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Review Article

Components of Health Surveillance System in Natural Disasters that Affect Military Health Services: A Systematic Review

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Abstract

Background: Military health surveillance system, as the first responder in natural disasters, plays an important role in public health. This study aimed to identify those components of the health surveillance system, which influence military health services in natural disasters.

Methods: Five databases of Medline, SCOPUS, Web of Science, ProQuest, Cochrane Library, and search engines of Scholar Google, scienceopen.com, openGery.eu, and WHO.int were reviewed from Jan 1990 to Jan 2022. Due to the heterogeneity of the included studies, various JBI quality assessment tools were applied and the extracted data were analyzed by meta-synthesis method.

Results: Out of 6538 retrieved studies, after the duplicates and irrelevant studies identified in screening stage were removed, 174 studies extracted from the electronic search of databases and 16 studies retrieved from the manual search of other sources were reviewed based on the study inclusion criteria. Finally, 24 studies with inclusion criteria were selected for data extraction. Ten criteria of monitoring, detecting, data collection and reporting, tracking, type of surveillance system, operational readiness, coordination and interaction, feasibility, flexibility, and acceptability were identified as effective components in the surveillance system of military health services. The identified components were classified into two main categories of structural and operational components.

Conclusion: The structural components of the military health surveillance system describe the important infrastructural features of the health surveillance system to preparing for natural disasters; and the operational components explains the effective functional features of military health surveillance system in response of natural disasters. The results of this study help policymakers in military health services implement a more effective health surveillance system in natural disasters.

Keywords: Public health surveillance; Natural disaster; Military health services

Introduction

The natural hazards leading to environmental damage, health problems, and human mortality are called natural disasters (1, 2). From 2000 to 2019, approximately more than 6000 natural disasters, which caused 510837 death and 3.9 billion affected people, have been recorded (3). Health-

related needs of the affected population are evaluated with an active surveillance system (4). The health surveillance system is the continuous process of public health-related data collection, analysis, and interpretation required for planning, implementation, and evaluation of public health performance (5). The information this system provides is vital to public health decision making as well as taking effective relief measures and establish resources for the affected people (6, 7).

Effective surveillance works as an early warning system for an impending outbreak, which can become a public health emergency (4). Post-disaster the system monitoring the epidemiology of health problems, detecting changes in trends, and focuses on health situations capable of becoming an epidemic with the highest risk of injury and death to the population (8-10).

The military forces acts as the first responders during natural disasters to providing security services and sharing military health services capabilities with national health (1, 11). Hence, military health services are essential in health relief operations during natural disasters (12). Over the recent years, the need for military preventive medicine and military healthcare personnel aware of the special needs in disaster situations has been felt more than ever (1). Moreover, the technical support on reporting and cooperation to response potential public health hazards of natural disasters has become critical for the commanders of preventive medical as well as public health surveillance system in military health services (13). Therefore, the study of public health surveillance of military services in response to natural disasters was attracted researchers of this study.

In order to understand the health surveillance system of military services during natural disasters, it is necessary to gain knowledge about factors and components through literature review. To the best of authors' knowledge during the search period, the present study is the first systematic review on the components of the health surveillance system that influence the military health services during natural disasters.

Thus, we aimed to diagnos the components of the health surveillance system in natural hazards which are effective in providing military health services.

Materials and Methods

Protocol and Registration

The protocol of this study has been registered on PROSPERO website under the code (CRD42022319452).

Eligibility criteria

The studies included in the present study were works on the components of health surveillance system, studies about natural disaster and works on military health services in the natural disasters health surveillance system.

Natural disasters usually happen suddenly and threaten the public health. Among 300 natural disasters identified around the world (9), those caused by natural hazards such as climatological, geophysical, hydrological and biological hazards, epidemics and pandemics of infectious diseases were included here (14). Thus, the studies evaluating the health surveillance system in non-natural hazards, wars, and chemical, nuclear and microbial attacks were excluded.

As for the third inclusion criterion, i.e., investigating military health services in the natural disasters health surveillance system, all studies addressing, directly or indirectly, the components of natural hazard health surveillance system in military health services were included. However, no methodological or linguistic limitation was applied on the inclusion of studies here. Due to the incomplete bibliographic information of the electronic literature and the unavailability of the full text of some studies conducted before 1990, the beginning of the search period in this research was considered 1990.

Information sources

Here, five databases of PubMed, SCOPUS, Web of Science ISI, ProQuest, Cochrane Library from Jan 1990 to Jan 2022 were electronically searched

with the specific search term of each database. Google's search engines such as Scholar, science-open.com, OpenGery.eu, and WHO.int were manually searched to cover other sources and gray literature. At the end, the reference of the included papers was reviewed to find other studies with the same inclusion criteria, but no new item was identified.

Search Strategy

Based on the main variables of the research question, surveillance system, natural disaster and military health service, as well as their synonym retrieved using MeSH were selected as keywords to be searched. The final keywords for PubMed database were selected by combining the synonyms with OR operator and combining components with AND operator and the resulting phrases were searched in other databases. Number Need to Read (NNR) for databases was considered from 12 to 16 (15).

Selection process

All studies retrieved from databases, search engines were entered into EndNoteX9, and duplicates were removed by electronic configuration in Endnote software as well as manual comparison of similar cases. Then, in the screening stage after studying the title and abstract of the studies, those not related to this study were executed. Next, two researchers evaluated the full text of the studies independently based on the inclusion criteria. In cases of uncertainty or misunderstanding between the two researchers, a third expert decided on the inclusion of exclusion of the study. Then, the reference of the included studies was reviewed to find other related studies, but no new item was found. No linguistic limitation was applied in the selection stage and Google Translate was used for translating non-English studies.

Data collection

Two members of the research team independently extracted the data out of the included studies based on the data extraction form designed in two parts and nine questions. Part 1 contains the articles' specifications and part 2 includes the components of research question.

Risk of bias in individual studies

In term of methodology, the included studies were qualitative and quantitative, descriptive and analytical cross-sectional, survey, learned lesson, and report. They were scored conventionally and qualitatively in terms of their quality evaluated by specific tools. Surveys was evaluated using CEBMa center for evidence based-management, critical appraisal tool for survey (16). The conventional scoring scale was weak (0-4), moderate (5-8) and strong (9-12). To evaluate the quality of qualitative studies and retrospective analysis, the JBI tool specific to these studies was used. For cross-sectional analytical studies, JBI critical appraisal checklist for analytical cross-sectional and for descriptive cross-sectional studies, JBI critical appraisal checklist for studies reporting prevalence data were employed (17). The conventional scoring scale was weak (0-3), moderate (4-6) and strong (7-9, for descriptive studies and 7-10, for analytical studies). The quality of gray literature was assessed using the JBI standard tool for Critical Appraisal of texts and Opinions (18). This checklist had six questions and the scoring scale was weak (0-2), moderate (3-4), and strong (5-6).

Data synthesis

As the data collected here were qualitative, thematic content analysis with inductive approach was used for combining them (19). During the analysis, components identification, coding, theme production, themes reviewing, identification of common themes and naming of themes as the components of health surveillance system, which affect military health services, were done by the main researcher.

Results

Selection Process

Overall, 6538 studies were retrieved from five electronic databases of MEDLINE (via PubMed), SCOPUS, Web of Science, ProQuest,

Cochran library. Among them, 826 electronically found studies and 220 manually identified studies were removed as duplicate. Thus, 5492 studies were scanned based on their title and abstract, out of which 5318 studies were eliminated as irrelevant studies and 174 studies were selected to be completely reviewed. As the full text of two studies was not found, the full texts of 172 studies were evaluated based on the inclusion criteria. In addition, the full text of 13 out of 16 studies retrieved from the manual search of search engines, gray literature, and WHO website were evaluated based on the inclusion criteria. Finally, 24 studies characterized with inclusion criteria were included in this systematic review (Fig. 1).

Characteristics of included studies and quality assessment

Among the included studies, there were 23 articles and only one book section (1) published in 1993-2021. Most studies were done in the USA and France and one study in North America, Canada, Japan, Singapore, Indonesia and Thailand, Sierra Leone, and Ghana (Table 1). As no linguistic limitation was applied, a French study was included, (20) and translated by Google Translate.

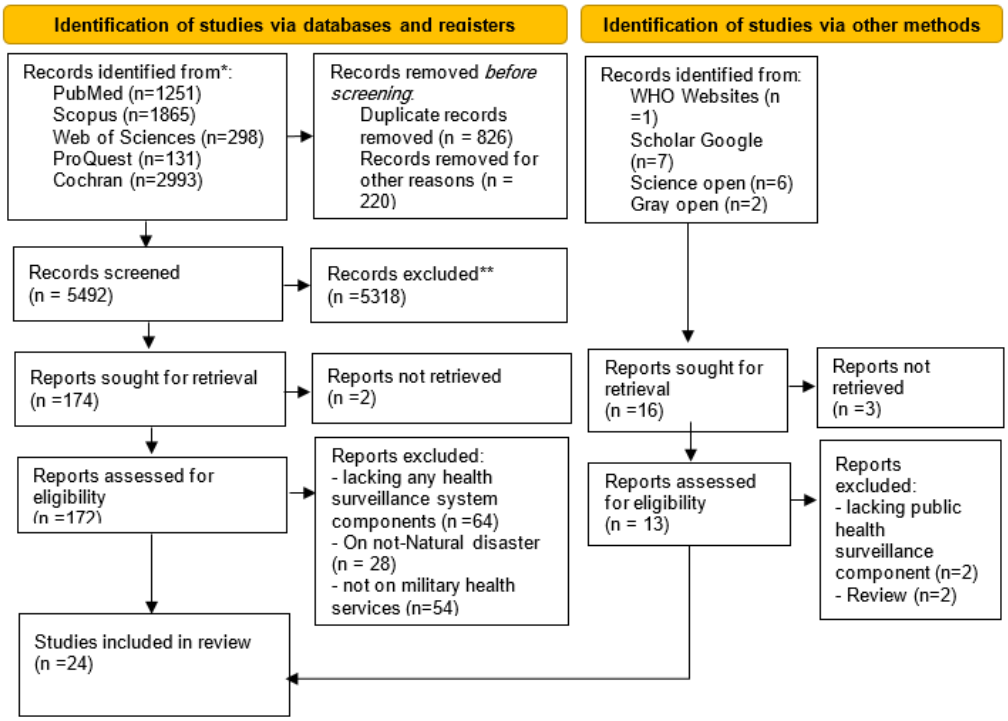

Fig. 1: PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources, systematic review on the components of public health surveillance system in natural disasters which affect military health services

Most of the included studies were about the epidemics and pandemics in natural disasters. Four studies were about geophysical hazards (21-24) and two was related to climatological hazards (1, 25). In addition, there were five learned lessons and one report and the rest were article.

In term of methodology, studies were nonhomogeneous as descriptive cross-sectional studies, analytical cross-sectional studies, and qualitative studies, retrospective analysis and surveys (Table 1).

Table 1: Characteristics of the included studies

	Author(s)	*Year*	*Setting*	*Study design*	*Study purpose*	*Natural disaster type*	*Quality assessment*
1	Petruccelli, Bruno. et.al.	2010	North America	Descriptive report	The role of the department of defense in influenza surveillance and effective response in pandemics	Pandemic	Moderate
2	Tan, K. W. A. et.al.	2021	Singapore	lesson learn	Epidemiological studies on COVID-19 cases in the Singapore Armed Forces and public health strategies and measurescon-sistent with the National COVID-19 Control Strategy to mitigate the risk of COVID-19 transmission in military camps	Pandemic	Moderate
3	Sanchez, Jese L Horosko III, Steve.	2006		Book chapter	The US military involvement in disaster relief	Climatological geological	Strong
4	Gache, K. Mayet, A. et.al.	2013	France	Qualitative evaluation	Assessment of the two surveillance systems with pandemic surveillance system used in the French armed forces	pandemic	Moderate
5	Pohl, Jean-Baptiste Mayet, et.al.	2014	France	survey	Assessing the role of the epidemiological surveillance system in influenza A (H1N1) epidemic management at different levels of the Department of Defense and understanding how daily data are collected,	pandemic	Strong

					although not regarded as necessary by epidemiologists, in order to help in decision-making for epidemic risk managers in the French Armed Forces		
6	Zhao, G. et.al.	2021	Sierra Leone	Cross-sectional/ descriptive	Describing the design and implementing a mobile electronic surveillance system for infectious diseases (MESSID) developed in collaboration with the Armed Forces of the Republic of Sierra Leone (RSLAF)	Infectious disease epidemic	Strong
7	Lee, L. E. et.al.	1993	Florida	survey	Describing and detecting the health status and prevalence of the disease in the population affected by Hurricane Andrew in South Dade, Florida	Hurricane	Strong
8	Edge, H. M. Carlucci, S. Lu, D.	2020	Canada	Rapid communication	Describing the response of the Canadian Armed Forces to protecting the health of troops in the Covid-19 pandemic	Pandemic	Strong
9	Robert, L. L.	2001	USA	Lesson learned/descriptive cross-sectional	Describing the planning, monitoring, and operational measures used by the U.S. military to minimize the effects of malaria during military operations	Epidemic	Moderate
10	Kelley, P.	2009	USA	commentary	A commentary on	Infectious	Strong

	W.				the role of the military system in global influenza monitoring	disease epidemic	
11	Jefferson, Henry. et.al.	2008	France	Qualitative	Evaluation of a new system of military syndromic monitoring	Infectious disease epidemic	Moderate
12	Watson, N. A.	2013	Japan	brief summary	Summary of public health activities by the army medical command in the pacific and the Japan veterinary command after March 11, 2011 earthquake, tsunami and nuclear reactor explosion in northeastern Japan	Earthquake and tsunami	Strong
13	Rusiecki, Jennifer A .et.al.	2014	USA	Cross-sectional survey	Evaluating the health effects of paramedics during disasters	Hurricanes Katrina and Rita	Strong
14	Odoom, John Kofi . et.al.	2012	Ghana	Cross- sectional survey	Training the military forces and monitoring the bird flu in Ghana military barracks	Infectious disease epidemic	Strong
15	Meynard, J. B. et.al	2008	France & British	survey	Describing a new framework for evaluating military surveillance systems for early diagnosis of outbreaks in duty areas	Infectious disease epidemic	Moderate
16	Lucero, C. A.et.al.	2011	Retrospective analysis	USA	Evaluating disease surveillance using a biosecurity program which combines data from two Ministry of Defense populations	Infectious disease epidemic	Moderate
17	Caserio-Schonemann, C. Meynard, J.	2015	France	Meeting reports/ Lesson learned	Expressing the experiences of health system providers, deci-	Extreme weather conditions, Infectious	Strong

	B.				sion makers, and stakeholders to present future cooperation between civil and military surveillance	disease epidemic	
18	de Laval, F.et.al	2013	France	Brief communication	Diagnosis of the risk related to dengue virus in areas where the French Armed Forces are stationed	Infectious disease epidemic	Strong
19	Pavlin, J. A. et.al.	2013	USA	Survey	Improving the possibility of early diagnosis and alerting of health events of regional and national significance by creating an integrated system which maximizes both sample size and diversity of monitored populations and represents the goals of improving integration and coordination	Epidemic	Strong
20	Mayet, A. et.al	2010	France	Descriptive cross-sectional	Presenting the first results of adaptation of surveillance system tools for epidemic conditions	Pandemic	Moderate
21	Mayet, A. et.al	2011	France	Descriptive cross-sectional	Presenting the results of monitoring the spread of influenza among the French Armed Forces	Epidemic	Strong
22	Lombardo, J. et.al.	2003	USA	Descriptive cross-sectional	Describing the e-surveillance system for the early notification of community-based epidemics	Community-based epidemics	Strong
23	Chretien, Jean-Paul.	2006	Indonesia &	Lesson learned	This paper shows how the Depart-	Tsunami	Moderate

			Thailand		ment of Defense (DoD) Global Outbreak Infection Monitoring and Response System (DoD-GEIS) has strong, pre-existing laboratory and epidemiological capabilities, and partnerships with affected countries and other agencies to increase preparedness for tsunami post-epidemic		
24	Burkom, H. et.al.	2021	USA	Lessons learned/ Descriptive study	Describing the components and developing a bio surveillance system which coordinates health surveillance with an approach to all hazards and infectious disease monitoring in large and small health departments	Community-based epidemics	Strong

The results of survey studies

The components of health surveillance system of natural hazards known to influence military health services were classified into structural and operational components (Table 2).

Structural components included Health monitoring (20, 25-29), detecting of health risk (25, 27, 28, 30-32), data collection system and reporting (23, 25, 31, 33, 34), tracking health risks (26, 29, 32, 35) and choosing the type of surveillance system appropriate for the natural disasters (25, 26, 36-38).

The most effective operational components were operational readiness (20, 28, 31, 35, 37), interaction of military health surveillance system with civil surveillance system (35), coordination of military health surveillance system with national health surveillance system in natural disasters (29, 39), feasibility (27, 29, 33, 39), flexibility (20, 27, 33) and acceptability (27, 33).

Table 2: Thematic content analysis of findings

Category	*Sub- Category*	*Examples of important factors*
Structural components	Monitoring	Monitoring the surveillance system performance
		Reactivity system, a system which knows the threshold of an epidemic
	Detecting	Early diagnosis
		Early warning
		Quickly detect
	Data collection & Reporting	Simple and transparent reporting process
		fast and easy Data collection
	Tracking	A comprehensive approach to tracking diseases and epidemics
		Multilateral surveillance
		Following a comprehensive national strategy in tracking epidemics
	Type of surveillance system	Permanent-Daily-Seasonal Period
		Active surveillance
		Syndromic surveillance
Operational components	Operational readiness	human resources readiness
		Force protection
		Laboratories and facilities ready for emergencies
	Coordination and interaction with national health	Interaction of military health services in the implementation of the national health surveillance system
		Coordination of military institutions with the laboratory
		Coordination of military institutions with national health facilities
		Use of strong military epidemiological research capabilities and aggressive contact tracking measures
	Feasibility	Easy collection of indicators
		High quality method of data collection
		applicable method of data collection and control
	Flexibility	Possibility of analysis of the data according to the decision needs
		Flexibility in decision making
		Flexibility regarding the type of natural disaster
	Acceptability	Having the best performance in terms of epidemiological and biological monitoring
		Cost-effective manpower and support
		Relevance, usefulness and usability in the event of natural disasters
		Highly efficient
		Convenience

Discussion

Structural components in the health surveillance system

Monitoring as a significant component of health surveillance system is essential in controlling the spread of diseases, understanding disease burden over time, and detecting changes in the prevalence of the disease (40). Former systematic reviews attributed the best performance during epidemics to surveillance systems with an active monitoring system (27). In public health surveillance systems, monitoring aims to strengthen the early warning capacity of public health events

because the detection, monitoring and evaluation of unexpected or even expected public health threats is accelerated by continuous public health monitoring (25). Based on the literature, US Department of Defense allocates an annual budget for disease surveillance systems due to the significance of monitoring and early diagnosis of infectious and emerging global diseases (26, 31). Monitoring improves the responsiveness of the health surveillance system for a surveillance system, which knows the epidemic threshold (27). Thus, in studies on health surveillance system in military health services, monitoring is an essential structural component (20, 25-29).

Ability to diagnose disease and hazards (32) as another structural component allows rapid and early warning of public health threats (25, 28, 35, 37, 41, 42). Early diagnosis as a significant result of detection in health surveillance systems in military health services helps prevent hazards from turning into disasters (43). The evaluation of syndromic surveillance system indicated that this system in military public health services has led to the early diagnosis of disease (36).

Among the syndromic surveillance systems, the intelligent surveillance system, which is capable of real-time information analysis, can accurately and strongly predict the outbreak of the disease in the early stages and speed up dealing with the epidemic based on prior knowledge and before clinical and laboratory confirmation of the disease (44).

Health surveillance systems with a simple and transparent process of data collection and reporting has been introduced as systems that are more efficient during natural disasters (22, 33, 45). The use of electronic surveillance systems, mobile electronic surveillance system and mobile applications over the recent years has facilitated the collection of data on occurrence, prevalence and management of health databases (33). During the early stages of the COVID-19 epidemic in Africa, many cases were diagnosed by military medical mobile electronic surveillance system (33).

Tracking is another significant component related to the structure of health surveillance system, which influences military health services (26). It gains more importance during epidemics because it helps identify cases of contact between sick people and other people (46). Studies on military health services found that comprehensive approach to disease and epidemic tracking and multidimensional surveillance considerably affect health surveillance system (26, 35).

The type of surveillance system is another important structural component in providing military health services during natural disasters. Active and syndromic surveillance systems were known as military health service systems commonly used in natural disasters (1, 22, 25, 26, 36-38). An epidemiologically active surveillance system is applied for evaluating the cause of death and distribution of diseases and injuries caused by disasters in the affected population (1). After Hurricane Andrew, the U.S. military- by monitoring the visits of civil and military hospital emergencies- performed an active surveillance for gastrointestinal and respiratory diseases and injuries, which led to reduced complications of injuries and prevention of infectious diseases (22). Studies on active surveillance system indicated that in the event of disasters and field emergencies and in military hospitals, the active surveillance system contributes to the immediate assessment and initial estimation of disaster complications (1), which confirms it significance in the health surveillance system in natural disasters.

The syndromic health surveillance system, by collecting time-sensitive data, provides the most up-to-date information for effective information evaluation and resource allocation for decision makers (25). Surveillance time, which varies, based on the type of surveillance system influences the efficiency of military health services during the identification and control of diseases and epidemics (20, 28, 32). For instance, comparison of the syndromic and traditional health surveillance systems in the French Armed Forces showed that traditional surveillance is a weekly reporting system, while syndromic surveillance is a real-time reporting system that makes possible the timely detection of the prevalence (36).

Operational components in the health surveillance system

Operational readiness refers to both human resources readiness and facilities readiness. Maintaining human resources readiness and protecting them are among the most significant components of operational readiness (31, 35). Personnel trained in public health practices played a more active role in early diagnosis of health hazards (31) and preparation of health surveillance system for natural hazards (26, 31).

Laboratories and facilities ready for emergencies is another component of operational readiness (24, 33). Military service laboratories are considered as well- equipped diagnostic laboratories due to their readiness for biological threats. They should be prepared during natural hazards to deal with public health threats (35).

Due to the pervasiveness of complications in the community during natural disasters, the coordination and interaction of military and civil services as another operational component affect the success of the community health surveillance system (21, 29). For instance, in flu outbreak, Department of Defense's interaction with the state surveillance system provided for public health personnel more information such as the spread of disease in the military and civilians including children, youth, and the elderly, (31). Furthermore, laboratory reporting methods in military and civilian service facilities should be coordinated in the event of public health hazards to make effective public health decisions and measures so that the results requested by state health authorities can be analyzed and decided(26).

Another operational component of health surveillance system is feasibility. Feasibility in the military health surveillance system means the extent to which the equipment and facilities of a health surveillance system meet the needs of the military health surveillance system (27). For instance, the method of data collection and calculation of indicators in the natural health surveillance system should be easy, feasible and of high quality (22, 27). A feature of health surveillance systems' feasibility during natural disasters and crises is the possibility of easy monitoring, evaluation, and control (33). In military service surveillance systems, limited access to health information affect the evaluation of military health surveillance systems (37). Therefore, this review detected the access of the military health surveillance system to public health data as another significant factor in the feasibility of that health surveillance system.

Another critical operational component is the flexibility of the system that is the health surveillance system should have flexibility in decision-making with respect to data analysis (20). The type of natural disaster creates the need for the flexibility of the health surveillance system in data collection, surveillance time, risk analysis and effective measures for community health (27).

A health surveillance system should be acceptable to stakeholders to be effective. Some studies evaluated system's acceptability based on the relevance, ease of implementation and usability of the system in natural disasters (28, 33). In health surveillance systems, new approaches to data collection and analysis, as well as the exchange of health information, which reduce the workload of health professionals and personnel, are more acceptable. For instance, automating the collection of epidemiological data from military medical records in military health surveillance systems has increased the acceptance of these systems among medical personnel (28).

Another component of acceptability is the cost of human resources and support (27). Although health surveillance systems with daily monitoring will be useful at the highest levels of military medical decision-making during an epidemic, this system is not more accepted among military epidemiologists and general practitioners in comparison to the weekly health surveillance system because it increases workload and human resources costs (28). The evaluation of the acceptability of health surveillance systems in military health services revealed that cost-effective systems are more acceptable among stakeholders (27, 28, 33).

Strength, weakness and limitation

This is the first study with comprehensive systematic research of databases and search engines

for this subject. The studies heterogeneity in risk of bias assessment was study limitation, which we resolve by qualitative conventional scoring scale.

Conclusion

The present studies identified the most effective components of the military health surveillance system in natural disasters and grouped them into structural and operational components. Based on the results, continuous monitoring, early diagnosis, easy data collection and reporting, disaster tracking and choosing a surveillance system appropriate to the type of hazards should be considered in selecting the structure of the military health surveillance system during natural disasters. This study can help policy makers and decision makers of military health services design a more effective health surveillance system during natural disasters. The military health surveillance system should be operational in terms of feasibility, flexibility, and acceptance among stakeholders. Further, it should be prepared for operations, coordination and interaction with the civilian surveillance system in the face of disasters. The present study identified the components affecting the military health surveillance system. However, more research is required to study quantitatively the effect of each component in the future.

Journalism Ethics considerations

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

Conflict of interest

The authors declare that there is no conflict of interests.

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