in the field over the past 20 years. The findings of this study can be used to guide EMS responder safety in future natural disasters.

### **Scoping review question**

What are the factors that influence EMS responder health and safety during rescue activities in natural disaster?

### **Aim of the study**

The aim of this study is to identify the most important factors that affect the health and safety of EMS responders in natural disasters as well provide information to mitigate factors to harm in future natural disasters.

## **Objectives**

1. Perform a scoping review using literature from the past 20 years to provide an overview of the literature and identify the factors that influence the responders' health and safety during rescue work in natural disasters and gaps in the literature.
2. Provide information that can inform: (I) Interventions for EMS responder health and safety in future natural disasters (II) future research in the field.

## **Methodology**

### **Study design**

The scoping review will be informed by a protocol developed *a priori* to predefine the study's objectives and methodology. All steps of the protocol, including screening, inclusion, and charting, will be done independently by one reviewer, and only the inclusion and exclusion of titles, abstracts and full-text are done by two reviewers.

The proposed concepts and search strings include:

*Search strategy:*

Please refer to appendix A

A three-step search strategy, as recommended by Aromataris *et al.* (26) and similar to that of a standard systematic review, will be employed to identify all literature in a systematic and exhaustive manner as follows:

1. Identifying synonyms in studies that were found in an initial search of a database include: PUBMED, MEDLINE, google scholar, SCOPUS, African-Wide, and National ETD (grey-literature). to gather titles and abstracts on studies relating to implementation in natural disaster settings and/or safety.
2. synonyms identified in step 1 will be used to search all databases for appropriate studies. All text will then be analysed to identify keywords. Index terms will be abstracted and reviewed for relevancy, as will medical subject headings (Mesh), where appropriate.

3. Reference lists from all studies identified in step 2 will be reviewed to identify additional studies.

*Inclusion criteria:*

- Articles published between 2000 and 2020
- Articles pertaining to natural disasters and/or responder safety
- Articles that outline interventions to mitigate health and safety risk in natural disasters
- Both review and original research articles
- Articles need not be directly related to healthcare
- Grey literature

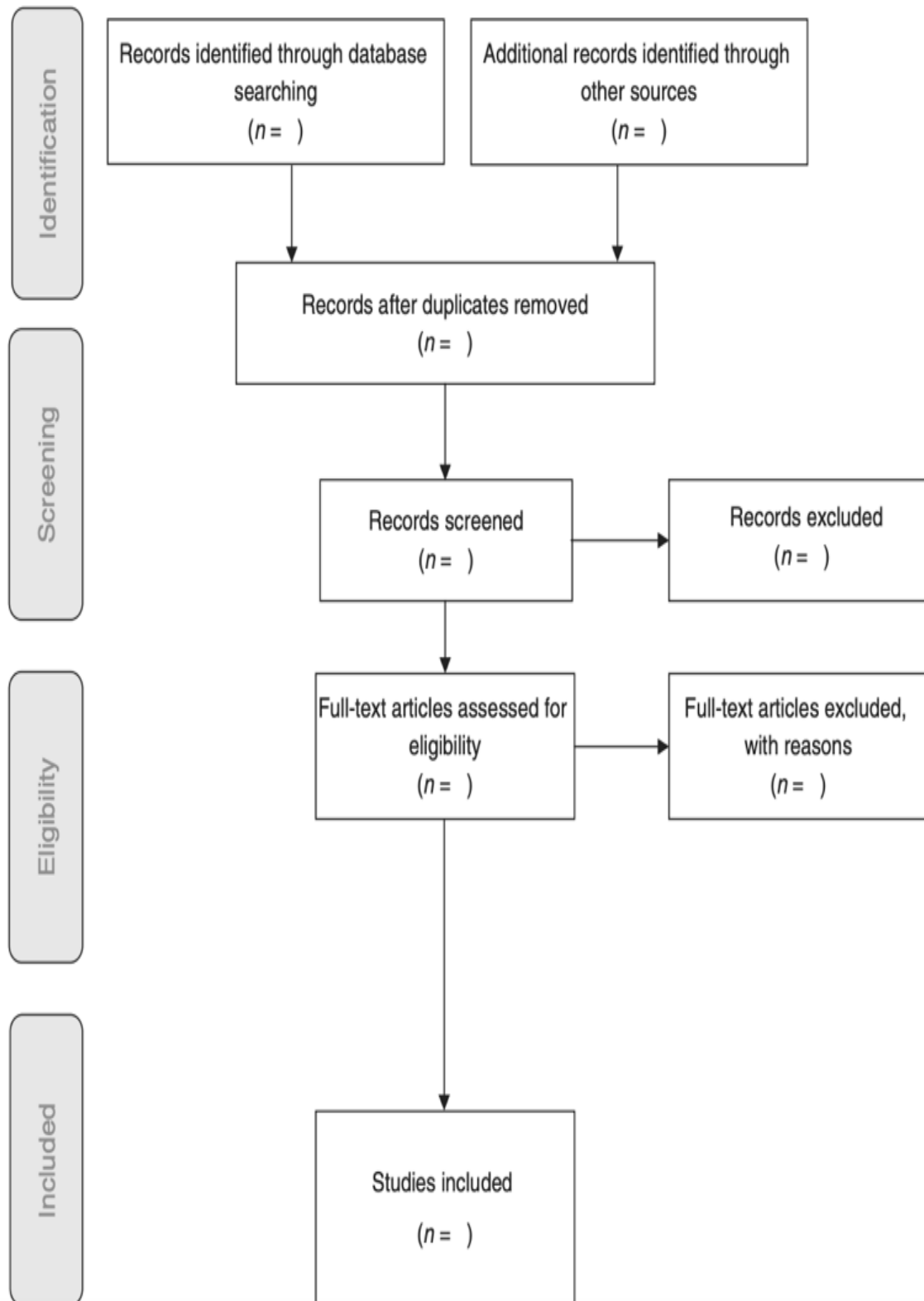
*Exclusion criteria*

- Articles published prior to 2000 and after 2020

Articles will be screened by assessing the title and the abstract. The full text manuscript of screened articles will be evaluated to determine eligibility.

This process will be documented by a flow chart similar to Figure 1.

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram for the scoping review process (27).



Data from studies meeting eligibility criteria will be extracted and charted for analysis. The following fields will be extracted for the study, where applicable:

1. Author(s)
2. Year of publication
3. Complete citation
4. Source origin/country of origin
5. Resource-level of study setting
6. Aims/purpose
7. Study population and sample size
8. Methodology
9. Description of disaster type
10. Description of disaster magnitude
11. Health and safety risks to EMS responders
12. Interventions to mitigate the health and safety risks to EMS responders

Results will then be classified under main conceptual categories and summarized using charts, tables, and maps.

### **Ethical considerations**

This study does not involve human participants and therefore poses little to no risk or harm. Given that this study may include grey literature, there may be some data that are not fully anonymised; any data of this nature will be de-identified by the researchers prior to inclusion. As this study is a review of the literature, no ethical approval will be required; however, the study protocol will be submitted to UCT HREC for confirmation and notification.

### **Limitations and strengths**

#### *Strengths*

1. The finding of this review will be generated from data that were collected from all relevant international studies over the past 20 years and will be representative of extensive experiences in the field.
2. The findings of this study can identify research gaps in the field and could () be used to design safety and health frameworks that could add value to organisations who provide aid in natural disasters.

### Limitations

The broad scope of the review objective may lead to difficulty establishing boundaries for the study. To keep the scope defined, we have developed an *a priori* protocol that includes multiple steps for refinement of potential inclusion studies. We have also included duplicate reviewers in this effort to reduce error and increase reliability.

### Dissemination plan

The expected outputs of this study will be the thesis available at the University of Cape Town repository and Publication of the review in an open access journal.

### Project Time Line

Table 2. Proposed timeline

2020-2021	October	November	December	January	February
EMDRC					
Data Collection					
Data Analysis					
Write up					
Submission					

### Resources and Budget

#### Hardware

Laptop, Storage (External Hard Drive), Printer

### *Software*

Word Processor: Microsoft Word (2016)

Spreadsheet: Microsoft Excel (2016)

Referencing software: Endnote x9 (UCT license)

Statistical software: SPSS (Statistical package for the social sciences)

### *Access Required*

- The principal investigator will procure and funds for the hardware and software required (where necessary). Access to the electronic databases mentioned above will be sought as soon as the appropriate approval has been granted.
- The study will be self-funded (Table 2) and there will be no applications for funding.

Table 3. Budget

Consumables	Description	Total
Office supplies	Stationery: pens, notepads, files	R500
Printing	Data collection forms, reports, manuscript, submission	R700
Internet and editing	Editing and language editor, UCT internet and access	R2000
Total		R3200

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## Appendix A

### Concept A: Natural disasters

"Natural disasters "[Text Word] OR " Natural Risks \*"[Text Word] OR " Floods "[Text Word] OR "A lot of water\*"[Text Word] OR " Natural hazard \*"[Text Word] OR " Tropical cyclones \*"[Text Word] OR " Thunderstorms \*"[Text Word] OR " Tornadoes "[Text Word] OR " Drought \*"[Text Word] OR " No water \*"[Text Word]." tsunamis "[Text Word] OR" volcano "[Text Word] OR" tornado "[Text Word] OR" wildfire "[Text Word] OR" earthquake "[Text Word] OR" earthquakes "[Text Word] OR" landslides "[Text Word] OR" sinkholes "[Text Word] OR" limnic eruptions "[Text Word] OR" cyclonic storm "[Text Word] OR" blizzards "[Text Word] OR" hailstorms "[Text Word] OR" ice storms "[Text Word] OR"cold waves"[Text Word] OR "cold waves"[Text Word] OR "heat waves"[Text Word] OR "solar flare"[Text Word] OR"

"Natural events "[Text Word] OR " Natural Risks \*"[Text Word] OR " Floods "[Text Word] OR "A lot of water\*"[Text Word] OR " Natural hazard \*"[Text Word] OR " Tropical cyclones \*"[Text Word] OR " Thunderstorms \*"[Text Word] OR " Tornadoes "[Text Word] OR " Drought \*"[Text Word] OR " No water \*"[Text Word]." tsunamis "[Text Word] OR" volcano "[Text Word] OR" tornado "[Text Word] OR" wildfire "[Text Word] OR" earthquake "[Text Word] OR" earthquakes "[Text Word] OR" landslides "[Text Word] OR" sinkholes "[Text Word] OR" limnic eruptions "[Text Word] OR" cyclonic storm "[Text Word] OR" blizzards "[Text Word] OR" hailstorms "[Text Word] OR" ice storms "[Text Word] OR"cold waves"[Text Word] OR "cold waves"[Text Word] OR "heat waves"[Text Word] OR "solar flare"[Text Word] OR"Natural events "[Text Word] OR " Natural Risks \*"[Text Word] OR " Floods "[Text Word] OR "A lot of water\*"[Text Word] OR " Natural hazard \*"[Text Word] OR " Tropical cyclones \*"[Text Word] OR " Thunderstorms \*"[Text Word] OR " Tornadoes "[Text Word] OR " Drought \*"[Text Word] OR " No water \*"[Text Word]." tsunamis "[Text Word] OR" volcano "[Text Word] OR" tornado "[Text Word] OR" wildfire "[Text Word] OR" earthquake "[Text Word] OR" earthquakes "[Text Word] OR" landslides "[Text Word] OR" sinkholes "[Text Word] OR" limnic eruptions "[Text Word] OR" cyclonic storm "[Text Word] OR" blizzards "[Text Word] OR" hailstorms "[Text Word] OR" ice storms "[Text Word] OR"cold waves"[Text Word] OR "cold waves"[Text Word] OR "heat waves"[Text Word] OR "solar flare"[Text Word] OR"

Concept B: Emergency Medical Services OR EMS including prehospital care

Emergency Medical Services [tw] OR "emergency responders"[tw] OR "emergency technicians"[tw] OR " emergency technician"[tw] OR "paramedic"[tw] OR "paramedics"[tw] OR "emergency personnel"[tw] OR "emergency medical personnel"[tw] OR "emergency service"[tw] OR "emergency services"[tw] OR "emergency medical service"[tw] OR "emergency medical services"[tw] OR "emergency medicine"[tw] OR "emergency health service"[tw] OR "emergency health services"[tw] OR "emergency care"[tw] OR "emergency healthcare"[tw] OR "emergency treatment"[tw] OR "emergency treatments"[tw] OR "emergency department"[tw] OR "emergency departments"[tw] OR "emergency room"[tw] OR "emergency rooms"[tw] OR "emergency ward"[tw] OR "emergency wards"[tw] OR "emergency unit"[tw] OR "emergency units"[tw] OR "emergency hospital"[tw] OR "emergency hospitals"[tw] OR "emergency clinic"[tw] OR "emergency clinics"[tw] OR "emergency setting"[tw] OR "emergency staff"[tw] OR "emergency response"[tw] OR "emergency medical technician"[tw] OR "emergency medical technicians"[tw] OR "paramedic"[tw] OR "paramedics"[tw] OR "ambulance"[tw] OR "ambulances"[tw] OR "ER"[tw] OR "first responder"[tw] OR "first responders"[tw] OR "rescue work"[tw] OR "rescue worker"[tw] OR "rescue workers"[tw] OR "relief work"[tw] OR "relief worker"[tw] OR "relief workers"[tw] OR "fire fighter"[tw] OR "trauma center"[tw] OR "trauma centers"[tw] OR "trauma unit"[tw] OR "trauma units"[tw] OR "critical care"[tw] OR "critical illness"[tw] OR "critical illnesses"[tw] OR "resuscitation"[tw] OR "shock"[tw] OR "sepsis"[tw] OR "septicemia"[tw] OR "septicaemia"[tw] OR "acute care"[tw] OR "acute disease"[tw] OR "acute diseases"[tw] OR "prehospital"[tw] OR "pre hospital"[tw] OR "wound"[tw] OR "wounds"[tw] OR "triage"[tw] OR "pregnancy complication"[tw] OR "pregnancy complications"[tw] OR "obstetric complication"[tw] OR "obstetric complications"[tw] OR "obstetric emergency"[tw] OR "obstetric emergencies"[tw] OR "military"[tw] OR "defense"[tw] OR "army"[tw])

Concept C: Safety Response\*

(("safety"[MeSH Terms] OR "safety"[All Fields]) OR "safeties"[All Fields]) AND "response\*"[All Fields]

Concept D: Safety of Health Responders

((("safety"[MeSH Terms] OR "safety"[All Fields]) OR "safeties"[All Fields]) AND (((((((((((("respond"[All Fields] OR "respondant"[All Fields]) OR "respondants"[All Fields]) OR "responded"[All Fields]) OR "respondent s"[All Fields]) OR "responder"[All Fields]) OR "responders"[All Fields]) OR "responding"[All Fields]) OR "respondings"[All Fields]) OR "responds"[All Fields]) OR "surveys and questionnaires"[MeSH Terms]) OR ("surveys"[All Fields] AND "questionnaires"[All Fields])) OR "surveys and questionnaires"[All Fields]) OR "respondent"[All Fields]) OR "respondents"[All Fields]).

## APPENDIX 3: HREC approval letter



**UNIVERSITY OF CAPE TOWN**  
**Faculty of Health Sciences**  
**Human Research Ethics Committee**



Room G50-46 Old Main Building  
Groote Schuur Hospital  
Observatory 7925  
Telephone [021] 406 6492  
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Website: [www.health.uct.ac.za/fhs/research/humanethics/forms](http://www.health.uct.ac.za/fhs/research/humanethics/forms)

11 November 2020

**HREC/REF: 754 /2020**

**Dr S Rambharose**  
Division of Emergency Medicine  
F-51, OMB  
Email: [sanjeev.rambharose@uct.ac.za](mailto:sanjeev.rambharose@uct.ac.za)  
Student: [YA92ZH@gmail.com](mailto:YA92ZH@gmail.com)

Dear Dr Rambharose

**PROJECT TITLE: FACTORS THAT INFLUENCE EMS RESPONDER HEALTH AND SAFETY DURING RESCUE WORK IN NATURAL DISASTERS: A SCOPING REVIEW-MPHIL CANDIDATE YAHYA ALZHRANI-SYSTEMATIC REVIEW**

Thank you for submitting your request to the Faculty of Health Sciences Human Research Ethics Committee.

The HREC note that the proposed study is a systematic review.

As the systematic review involves published literature available through publicly accessible electronic databases, research ethics review and approval is not required.

This is in accordance with Section 1.1.8 of the Department of Health's Ethics in Health Research: Principles, Processes and Structures (South African Department of Health, 2015), which states: "*Research that relies exclusively on publicly available information or accessible through legislation or regulation usually need not undergo formal ethics review. This does not mean that ethical considerations are irrelevant to the research.*"

The HREC recommend that researchers refer to the PRISMA website, for the PRISMA statement and checklist, to facilitate the reporting of systematic reviews and meta-analyses. For more information, please refer to <http://www.prisma-statement.org/>.

Further, fundamental ethical principles for health-related research should be considered in the objectives and methods of the systematic review. See, for example, the Declaration of Helsinki (Fortaleza, Brazil, 2013) and the Department of Health's Ethics in Health Research: Principles, Processes and Structures (South African Department of Health, 2015).

The HREC acknowledge that the MPHIL Candidate, Mr Yahya Alzahrani, was also involved in this project.

Yours sincerely

**PROFESSOR M BLOCKMAN**  
**CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE**

Hrec.ref754/2020sa