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Pharmaceutical Management in Response to Natural Disasters: A Systematic Literature Review

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ABSTRACT

Background: Problems still occur regarding pharmaceutical supplies management in overcoming natural disasters, such as excess stock, slow distribution, staff knowledge about emergency response, logistics systems, inappropriate pharmaceuticals for the disaster type, and cross-sector coordination.

Objectives: This is a systematic review of natural disasters. The results are hoped to provide recommendations to improve pharmacy management responses.

Methods: Research on pharmaceutical management at natural disaster sites, covering all phases of the management process from pharmaceutical selection to disposal, original research that is fully accessible, and those published in English within 2019-2024, are the conditions for inclusion. Duplication of publications is the exclusion criteria. Databases were searched for information about pharmaceutical management for natural disasters, such as Crossref, Science Direct, PubMed, Research Gate, and Google Scholar. This study'squality assessment applied the JBI CAT checklist, and was thematically synthesized.

Results: Six studies were included in the total of59.794 identified studies. The relevant characteristics of the studies are related to pharmaceutical management scope, specifically the Drug Management Cycle.

Conclusion: This study concludes that pharmaceutical management in dealing with natural disasters focuses more on aspects of planning, distribution, and management support when disasters occur. The limitation of this review is the lack of research on the scope of storage, recording and reporting, evaluation, and disposal of pharmaceuticals.

Keywords: Health Crisis; Logistics; Medicine; Preparedness; **Response**.

INTRODUCTION

Indonesia is among 20 countries that have the potential to face a high risk of disaster in conditions where the majority of the population lives below the poverty line. This can worsen the socio-economic and human impact of disasters in Indonesia, both short and long-term [1] Disasters in Indonesia during 2022 amounted to 3,544 incidents, with sudden onset natural disasters dominating at 3,262 incidents, and slow onset disasters at 282 incidents [2]

As much as 80% of emergency management research concerns emergency logistics activities[3] This is because problems that often occur regarding the logistics of health crises such as those in Indonesia are the excess stock of goods for non-urgent needs, uneven distribution of aid, and slow distribution of aid to disaster victims[4]. Apart from that, health workers' knowledge regarding emergency response to a health crisis, logistics, and evacuation systems is something that needs to be considered with regard to preparedness in facing health crisis[5] Incongruities also occur, such as medicines not being suitable for the type of health crisis, there being no officers to verify donated medicines, and cross-sector coordination not being well established. The consequences of this misalignment include drug accumulation, problems with storage, security, and use of drugs[6] This is in line

with the results of the evaluation of Indonesian health crisis management in 2021, where out of 450 crisis incidents, some obstacles are generally faced in each affected area, namely related to the availability of medicines, distribution of medicines, and health crisis management skills among stakeholders[7]

Health logistics problems during natural disasters are related to the drug management cycle, which includes the stages of Selection, Procurement, Distribution, and Use. This cycle is more detailed and operationally described into the stages of Planning, Procurement, Receipt, Storage, Distribution, Use, Monitoring, Evaluation, and Disposal.[8] This context is all included in the pharmaceutical management framework, and can be said to be an extension or local implementation of the Drug Management Cycle in Indonesia.

There are several studies from various points of view regarding pharmaceutical supplies in disaster conditions or in the preparation phase to face all kinds of disruption from 2019 to 2024. Few studies evaluated the resilience mechanism of the pharmaceutical supply chain in the industrial pharmaceutical sector in the face of various disturbances, including natural disasters[9,10] A scoping review examines the management of pharmaceutical supply operations specific to the Covid-19 context, in which 11 pharmaceutical supply operations management components (needs assessment, selection, demand forecasting, logistics assessment, procurement, donation, compounding, storage, supply and distribution, monitoring and supervision, and supply and demand management) and 4 management support components (human resources, use of technology, committees, and communication) during the disaster preparedness and response phase were identified[11]

Based on several previous research articles, it can be seen that research on pharmaceutical management in overcoming health crises still focuses on the stability of the pharmaceutical supply chain in the pharmaceutical industry. Even if there is research on pharmaceutical management in communities where health crises occur, it only focuses on the emergency preparedness and response phase, specifically for the COVID-19 pandemic. Existing research on drug logistics management takes place in hospitals only [12 - 15]. Meanwhile, research on pharmaceutical management at the scene of a natural disaster, with the scope of management starting from the preparedness period, the emergency response period, to the recovery period, has not been widely studied.

The objective of this study is to offer a systematic literature review of pharmaceutical management in dealing with health crises, especially those caused by natural disasters. The novelty of this study lies in the absence of research on the development of the management of pharmaceuticals at natural disaster sites. The contribution or difference from other studies is that this study presents pharmaceutical management in natural disasters from the management stages in a more comprehensive manner, namely from planning to the disposal of drugs.

METHODS

Study Design & Search Strategy

This study constitutes a systematic literature review. This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A systematic search was conducted in databases to identify relevant literature. Finding studies pertinent to the subject of pharmaceutical management in natural disaster management was the goal of this literature search. Literature was searched from Crossref, Science Direct, PubMed, Research Gate, and Google Scholar. Keywords used are "pharmaceutical" AND “supply” OR “logistic” OR “planning” OR “procurement” OR “storage” OR “distribution” OR “management” AND “natural disaster” OR “health crisis” AND “preparedness” OR “relief” OR “response”. After determining the research question and the inclusion and exclusion criteria for the studies being searched, in each selected database,the researchers used the automatic filter feature available on the database page to make it easier to sort the studies being searched. On July 5, 2024, via the Publish or Perish application, a search for articles in the PubMed database was initiated, where detailed data are in the additional files of this study. A search was also conducted on July 24, 2024, in the Research Gate database, to identify additional studies by searching the reference lists of publications eligible for full-text review. Searches on the Science Direct database were conducted on July 27, 2024, searches for appropriate studies on Google Scholar were carried out on July 28, 2024, and finally, searches was performed on the Crossref database on August 26, 2024.

Eligibility Criteria & Study Selection

The inclusion criteria comprised research about pharmaceutical management in natural disaster sites, covering every stage carried out in managing pharmaceuticals, starting from selection to the disposal of pharmaceutical supplies. Other inclusion requirements are original research articles with full text that can be fully accessed, as well as articles published in English between 2019-2024 so that eligible studies are the most

recent studies. The exclusion criteria were duplication of articles and forms of health crises other than natural disasters. At the study selection and evaluation stage, studies were selected that met the inclusion and exclusion criteria, involving 2 stages, namely examination of the title and abstract, and then a full assessment of the study text.

Data Extraction & Variables Collected

This stage tries to discover and document key findings from each relevant study. Collecting data items in a systematic literature review is a crucial step for transparency, reproducibility, clear structure, in-depth analysis, synthesis of findings, identification of research gaps, evaluation of study quality, better context, and supporting policy and practice. Each researcher looked at the titles and abstracts of every record independently before reaching an agreement. The researchers then independently reviewed each article's abstract and title that they had retrieved. Data collected by one reviewer was then checked by another, and any processes were used to resolve disagreements between reviewers. The extracted data is presented in Table I which provides key characteristics of the studies, including authors, year, setting, study design, participants, objective, data method, Keykey findings, and drug management cycle as the variable studied. The data collection process was carried out using a data extraction form created in a computer application. A team member carried out the extraction process and then discussed it independently with the supervisor. If there was inconsistent or missing data, alternate sources were sought as a critical step in ensuring data validation and reliability throughout the data item stage. If data was missing, additional material from other sources, such as linked articles, would be searched to help fill in the gaps. The data extraction stage in this study is critical because it helps researchers find areas that have not received enough attention in prior studies on the topic of pharmaceutical management in natural disasters. For the validity of data extraction, the data was checked again to ensure accuracy by involving supervisors in preparing the systematic literature review.

Study Quality Assessment

The researchers used the Joanna Briggs Institute (JBI) Critical Appraisal Tools to conduct a quality assessment study. Depending on the study type, the researchers applied two different critical appraisal tools: the JBI checklist for qualitative research and the JBI checklist for cross-sectional research. There are 8 questions for the JBI Critical Appraisal Checklist for Analytical Cross- Sectional Studies. The JBI checklist for qualitative research contains 10 questions that need to be answered by the reviewer of the selected studies. To assess each question, usually 4 options are used: Yes (if the criteria are met well); No (if the criteria are not met); Unclear (if there is not enough information or it is not clear); Not Applicable (can be used for several points in certain contexts). A reviewer independently assessed the selected studies, which were then reviewed again by 3 supervisors to check whether the reviews carried out followed the supervisor's opinion. The reviewers chose not to assign a category rating (High/Moderate/Low) to the assessment of each question, because JBI does not provide an official numerical scoring scheme as a basis for determining such scores. However, the reviewers only mentioned the highest number of "Yes" answers as a basis for caution in synthesizing the findings of the selected studies.

Data Synthesis

The analysis in this review uses thematic synthesis because the studies reviewed are qualitative studies or conceptual topics that cannot be analyzed quantitatively. The aim is to explore themes, patterns, strategies, practices, or factors from a variety of sources. Reporting of data extraction results is presented in tabular form.

RESULTS AND DISCUSSION

Study Selection

59,794 records in all were found using database searches. 3,433 full-text articles were evaluated for eligibility after duplicates, records deemed ineligible by automation tools, and records eliminated for other reasons were excluded as well as title and abstract screening were completed. Six of these papers were included in the evaluation after fulfilling the inclusion criteria (Figure 1). The research's pertinent features pertain to the scope of pharmaceutical management such as planning, distribution, and management support. Research on the extent of pharmaceutical storage, recording, reporting, evaluation, and disposal is lacking, which limits the review.The study selection process is presented in the PRISMA flow diagram (Figure 1).

Characteristic of Included Studies

The included studies varied in design, geographical scope, and focus areas of pharmaceutical management during health crises. Most studies originated from countries affected by natural disasters and explored various stages of the pharmaceutical supply chain, including planning, procurement, distribution, and system-level coordination. Studies show that the distribution of humanitarian aid for natural disasters is the most researched area. Of the 6 articles retrieved for this study, three were studies on the distribution of humanitarian aid in natural disaster and two were articles on pharmaceutical procurement planning. Meanwhile, an article is grounded theory research on information management, health service coverage, as well as on the selection, procurement, distribution, and use of pharmaceuticals in natural disaster conditions.

The goal of Xavier study is to provide a mathematical model that will aid in the planning and optimization of helicopter utilization for air transport logistics and aeromedical evacuations during small to mediumsized natural disaster response operations. Reducing the amount of time that aviation resources must be mobilized for last-mile delivery during relief operations is another goal. This study uses a mixed method of secondary data, and interview reports analysis. The helicopter samples tested in this study were 5 models of aircraft (AS350, Bell Huey H1, UH60, AS332, EC725), an informant from the Rio de Janeiro State Military Fire Brigade, and a person from the Brazilian Air Force for interviews. For the routing process, 5 aircraft were selected. The times considered are for helicopter landing and take-off, for loading and unloading, refuelling, and unloading of medium-sized aircraft. The distance matrix between the central depot and each demand point is estimated by considering the linear distance, and the maximum working day per vehicle is 720 minutes. The cruising speed of each aircraft as well as its loading capacity and loading/unloading time are determined. The decision-maker may have various options when the suggested model is used to plan the distribution of relief supplies. It was confirmed that load capacity directly affects the number of routes needed to complete the task when calculating the number of itineraries or routes needed by each of the five aircraft models. Since the overall mission duration is regarded as the preponderant criterion, four AS350 aircraft or two identical aircraft of any other model are needed to complete the deliveries. Even though it would take longer to finish, it could be confirmed that using AS350 aircraft would result in cheaper logistics expenses (US$20,590).[16] The final outcome is that there is a method of distributing aid for natural disasters that optimizes a certain type of helicopter at a cost that is commensurate with the delivery time and the large capacity of the logistics being sent.

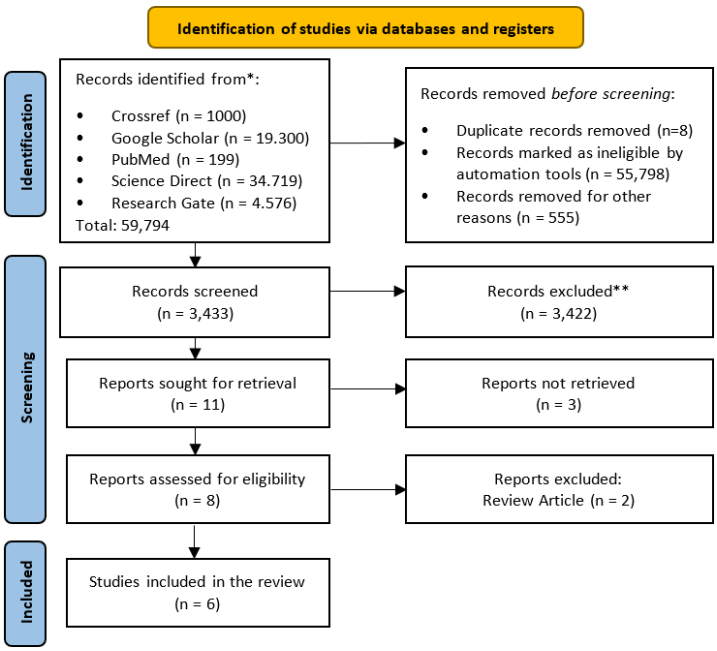

Figure 1. PRISMA Flow Diagram

Table I. Characteristics of Individual Studies

No	Short Reference	Setting	Study Design	Participants	Objective	Data Method	Key Findings	Variables (Drug Management Cycle)
1	Xavier IR, 2020	2011 floods, Serrana region, Brazil	Mixed method (Unclear)	2 informants, 5 aircraft models	Proposing a mathematical model to assist in the planning of the distribution of aid via helicopters	Secondary data analysis in the form of reports and statistics	Model applied to improve logistics planning and efficiency	Distribution
2	Bastani, 2021	Iran (Bam, East Azerbaijan, Kermanshah, etc.)	Qualitative (Grounded Theory)	Managers & staff in organizations	Proposing a customized, resilience-oriented model for pharmaceutical supply in crises	Constant comparative method	Identified themes and subthemes in resilience models for pharmacy supply during disasters	Full cycle of drug management
3	Meilani, 2021	Padang City, West Sumatra, Indonesia	Quantitative	Secondary data	Designing a GIS system for disaster relief distribution	Black-box testing	Developed disaster distribution points using spatial data	Distribution
4	Maghfiroh, 2020	Yogyakarta Province, Indonesia	Quantitative (model development)	Secondary data	Proposing multi-modal logistics model for medicine distribution in disaster-prone areas	Sensitivity analysis	Identified 5 Logistic Operational Areas (LOA) and optimized distribution	Distribution
5	Safaei, 2020	Mazandaran, Iran	Descriptive Quantitative	Secondary data	Optimizing supplier and vehicle assignment model	Sensitivity analysis	Analyzed four suppliers and proposed a model for minimizing response time	Procurement
6	John, 2022	Unclear; case on UNICEF procurement of therapeutic milk (F100 TherapCAN 400g)	Descriptive Quantitative (Case Study)	UNICEF	Demonstrating the use of the options contract in the humanitarian supply chain using therapeutic milk procurement as an example	Mathematical modelling using theNewsvendor problem to optimize contract parameters and coordination	Discovered that options contract reduces the risks of over/understocking and allows pricing flexibility; supports decentralized negotiation and coordination	Procurement

A study conducted by Bastani aims to propose a customized and resilient supply chain model for pharmaceuticals and consumable medical devices during disasters. This was a qualitative study that used a grounded theory methodology with a focus on the philosophy of Strauss and Corbin. Managers and employees of organizations tasked with obtaining pharmaceuticals and consumable medical equipment and responding to natural disaster scenes were among the informants in this study. Doctorate-holding specialists, physicians, pharmacists, experts in allied medicine, and participants with management training were also involved, as were food and drug deputies from Iranian Universities of Medical Sciences, personnel from the Red Crescent Population, military organizations, insurance companies, and distributors of pharmaceuticals and consumable medical equipment. The main themes that can be extracted into the resilience model for the pharmaceutical supply chain during crises are Disaster Management Structure, Information Management, Supply Chain Supervision, Sociocultural Characteristics, Planning, Resources Management, and Health Service Coverage. In terms of social and cultural factors, the way of life in the affected areas can have a significant impact on the expectations of the general population. As a result, people's emotional responses and those of healthcare professionals might pose challenges to providing services during catastrophes. In addition to stressing the value of adaptable and practical planning, earlier studies have focused on the agile pharmaceutical supply chain, which is formed by supplier prioritization, planning, trust-building, and performance evaluation. The study's findings indicate that resource waste is a primary variable in a resilience model of the supply chain for pharmaceuticals and consumable medical equipment during disasters. Other discoveries that result in time waste include delays in taking preventive action before the emergence of crises, hasty actions and poor decisions made during crises, delayed deployment of resources, duplications, and needless activities in the delivery of health services. The rate and scope of waste during natural disasters may be increased by a health system's inadequate disaster management structure, a lack of preparedness at all levels, and imprecise information infrastructures. Encouraging the supply chain for pharmaceuticals and consumable medical equipment to be more resilient in the event of a crisis requires that the dimensions of the current model be reinforced.[17] One of the ultimate goals of building a resilience model in the distribution of pharmaceutical goods is to create good collaboration between relevant stakeholders in maintaining supply under any conditions.

To facilitate the process of transferring information about disaster relief data more effectively, Meilani's study aims to provide information on the best routes for distributing relief supplies as well as information on the data needed for relief efforts. The secondary data gathered during the development of geographic information systems for emergency evacuation in Padang City Indonesia is analyzed in this paper. A map of Padang City is the spatial data required for this investigation. The distribution channel planning stage and the creation of geographic information systems for emergency evacuation aids were the two phases of the research that were conducted. To reduce distribution time, the distribution path planning implements the Dijkstra algorithm to identify the shortest path. According to the study's findings, the geographic system that was created can facilitate the delivery of humanitarian aid and support in the evacuation of people displaced by earthquakes and tsunamis in Padang City. The steps taken to obtain a safe and fast distribution channel begin with creating a disaster relief distribution network, designing the system, implementing the system, and verifying and validating the system. Planning distribution routes during the disaster relief distribution network development stage is done under the presumption that the route will follow the main route and avoid bridges and smaller routes that could sustain more damage and be challenging to traverse in the event of a major earthquake. Two external entities—the administrator and the user—are identified by the context diagram. Data needed for logistical support is entered into the system by administrators. In order to calculate the shortest path, users provide data to the system in the form of distribution objectives. Admin and user are the two user levels in the system. The technology will be utilized primarily in the event of a disaster and within the purview of Padang City's Regional Disaster Management Authority. The system created is primarily intended to be utilized as a tool for disaster aid distribution throughout the evacuation process. The command structure for disaster management is referenced in the system's user determination. Designing the user interface is the next stage. The user page and the admin page are the two functional pages that make up the web application's user interface design. The three phases of the system implementation process include programming, documentation, and testing. Implementing a geographic information system for the disaster aid distribution procedure comes next when the design is complete. The last step is to perform system verification and system validation. The black-box testing approach is used to test the system in order to verify it. The software's functional requirements are the main focus of this test. It can be said that the system is operating correctly if the software operates as it should. On the other hand, users of the system participate in the process of system validation. If the software meets the needs of the user,

the validation is considered successful. The outcome of this study is that the designed geographic information system can accelerate the aid distribution process for earthquake and tsunami disasters that have the potential to occur in Padang City, Indonesia.[18]

Another study related to distribution models for response operations to natural disasters was also carried out by Maghfiroh who wanted to test a multimodal model for relief distribution networks with time-varying features and multiple trips by maintaining undisrupted network services in large-scale failure scenarios. Three stages of disaster response activities are among the time-varying characteristics: (1) emergency response; (2) continuum response; and (3) initial recovery. This study developed a multi-modal distribution model with a three-layered relief distribution network: Supply Node (SN); Logistics Operational Area (LOA); and Affected Area (AA). To assist disaster operations, relief supplies, including food, shelter, and medication, must be delivered swiftly and effectively from supply nodes (SNs) to the affected areas (AAs). Time becomes the most important aspect throughout the early phase of the response. As a result, the majority of transportation methods are airlifts and helicopters. During the second phase, until demand declines enough, the mode of transportation changes from air to road. Cost is the main consideration in the last stage, when the distribution system resembles commercial shipping further. This study aims to develop a transportation network from each SN to AA via LOA with the lowest cost using only available vehicles. This study used secondary data from the Yogyakarta earthquake of 2006 in Indonesia, revealing 11 selected logistics operational areas in which all modes of transport were utilized for relief delivery, mainly trucks and airplanes. Despite using the multitrip idea, the model only permits vehicles to transfer items between the Supply Node and the Logistic Operation Area,and the Affected Area in one layer. Rather than employing a pooling system, which permits car travel to a node with a high demand for vehicle movement, this approach could make the distribution system easier to administer.[19]

Safaei's research focuses on planning for emergency logistics , because providing and delivering the right kind and amount of relief supplies in a dynamic environment of crisis situations is one of the most crucial aspects of crisis management. This paper's model aims to reduce unfulfilled demand and maximize operating expenses. Bi-objective upper-level problems and objective lower-level problems are the methods used. The goal of the upper-level model is to satisfy victim needs while also identifying the best distribution strategy and transfer depot site. The two goals of this level are as follows: 1) Minimization of total unmet demand (the upper-level goal is to reduce the overall amount of unmet demand across all commodities, time periods, and demand points); 2) Minimization of total costs (the upper-level decision maker also seeks to control operational costs, which include setup, procurement, inventory holding, and transportation costs between network nodes). As the lower-level decision makers, the procurement department assesses the lower supply risk providers that are accessible. These choices impact operating expenses and unmet demand. A case study is done to illustrate the actual application of the suggested model for supply-distribution planning and seismic disaster operations in some deteriorated regions of Iran's Mazandaran. The suggested approach provides a strong response strategy for natural disasters with an acceptable overall cost and uncovered demand in the impacted areas, taking supply risk into consideration, according to a case study using real-world data.[20] In emergency disaster conditions full of uncertainty with drastically increasing logistics demand, a clear division of tasks between upper and lower management is required as part of planning the provision of these logistics.

One essential component of the Humanitarian Supply Chain (HSC) is the acquisition of humanitarian materials, and the Humanitarian Organization's (HO) procurement managers frequently attempt to strike a balance between cost and responsiveness in their planning. When providing solutions, the timing, location, catastrophe severity, institutional stability, and unique needs based on the geography and/or culture of the impacted area must all be taken into account, which makes the HSC procurement process more complex. Research conducted by John wanted to improve the coordination in the humanitarian supply chain by exploring the role of options contracts in humanitarian supply chain procurement. This research aims to develop an optimization model that combines a fixed procurement process with an optional contract, which can be used by Humanitarian Organizations in the pre-disaster stage procurement. This case study wants to propose a Humanitarian Supply Chain strategy that helps decision makers in formulating the procurement process and identifying the optimal price by combining procurement that has been fixed in internal stock and the existence of negotiated agreements if natural disaster occurs, ensuring that additional procurement is still at an affordable price. The sample in this research is the use of the options contract by UNICEF in the humanitarian supply chain, using an example of therapeutic milk cans (F100 TherapCAN 400 g) procurement for consumption by children. The results of this research show that Humanitarian Organizations can use options contracts in conjunction with the implementation of routine procurement methods, other than the procurement method of direct purchase at spot markets in disaster areas. The options contractis considered efficient in guaranteeing the quantity of

products that must be produced by suppliers combined with the estimated demand required by the Humanitarian Organizations. The options contract allows for collaboration between HO & supplier in the HSC and offers flexibility on two fronts. In the first place, it enables the HO to buy more than the original order at a price that is less expensive than what is offered at the spot market. Second, the HO can select from a variety of fixed order and option order combinations even within the options contract. Additionally, the HO can determine whether the supplier's chosen prices are appropriate for them; if not, they can decide whether to accept or reject the rates and bargain for a better offer. So humanitarian organizations will use multiple procurement methods rather than sticking to just one method. The price provided by the suppliers and the matching quantity purchased by the humanitarian organizations allow for decentralized planning by two parties, making it more conducive to actual implementation because the ideal decision parameters are not point estimates but rather a continuum.[21]

Study Quality Assessment

Assessment of the methodological quality of the studies was carried out using appropriate risk of bias assessment tools or checklists. In this study, assessment of the risk of bias was carried out using a checklist for analytical cross-sectional studies and a checklist for qualitative research from the Joanna Briggs Institute Critical Appraisal Tools Out of 6 included studies, 5 studies were checked using cross-sectional critical appraisal type checklist, which showed that out of 8 appraisal question items, the number of "Yes" answers that the reviewer got was between 3 - 5. Meanwhile, a qualitative study was checked using qualitative research critical appraisal type checklist, which showed that the number of "Yes" answers was 8 out of 10 questions. Common limitations included Unclear and Not Applicable answers for some questions (Table II).

A study that used a critical appraisal checklist for qualitative research showed that of the 10 assessment indicators, only 1 indicator was unclear, namely the description of the researcher's influence and vice versa. Meanwhile, indicators regarding congruity on stated philosophy, methodology, research question, methods used, data analysis, and interpretation of results can be described clearly. Apart from that, indicators regarding statements locating the researcher culturally or theoretically, representation of participants, research ethical approval, and the conclusions drawn in the research report flow from the analysis or interpretation of data are clearly stated.

Most of the studies that use a cross sectional critical appraisal type checklist approach are not very clear in defining the inclusion criteria for each sample. This could happen because the reviewers of this study have not found statements in the study that lead to the inclusion criteria in these studies. For the description of the study subject and setting indicator, four studies [16,18,19,20] stated it clearly, except for the study by John[21] Exposure is measured in a valid and reliable way for all studies, and objective, standard criteria are used for the measurement of the condition, as well as the outcomes measured in a valid and reliable way. Confounding factors were not identified for all studies, nor were strategies for dealing with these confounding factors. The last indicator in the JBI assessment for cross-sectional is regarding the use of appropriate statistical analysis. All studies in this review do not use statistical analysis because they are only simple quantitative studies, more like descriptions and case studies of a model in real conditions in the field. The reviewers in this study concluded that this indicator is not applicable to all studies.

Thematic Synthesis

All studies can be retrieved not based on the similarity of output or outcome, but rather on the similarity of the major research topic, where all of these studies raise topics regarding the scope of the drug management cycle in natural disaster conditions, namely in the aspects of planning, procurement, distribution, and also regarding management support and financing in the drug management cycle. Although there are no studies that address aspects of the drug management cycle in terms of supervision, use of medicine, and ways to evaluate and mechanism for collecting remaining medicines and destroying them, it is found that some can no longer be used in natural disaster recovery conditions.

Table II. IStudy Quality Assessment

Cross-Sectional Critical Appraisal Type Checklist										
No	**Study**	**Inclusion Criteria**	**Study Subject & Setting**	**Valid & reliable exposure measured**	**Objective, standard criteria used**	**Confounding factors**	**Strategy for Confounding Factors**	**Valid & reliable way to measured outcome**	**Used of appropriate statistical**	**Overall Conclusion ("Yes" answer)**
1	Xavier, 2020	Unclear	Yes	Yes	Yes	Unclear	Unclear	Yes	Not Applicable	4
2	Meilani, 2021	Unclear	Yes	Unclear	Yes	Unclear	Unclear	Yes	Not Applicable	3
3	Maghfiroh, 2020	Unclear	Yes	Yes	Yes	Unclear	Yes	Yes	Not Applicable	5
4	Safaei, 2020	Not Applicable	Yes	Yes	Yes	Unclear	Unclear	Yes	Not Applicable	4
5	John, 2022	Unclear	Unclear	Yes	Yes	Unclear	Unclear	Yes	Not Applicable	3

Qualitative Research Critical Appraisal Type Checklist												
No	**Study**	**Congruity between philosophical - methodology**	**Congruity between methodology - objectives**	**Congruity between methodology - collecting data method**	**Congruity between methodology - representation & data analysis**	**Congruity between methodology – results interpretation**	**Statement culturally & theoretically**	**Influence of the researcher & vice -versa**	**Representation of participants voices**	**Ethical Approval**	**Conclusions flow from analysis, data interpretation**	**Overall Conclusion ("Yes" answer)**
6	Bastani, 2021	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	8

Thematic synthesis identified five overarching themes that capture strategies of pharmaceutical management in natural disaster situations:

Distribution of Medicines and Logistics:

Distribution of medicines becomes a major challenge during crises due to infrastructure disruption, geographical isolation, and urgency of demand. Xavier proposed a model utilizing helicopters for emergency drug delivery in flood-affected areas.[16] Meilani developed a Geographic Information System (GIS)-based tool to optimize the distribution network in Padang, Indonesia.[18] Maghfiroh introduced a multi-modal relief distribution model based on regional division known as Logistics Operation Areas (LOA), to enhance efficiency and accessibility in post-disaster supply.[19]

Planning and Forecasting Needs

Several studies emphasized the importance of advanced planning and need estimation under uncertain conditions. Safaei [20] developed a supply risk-based optimization model to support emergency logistics planning, while John [21] highlighted how warehouse location planning and route optimization are essential to reduce delivery time and ensure uninterrupted supply during health emergencies.

Emergency Procurement Mechanisms

Procurement under emergency conditions requires flexible and accelerated procedures. The included studies suggest various strategies such as emergency tendering, direct contracting, flexible supplier arrangements, and use of special e-catalogs designed for crisis contexts. These approaches are intended to bypass bureaucratic delays and ensure timely availability of essential medical supplies.[21]

Coordination and Supply Chain Management

Effective coordination across institutions and levels of government is crucial for sustaining pharmaceutical supply during crises. John emphasized the importance of centralized coordination and real-time data sharing among stakeholders in the humanitarian supply chain.[21] Bastani showed how cross-sector collaboration and the presence of resilient organizational structures can improve responsiveness and logistical efficiency during public health emergencies.[17]

Pharmaceutical System Resilience

Bastani proposed a resilience model encompassing five domains of the Drug Management Cycle (DMC): information, planning, procurement, distribution, and utilization. The study underscored the need for integrated, adaptive, and flexible systems to strengthen pharmaceutical preparedness and responsiveness, particularly during prolonged or large-scale crises.[17]

Identification and reporting of limitations in this study are important to demonstrate integrity and objectivity in the research. The limitations in this review methodologically are in the form of determining keywords that may not be appropriate, so that the reviewers cannot collect all existing studies or research results. The reviewers find it difficult to find studies that comply with the inclusion criteria that have been determined in terms of the number or quality of the studies included. Time and resources are limited in literature searches or research analysis. Another drawback is that numerous research publications meet the criteria but are not available in full because they are paid for. What is no less important is also the subjectivity of the reviewers which results in the potential for bias from the reviewers in assessing the studies. One of the limitations in terms of review is the time and review process, where the reviewers do not work at the same time and work independently, resulting in a lack of discussion process among them. In addition, the output of the studies taken cannot be synthesized because the output and scope of pharmaceutical management differ. Therefore, only conclusions about what aspects have been researched and what aspects have not been researched much in the existing studies could be drawn.

Suggestions for further studies are to pay more attention to determining keywords, the number of databases, the reviewers' time availability for increasing discussions in the process, more appropriate assessment methods, and taking studies that are not only in English to increase the number of studies taken, because translation technology is available nowadays and can be optimized. Given the several limitations that have been stated, it is necessary to be reminded of the importance of considering these limitations in interpreting the results of the review.

CONCLUSION

This study finds that pharmaceutical management in coping with natural disasters focuses on areas of preparation, distribution, and management support during disasters. The review's shortcoming is a paucity of

research on pharmaceutical storage, recording and reporting, evaluation, and disposal. Hopefully, the results of this study can be useful and applied in practice. The research under review emphasizes how crucial flexible and effective logistical tactics are when responding to disasters. Aid is delivered on time because of innovations like multi-modal, layered distribution networks, GIS-supported route planning, and helicopter-based distribution for difficult areas. Additionally, resolving inefficiencies brought on by delays, poor coordination, and resource waste is necessary to increase the resilience of the pharmaceutical supply chain. Bi-level optimization models for emergency logistics and the use of options contracts for flexible procurement are two examples of policy-relevant techniques that provide insightful information for enhancing disaster planning and response systems.

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STATEMENT OF ETHICS

None.

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