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A scoping review of non-professional medication practices and medication safety outcomes during public health emergencies.

Kelly D^{1,2}, Koay A³, Mineva G¹, Volz M¹, McCool A¹, McLoughlin E³, Ó Conluain R⁴, Sharma M⁵, Kerr A⁶, Franklin BD^{7,8,9}, Grimes T³

1. School of Medicine, University of Limerick, Limerick, Ireland
2. Health Research Institute, University of Limerick, Limerick, Ireland
3. School of Pharmacy and Pharmaceutical Sciences, Trinity College Dublin, Dublin, Ireland
4. School of Medicine, Trinity College Dublin, Dublin, Ireland
5. Research Department of Primary Care and Population Health, University College London, London, UK
6. School of Pharmacy and Life Sciences, Robert Gordon University, Aberdeen, UK
7. Imperial College Healthcare NHS Trust, London, UK
8. NIHR Imperial Patient Safety Translational Research Centre, Imperial College London, UK
9. UCL School of Pharmacy, London, UK

Provide the full postal address of each affiliation, including the country name and, if available, the e-mail address of each author.

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Corresponding author: tagrimes@tcd.ie

Abstract

Objectives:

Public health emergencies (PHE) can disrupt personal medication practices and increase the risk of medication-related harm and other negative medication-related outcomes. Our aim was to examine the extent and nature of published research on this topic to guide future research and practice.

Study design: Scoping review.

Methods:

Standard electronic databases were searched. PRISMA-ScR guidelines were followed. Extracted data were organised in response to review questions and narrative accounts developed.

Results:

One-hundred-and-twenty-nine studies were included, conducted across 32 countries, mostly in the United States of America (n=42). Sixty-eight (53%) reported on infectious events, 49 (39%) climatological or ecological events and the remainder a mixture of terrorism, war or other disasters. The studies described several medication safety outcomes (medication-related harm, adherence, supply) and adaptive medication practices (self-altering prescribed medications, sharing medications and changing healthcare providers). Challenges to maintaining routine medication practices during a PHE included transport, finance, quarantine and knowledge-related issues. Twenty-eight studies (22%) examined health inequalities pertaining to adverse medication-related outcomes, with findings suggesting that gender, age, ethnicity, educational and socioeconomic status may be related to inequalities. Research gaps identified included carers', children's and minority communities' experiences and intervention studies.

Conclusions:

There is considerable evidence of disruptions to routine personal medication practices during PHEs and of medication-related harm and other negative outcomes. Maintaining medication supply for the management of chronic conditions is a universal problem across all emergency types. Research is needed to address these disruptions, particularly amongst people who experience health inequalities who may need additional support. 248 words

Keywords:

Medication safety, public health emergency, medication-related harm, medication adherence

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Introduction

Medications are the most common healthcare therapy and can cause unwanted medication-related problems¹. These can significantly affect patients' lives. Medication related problems have been shown to cause significant morbidity, with most harm being avoidable¹⁻³.

Public health emergencies (PHEs) are defined as extraordinary events with associated health consequences that have the potential to overwhelm routine community capabilities to address them⁴. Recently, there have been several significant PHEs associated with infectious diseases, such as the COVID-19 pandemic, and climatological or ecological issues, such as flooding, hurricanes and earthquakes⁵. Potential issues associated with PHEs include reduced access to healthcare; supply chain interruption; changes in household mobility, personal wellbeing and routine support; and widening of health inequalities. These create additional challenges for medications safety, at times when preventing and mitigating medication-related harm and any associated healthcare utilisation are particularly important. Although previous studies have reported on the impact of PHEs and their implications for healthcare generally, the specific impact on medication management is less well known, particularly regarding lay people's medication practices and medication safety. Inappropriate changes in medication-related behaviour during a PHE may have adverse acute effects on individual health or necessitate the need for urgent healthcare intervention. They also have potential to worsen chronic ill-health leading to poor individual and population health outcomes and greater strain on health services during all stages of a PHE. As such there is an important need to optimise personal medication management / usage during and after PHEs.

Interest in medication-related harm and the lay burden of work associated with managing medication is rising^{1, 6, 7}. We were keen to understand the impact of this in terms of personal medication safety. We are not aware of any systematic or scoping reviews of medication safety during PHEs. The aim of this scoping review is therefore to provide an overview of the extent and nature of the available research on laypeople's medication practices and medication safety outcomes at times of PHE. This review will assist in identifying medication safety issues during PHEs and responsive practices described in the literature, identify research gaps, and help guide future research and practice in this area.

Methods

Design

This scoping review was conducted in line with methodological guidance⁸ and reported in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR; Supplementary Document 1)⁹.

Review objective and questions

The aim was to provide an overview of the extent and nature of the available research on lay (non-professional) medication practices and medication safety outcomes at times of PHE. It was led by the following review questions (RQ), which were validated by discussion with informal carer and patient advocates:

- RQ1. What study designs and characteristics have been used to examine medication safety vulnerabilities and non-professional medication practices before, during or after PHEs?
- RQ2. What public and patient involvement occurred in the conduct of the research?
- RQ3. What study populations and events were examined?
- RQ4. What outcomes related to medication safety and non-professional medication practices/ behaviours were described?
- RQ5. What were the main findings of these studies?
- RQ6. What interventions have been evaluated to address these behaviours and outcomes during PHEs?
- RQ7. What outcomes were measured to evaluate these interventions?

Search strategy

Based on our research questions, a preliminary Ovid Medline search was designed to combine the concepts of medication practices or behaviours, medication safety outcomes, and PHE. Subsequent searches were adapted and applied to CINAHL, PsychInfo, Embase, Global Health Cochrane Library, Prospero, Joanna Briggs Institute and Trip database. The search reviewed records from database inception to April 2021, with no limits to language or date range applied. Upon retrieval, results from all databases were deduplicated and exported for management into Covidence¹⁰. The study protocol and search strategy are provided in Supplementary Document 2.

Study selection

Title/abstract screening, followed by full text review, was performed independently by two reviewers; conflicts were resolved by discussion or with a third reviewer. Articles were then iteratively reviewed for their relevance until group consensus on inclusion was reached.

Eligibility criteria

The inclusion and exclusion criteria are described in detail in Supplementary Document 2. In brief we focused on studies conducted before, during or after a PHE; an unrestricted⁴. Our study population included all individuals, regardless of demographic or clinical characteristics; any qualitative or quantitative outcome reporting on non-professional medication use, practices or behaviours or medication safety outcomes that met the criteria. We used the term medication-related harm to refer to changes in patient's health status associated with medication use such as adverse drug reactions and changes to clinical outcomes. We have classified changes to supply and adherence issues separately. We included published peer

reviewed journal articles with empirical data. We screened the bibliographies of identified systematic or literature reviews and included the original studies that matched our inclusion criteria, while excluding the review articles themselves.

Data extraction and charting

Data charting against each RQ, using a Microsoft Excel template, was undertaken mainly by one reviewer with 10% of data from studies extracted by a second reviewer. Accuracy and consistency between all extractions were assessed by a third reviewer to determine the validity of continued extraction by one team member. Non-English studies were translated by team members or a volunteer who were confident to translate the paper into English.

Summarizing and reporting the data

Data relating to RQs were synthesised from the charted data and reported as narrative accounts. Identified medication-related practices and outcomes were grouped into common themes. A PRISMA flow chart was prepared. We did not assess the methodological quality of the identified studies due to anticipated heterogeneity in study types and designs and in keeping with the standard practice for scoping reviews¹¹.

Results (1687 words)

One-hundred-and-twenty-nine studies were included in the review (Figure 1 and Supplementary Document 3), the majority reporting on infectious events (n=68, 53%), climatological or ecological events (n=50, 39%) and the remainder a variety of other disasters.

RQ1&2. Study characteristics and patient and public involvement

The earliest study identified was published in 1999, with the number of studies increasing substantially since 2020 (Figure 2). Most were reported in English (n=126). One study was published in each of Mandarin, German and Japanese. Most (n=105, 81%) collected only quantitative data. Five collected both quantitative and qualitative data, and 19 (15%) collected only qualitative data. All included studies were observational by design. Most were undertaken within the mitigation and preparedness phases during the PHE (n=62, 48%) or within the response and recovery phases afterward (n=60, 47%). A further seven studies that focussed on disaster preparedness were not temporally aligned to a single specific PHE, but rather to the participant's previous experience of one of several possible emergencies. Sixty-nine studies (53%) reported no specific funding source and the remainder reported funding from multiple sources. Seven (5%) studies reported patient and public involvement in conduct of the research¹²⁻¹⁸.

RQ3. Public health emergency and participant characteristics

Study participants

Studies typically investigated an exclusively adult population (Figure 2). Participants were recruited from a variety of settings, mostly the general population affected by the PHE (Figure 2). Regarding healthcare condition, there was no restriction for the largest group of

studies (n=50, 39%); the remainder focussed on various disorders or body systems (Figure 2).

Several studies investigated populations that may be at greater risk of health inequalities¹⁹ including those with physical disability²⁰⁻²², HIV²³⁻³³, mental illness^{15, 34-36} socioeconomic deprivation^{14, 37-39}, refuge or displacement^{13, 25, 37, 40-42}, opioid or other substance misuse or dependence^{30, 43-46}, people of black and minority ethnicity^{38, 43, 47} and men who have sex with men^{31, 48}.

Country and type of public health emergency

More than half (n=68, 53%) of the studies covered infectious events, 57 (44%) of which were the COVID-19 pandemic (Figure 3). Most were conducted in the Americas, the European region and the Western Pacific (Figure 3) and in a single country (n=123). Based on The World Bank's world economies classification, most studies (n=83, 64%) were undertaken in high-income countries.

RQ4. Study outcomes measured

The identified medication safety outcomes were categorised into three themes: (1) medication-related harm, (2) medication adherence and (3) medication supply.

Concerning medication related harm, five studies reported adverse drug reactions (ADRs)^{46, 49-51}. Other patient health outcomes associated with medication use or omission included asthma control⁵², withdrawal from opioids^{43, 44}, uncontrolled hypertension⁵³, autoimmune hepatitis relapse⁵⁴, seizure frequency²¹, glycaemic control⁵⁵ and perceived and actual rheumatic disease activity⁵⁶ and long term health status following myocardial infarction⁵⁷. Anxiety related to medication use was another common health outcome reported qualitatively and quantitatively via prompts in surveys and fears and concerns self-disclosed during interviews^{58-62, 15, 28, 51, 63-67}.

A quantitative outcome of "adherence" or "compliance", as termed by the study authors, was reported in 30 studies, using four distinct measurement types: (1) A discrete self-report at one time point using a variety of phrasing of questions (n=24)^{24, 25, 32, 33, 36, 53, 56, 61, 68-79}, (2) a discrete single time point measure comparing two study groups^{54, 57, 80}, (3) discrete measures at two times points^{16, 23, 81-83} and (4) calculated based on days of tablets remaining²⁸.

Effects on lay medication practices, reported qualitatively and quantitatively, were categorised into four themes: (1) accessing medication supply, (2) altering prescribed medication regimens, (3) accessing professional or lay support or services or (4) storing, administering and monitoring the effects of medication. Quantitative measures included using disaster risk assessment tools^{14, 84, 85} (n=3) and surveying experiences^{17, 18, 35, 47, 48, 51, 56, 59, 62, 64, 66, 72, 74, 78, 81, 82, 86-91}.

Twenty-eight studies examined outcomes by population groups at greater risk of health inequalities¹⁹: gender^{12, 26, 29, 38, 43, 50, 52, 86, 92-95}, age^{26, 29, 38, 43, 50, 52, 60, 77, 93, 94, 96}, race/ethnicity³⁸,

40, 50, 52, 65, 93, 97, 98 socioeconomic^{26, 29, 43, 50, 52, 96, 98, 99}, educational^{26, 43, 52, 60, 77, 95, 96}, marital^{26, 43, 95} or other^{15, 23, 25, 29, 34, 43, 60, 93, 95, 98, 100} status.

RQ5. Study findings

Medication-related harm

Published reports of ADR during a PHE most frequently related to antiviral medicines administered during the 2009/2010 A/H1N1 influenza pandemic in the UK and USA,^{46, 49, 50} and cancer chemotherapy⁵¹. One study reported an increase in perceived ADRs associated with self-medication during the COVID-19 pandemic, and more frequently in those taking chronic illness medication than others⁹⁵.

One study found epileptic seizures worsened for some patients immediately after an earthquake, attributed to lack of access to medication (5.6%)²¹. Two studies after hurricane Sandy reported an increased risk of relapse⁴³, and withdrawal⁴⁴, and changes in injection behaviours among opioid and intravenous drug using populations who were accessing substitution services pre-disaster^{43, 44}. Following the World Trade Centre disaster, an inverse relationship between adherence to long-term preventer medication and asthma control was identified amongst rescue workers with mental health viewed as a modifying factor⁵². Poor glycaemic control during COVID-19 was associated with medication non-adherence in type-2 diabetes, but not type-1 diabetes, with accounts of hyperglycaemia and diabetic ketoacidosis⁵⁵. Altered adherence was associated with: uncontrolled hypertension following a hurricane⁵³; perceived rheumatic disease activity⁵⁶ and exacerbation of rheumatic symptoms⁵⁸ during COVID-19; and index presentation to hospital with an acute myocardial infarction⁵⁷. During COVID-19, telehealth was associated with a beneficial effect on medication compliance and lower rates of relapse of autoimmune hepatitis⁵⁴.

Several studies reported patient anxiety around medication use associated with an emergency. Patients experienced anxiety about general medication issues¹⁰¹, and fear about maintaining access to medication supplies^{60, 66, 67}. Anxiety reportedly contributed to both decreased^{58-62, 15, 28, 51, 63, 64} and increased^{60, 91} use of medication. A fear of accessing healthcare facilities was associated with changes in medication-related behaviours^{33, 64, 67, 78, 89, 102}, while fear of infection was reportedly associated with medication stockpiling¹⁰³ and decreased medication adherence^{28, 62}.

Medication adherence

Several studies reported non-adherence to prescribed medications after a PHE, but without comparison to pre-PHE adherence levels^{15, 53, 56, 75, 76, 78, 79, 104} (Supplementary Document 5). Some studies reported little or no change to adherence during a PHE^{29, 36, 71, 82, 91, 105, 106}. Notably this did not always mean similar health outcomes. For example, one study found most people reported remaining adherent to their epilepsy medications, while simultaneously observing an increase of >50% of seizure frequency, attributed to stress and lifestyle changes⁷¹. Both improved and worsened adherence was reported^{36, 71, 72, 74}. For example, during one survey of 282 patients with cardiac disease during COVID-19, participants felt the pandemic had no effect on their medication compliance (73%), improved it (18%) and decreased it (10%)⁷⁴.

Medication supply

Twenty-seven studies quantified the prevalence of running out or having interruptions to medication supplies (Supplementary Table 5). The duration of medication shortages varied between studies, ranging from days to weeks^{29, 42, 55, 69, 87}. Hydroxychloroquine was reported to be in short supply in three studies during COVID-19^{64, 90, 107}. Being evacuated or displaced from home and forgetting to bring medicines^{20, 45, 53, 97, 98, 101, 108} were reported as affecting adherence. Barriers to obtaining medications included transport/relocation^{16, 25, 35, 45, 89, 109-112} and financial^{20, 25, 27, 55, 89, 71, 80, 115} and regulatory²⁷ issues. Delays in prescription deliveries were reported⁴⁷.

Practices related to altering prescribed medication regimens

Use of long-term immunosuppressant therapy for chronic disease management reduced during COVID-19 due to perceived increased risk of infection, with medications stopped either temporarily or completely and sometimes without medical advice^{18, 54, 56, 58, 59, 61-64, 88, 107, 113-116}. Patients requested to change their immunotherapy early into the COVID-19 pandemic but that requests to switch were no longer made later in the pandemic¹⁸. Patients made changes to their prescription medication regimen, without medical advice, including increased dosage^{18, 56, 106}, decreased dosage or frequency of administration^{18, 56, 90, 106, 107, 115}, rationing medication¹¹⁷, interrupting or suspending medication^{51, 61, 62, 64}, stopping medication use^{54, 59, 62, 63, 107, 113-115} and restarting previously used medication^{61, 63}.

Practices and barriers related to accessing medication supplies

People responded variably to the altered access to medication supplies. For example, attending a healthcare practitioner earlier than needed⁶⁷; maintaining an extra supply of medication^{21, 67, 109}; keeping medication separately in several places to support access²¹; bringing medications, medication lists and insurance cards with them when evacuated^{27, 118}; sharing medications (insulin and buprenorphine) between friends or acquaintances^{44, 119}; rationing medications^{46, 117}. In the aftermath of a hurricane, people with substance dependence were reported to move from prescription supply to illicit supply⁴⁶, and increase risky behaviours such as sharing needles or drug preparation equipment due to lack access to methadone dispensing and closure of needle exchange centres^{43, 44}.

Lack of knowledge was reportedly associated with lack of preparation of medication supplies, and lack of recognition of the risk of adverse effects of running out of medications^{14, 27, 70, 109}. Inadequate knowledge of one's medical history or records of medication names and dosages was identified as problematic for arranging a new supply of medications^{27, 120}. Difficulty communicating with healthcare providers online or inability to contact them to order a prescription or access treatment was occasionally reported as a barrier to medication supply^{47, 48, 78, 121}.

Practices related to accessing support or services

People accessed alternatives to their regular healthcare providers during an emergency, for example doctors and hospitals^{21, 79} and pharmacies^{38, 53, 90} in a different location. The use of an online children's asthma action plan reportedly decreased medical expenses during COVID-19⁸³. People accessed healthcare to support their coping with the PHE, for example, accessing counselling services was associated with a greater likelihood of medication use^{93, 122} and commencing medication use as a coping mechanism^{27, 93, 108, 122}. Having social support from other people ('social capital') was reportedly associated with increased adherence^{23, 25, 122}, the sharing of information and medication supplies^{37, 25} and the purchase of medication for others⁷⁹.

Practices related to storing, administering and monitoring the effects of medication

Two studies described medication storage issues including medication being accidentally thrown out²⁵ and difficulty refrigerating medications during an evacuation²⁰. Lack of assistance to administer medications^{22, 45, 109, 112, 123} was reported to affect adherence. Lack of privacy in a communal refugee space resulted in covert medication self-administration and decreased adherence²⁵. Lack of access to food was problematic for medications that should be taken with food²⁵. Self-efficacy was an identified barrier to medications taking^{24, 25, 76}. Financial issues were associated with (non-)adherence to medication monitoring recommendations⁵⁵.

Inequalities

Access to medicine supplies was associated with racial/ethnic^{50, 97, 98}, age⁹⁴, socioeconomic⁵⁰, educational²⁶, health²⁵ and displacement³⁴ status: Black and minority ethnic groups, older, less educated, socially deprived and those who were displaced experienced greater challenges accessing medication. Existing social inequalities were reportedly widened through favouritism of selected communities for distribution of medication supplies²⁵. Medication non-adherence and treatment failure was associated with religious status and stigma amongst people living with HIV who attended a treatment centre daily following an earthquake²³. Women were identified as more likely to administer medication to infected patients during a pandemic, thereby exposing them to greater risk than men of contracting the infection through caring duties¹². Drug misuse or illicit drug use in those experiencing dependence was associated with age^{29, 60}, social support²⁹, educational⁶⁰, occupational⁹⁹, health⁶⁰ and socioeconomic status⁹⁹. Females had greater medication use needs than males following a PHE, for example, needing medication refills or commencing hypnotic use^{14, 86, 92, 93, 95}. Inferior glycaemic control in people with diabetes who were home quarantining during

COVID-19 was reportedly more common in younger people and those with a greater number of years' education.

RQ6&7. Interventions evaluated and outcomes measured

Five studies described interventions that were implemented during PHEs; these were an action research study¹³, a mixed-methods study⁴² and three cross-sectional studies^{26, 83, 110}. Provision of extra take-home medication doses was associated with sustained access^{13, 26}. Provision of information about anticipated clinic closures and access to alternative clinics were considered as modifiable factors that can potentially help sustain medication access²⁶. Implementation of a multicomponent intervention for the management of hypertension and diabetes in a humanitarian situation identified the challenge of large-scale implementation in the field and the limited impact of the programme on continuity of medication supply⁴². A study observed the feasibility and acceptability of administration of medications for headache, reported to be a common health issue during a natural disaster¹³. Provision of an online platform for children with asthma was associated with improved medication adherence and reduced medical expenses⁸³. Finally, provision of an information kit about preparing for an emergency to a cohort of dialysis patients resulted in a self-perceived improvement in disaster preparedness in a subsequent follow-up survey¹¹⁰.

Discussion

This scoping review provides the first systematic overview of studies exploring lay, non-professional medication practices and medication safety outcomes during events of major public health concern. The review identified medication-related harm, adherence, supply, alteration of prescribed regimen and issues with the storage, administration and monitoring of medication as outcomes that have been assessed, both quantitatively and qualitatively. People's practices related to accessing medicines, support or services were commonly reported. The associations between health inequalities and medication-related outcomes and practices were frequently explored. The evidence suggests that medication-related problems are common during PHEs, that people adapt their medication use behaviours to respond to these challenges and that pre-existing inequalities may be widening during PHEs and affecting medication outcomes. The coming section summarises the evidence for each research question and the implications for future research.

RQ1 Study design and characteristics

Included studies employed mostly observational designs with limited potential to inform whether the medication management issues identified were associated with the emergency or whether they occurred routinely during "normal" times. Few studies were published in non-English languages, possibly reflecting the databases searched, or the dominance of the English language in science and social science¹²⁴. Other methodological challenges identified were the lack of pre- and post- reporting of medication adherence rates, and limited follow-up to assess long-term clinical impact. We acknowledge that comparative or prospective studies are challenging due to the unplanned and unpredictable nature of PHEs. Future research should employ comparative and experimental designs if possible and explore the long-term impact of PHEs.

RQ2 patient and public involvement

The absence of community engagement in this review is a clear research gap. Involving patients and the public in research has been widely recognized as a useful method to increase the relevance, use of research findings^{125, 126} and sustainability of new interventions in humanitarian settings¹²⁷.

RQ3 study population and emergency characteristics

The relative absence of studies conducted in low-income countries supports the recent call to prioritise global medication safety research efforts in low- and middle-income countries¹²⁵. Several studies focused on marginalised groups and many studies considered disadvantaged groups or specific clinical groups more vulnerable to certain medication-related harm during PHEs. The current literature extensively explores multiple clinical conditions and disease states but provides limited insight into the experiences and perspectives of children or informal caregivers. Given the increasing prevalence of vulnerabilities associated with informal caregivers' medication management, it is a potential area for future study¹²⁸. Few studies included complementary and herbal medications^{12, 107, 129, 130}, and this may also be worthy of future exploration¹³¹. COVID-19 accounted for almost half of the studies included in this review, likely reflecting its scale and impact worldwide. The review also included numerous studies set in the aftermath of climate disasters, mainly in the USA, and information about the experiences in other jurisdictions is relatively lacking.

RQ4 Outcomes measured

The key outcomes reported in this review were medication-related harm, adherence and supply, although few studies reported on the long-term health consequences these. There was an absence of exploration about how education on new and routine medication, and altered medication monitoring, affected long-term health outcomes. The inconsistent use of definitions, terminology or validated measures jeopardised the potential quality of the included research. For example, several studies reported challenges with obtaining medication supply in the short term as non-adherence or non-compliance, despite the outcome reflecting a discrete event rather than a behaviour over time. Therefore, ostensible findings regarding "adherence" potentially misidentify an organisational problem related to lack of continuity of medication supply with a personal pattern of medication use. This could affect development of effective solutions to improve patient outcomes during a future emergency¹³². Several studies measured doses missed during an emergency but failed to assess their clinical significance, a missed opportunity to differentiate more critical issues that should be addressed to mitigate harm¹³³.

RQ5 Findings

The review provided considerable evidence of disruptions to routine medication practices but less evidence about the impact of these disruptions on short- or long-term health outcomes. There is some evidence that these disruptions may contribute to stress, anxiety and other negative outcomes.

Self-alteration of medication was commonly described in studies. This is a new concept that typically involved medication discontinuation, reduction of immunosuppressant use or increased medication taking. During COVID-19, there was unprecedented sharing of information online¹³⁴. We hypothesise that self-alteration of prescribed medications could arise in response to: (1) health anxiety, (2) changing routines, (3) interrupted medication supply, and (4) uncertainties about the (side) effects or efficacy of medication when a new infectious disease is not well understood. The appropriateness of self-alteration and its impact on clinical or humanistic outcomes may support understanding of whether health behaviour modification techniques are merited.

The review identified that disadvantaged population groups are more vulnerable to negative medication-related outcomes during PHEs, and that PHEs may indeed exacerbate and widen pre-existing health inequalities, both directly and indirectly. Research is needed to determine the actions required to mitigate this.

RQ6-7 interventions to address identified problems during PHEs

The review identified few interventions to address medication safety outcomes during PHEs. There is an opportunity to address this by prioritising the identified medication-related challenges: medication adherence, supply and self-alteration. Our findings suggest that the public may not perceive medication-related hazards as a threat during PHEs despite evidence of them resulting in negative patient outcomes. Improving preparedness may mitigate medication-related harm. Emphasizing the importance of household-based preparedness such as keeping a written/printed record of medications in a safe and accessible place(s), and providing basic resources to affected communities may also be protective¹²⁸. Further exploration of system level changes to medication supply that have proven helpful in emergencies may support lay medication practices in future emergencies. This echoes calls for targeting systemic and organisational issues which contribute to medication risk¹²⁵.

Strengths and Limitations of this review

The main strengths of this scoping review are that it provides a comprehensive overview of the available published literature on this topic, with no restriction on language and inclusive of a wide range of databases. The review followed a rigorous methodological framework for scoping reviews, which assures consistency and structure of the search process and confidence in the reporting of findings. We did not assess the quality of the studies, as is typical for a scoping review. Regarding patient and public involvement, whilst we did validate the research questions with informal carer advocates, there were opportunities for deeper engagement, potentially following published guidance on stakeholder involvement in systematic reviews¹³⁵. Heterogeneity was introduced into the review by including different types of PHEs; future research should synthesise the issues and outcomes specific to certain PHE types. The review includes only studies published prior to April 2021 and therefore more recent evidence may be missing. However, the high volume of studies provided adequate data to respond to the research questions. The findings and discussion points regarding gaps in research should help to define an agenda for future research.

Conclusions

There is a considerable level of research evidence suggesting that medication supply and patient adherence are impaired during PHEs, that medication-related harm occurs commonly, and people adapt their medication regimen, without healthcare advice, in response to challenges experienced. The review identified that PHEs can widen pre-existing inequalities resulting in a disproportionate effect on medication outcomes for marginalised and minority groups. Despite this, we found very few interventions targeting lay, non-professional medication practices.

Author statements**Ethical approval**

Not applicable.

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Competing interests

The authors have nothing to declare.

References

1. World Health Organization. Medication without Harm - Global Patient Safety Challenge on Medication Safety <https://www.who.int/patientsafety/medicationsafety/> 2017.
2. Ahern F, Sahm LJ, Lynch D, McCarthy S. Determining the frequency and preventability of adverse drug reaction-related admissions to an Irish University Hospital: a cross-sectional study. *Emerg Med J.* 2014; 31:24-9.
3. Hamilton H, Gallagher P, Ryan C, Byrne S, O'Mahony D. Potentially inappropriate medications defined by STOPP criteria and the risk of adverse drug events in older hospitalized patients. *Archives of internal medicine.* 2011; 171:1013-9.
4. Nelson C, Lurie N, Wasserman J, Zakowski S. Conceptualizing and defining public health emergency preparedness. *Am J Public Health.* 2007; 97 Suppl 1:S9-S11.
5. Sohrabzadeh S, Yousefian S, Bahramzadeh A, Vaziri MH. A systematic review of health sector responses to the coincidence of disasters and COVID-19. *BMC public health.* 2021; 21:1-9.
6. Leppin AL, Montori VM, Gionfriddo MR. Minimally disruptive medicine: a pragmatically comprehensive model for delivering care to patients with multiple chronic conditions. *Healthcare;* 2015: Multidisciplinary Digital Publishing Institute.
7. Demain S, Gonçalves A-C, Areia C, Oliveira R, Marcos AJ, Marques A, et al. Living with, managing and minimising treatment burden in long term conditions: a systematic review of qualitative research. *PloS one.* 2015; 10:e0125457.
8. Peters MDJ GC, McInerney P, Munn Z, Tricco AC, Khalil, H. . Chapter 11: Scoping Reviews. In: Aromataris E MZ, editor. *JB I Reviewer's Manual*2020.
9. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018; 169:467-73.
10. Covidence systematic review software,. Melbourne, Australia: Veritas Health Innovation.
11. Peters MD, Godfrey CM, Khalil H, McInerney P, Parker D, Soares CB. Guidance for conducting systematic scoping reviews. *JB I Evidence Implementation.* 2015; 13:141-6.
12. Adongo PB, Tabong PTN, Asampong E, Ansong J, Robalo M, Adanu RM. Preparing towards Preventing and Containing an Ebola Virus Disease Outbreak: What Socio-cultural Practices May Affect Containment Efforts in Ghana? *PLoS Neglected Tropical Diseases.* 2016; 10.
13. Guetti C, Angeletti C, Papola R, Petrucci E, Ursini ML, Ciccozzi A, et al. Headache prevalence in the population of L'Aquila (Italy) after the 2009 earthquake. *The Journal of Headache and Pain.* 2011; 12:245-50.
14. Chan EYY, Kim JH, Lin C, Cheung EYL, Lee PPY. Is previous disaster experience a good predictor for disaster preparedness in extreme poverty households in remote Muslim minority based community in China? *Journal of Immigrant and Minority Health.* 2014; 16:466-72.
15. Li W, Zhao N, Yan X, Zou S, Wang H, Li Y, et al. The prevalence of depressive and anxiety symptoms and their associations with quality of life among clinically stable older patients with psychiatric disorders during the COVID-19 pandemic. *Translational Psychiatry.* 2021; 11.
16. Ciurea A, Papagiannoulis E, Bürki K, Von Loga I, Micheroli R, Möller B, et al. Impact of the COVID-19 pandemic on the disease course of patients with inflammatory rheumatic diseases: results from the Swiss Clinical Quality Management cohort. *Annals of the Rheumatic Diseases.* 2021; 80:238-41.
17. Cousino MK, Pasquali SK, Romano JC, Norris MD, Yu S, Reichle G, et al. Impact of the COVID-19 Pandemic on Congenital Heart Disease Care and Emotional Wellbeing. *Cardiology in the Young.* 2020.
18. Glintborg B, Jensen DV, Engel S, Terslev L, Pfeiffer Jensen M, Hendricks O, et al. Self-protection strategies and health behaviour in patients with inflammatory rheumatic diseases during the COVID-19 pandemic: Results and predictors in more than 12 000 patients with inflammatory rheumatic diseases followed in the Danish DANBIO registry. *RMD Open.* 2021; 7.

19. Williams E, Buck D, Babalola G. What are health inequalities? online: The King's Fund; 2020 [cited 2022 May]; Available from: <https://www.kingsfund.org.uk/publications/what-are-health-inequalities#what>.
20. Quail J, Barker RN, West C. Experiences of people with physical disabilities before, during, and after tropical cyclones in Queensland, Australia. *International Journal of Disaster Risk Reduction*. 2019; 39:101122.
21. Kobayashi S, Endo W, Inui T, Wakusawa K, Tanaka S, Onuma A, et al. The lack of antiepileptic drugs and worsening of seizures among physically handicapped patients with epilepsy during the Great East Japan Earthquake. *Brain and Development*. 2016; 38:623-7.
22. Mahmud MHS, Nahar N, Rahman A. Challenges for people with disabilities during disasters in Bangladesh: an exploratory study in Gaibandha district. *WFOT Bulletin*. 2014; 69:53-60.
23. Negi BS, Joshi SK, Nakazawa M, Kotaki T, Bastola A, Kameoka M. Impact of a massive earthquake on adherence to antiretroviral therapy, mental health, and treatment failure among people living with HIV in Nepal. *PloS one*. 2018; 13.
24. Reilly KH, Clark RA, Schmidt N, Benight CC, Kissinger P. The effect of post-traumatic stress disorder on HIV disease progression following Hurricane Katrina. *AIDS Care*. 2009; 21:1298-305.
25. Ghose T, Boucicaut E, King C, Doyle A, Shubert V. Surviving the aftershock: Postearthquake access and adherence to HIV treatment among Haiti's tent residents. *Qualitative Health Research*. 2013; 23:495-506.
26. Khawcharoenporn T, Apisarnthanarak A, Chunloy K, Mundy LM. Access to antiretroviral therapy during excess black-water flooding in central Thailand. *AIDS Care*. 2013; 25:1446-51.
27. Arrieta MI, Foreman RD, Crook ED, Icenogle ML. Providing continuity of care for chronic diseases in the aftermath of Katrina: from field experience to policy recommendations. *Disaster medicine and public health preparedness*. 2009; 3:174-82.
28. Marbaniang I, Sangle S, Nimkar S, Zarekar K, Salvi S, Chavan A, et al. The burden of anxiety among people living with HIV during the COVID-19 pandemic in Pune, India. *BMC public health*. 2020; 20:N.PAG-N.PAG.
29. Ballivian J, Alcaide ML, Cecchini D, Jones DL, Abbamonte JM, Casseti I. Impact of COVID-19-Related Stress and Lockdown on Mental Health Among People Living With HIV in Argentina. *Journal of acquired immune deficiency syndromes (1999)*. 2020; 85:475-82.
30. Hochstatter KR, Akhtar WZ, Dietz S, Pe-Romashko K, Gustafson DH, Shah DV, et al. Potential Influences of the COVID-19 Pandemic on Drug Use and HIV Care Among People Living with HIV and Substance Use Disorders: Experience from a Pilot mHealth Intervention. *AIDS and behavior*. 2021; 25:354-9.
31. Rhodes SD, Mann-Jackson L, Alonzo J, Garcia M, Tanner AE, Smart BD, et al. A Rapid Qualitative Assessment of the Impact of the COVID-19 Pandemic on a Racially/Ethnically Diverse Sample of Gay, Bisexual, and Other Men who Have Sex with Men Living with HIV in the US South. *AIDS and behavior*. 2021; 25:58-67.
32. Linnemayr S, Jennings Mayo-Wilson L, Saya U, Wagner Z, MacCarthy S, Walukaga S, et al. HIV Care Experiences During the COVID-19 Pandemic: Mixed-Methods Telephone Interviews with Clinic-Enrolled HIV-Infected Adults in Uganda. *AIDS and behavior*. 2021; 25:28-39.
33. Kalichman SC, Eaton LA, Berman M, Kalichman MO, Katner H, Sam SS, et al. Intersecting Pandemics: Impact of SARS-CoV-2 (COVID-19) Protective Behaviors on People Living With HIV, Atlanta, Georgia. *Journal of acquired immune deficiency syndromes (1999)*. 2020; 85:66-72.
34. Quast T, Gregory S, Storch EA. Utilization of mental health services by children displaced by Hurricane Katrina. *Psychiatric Services*. 2018; 69:580-6.
35. Muruganandam P, Neelamegam S, Menon V, Alexander J, Chaturvedi SK. COVID-19 and Severe Mental Illness: Impact on patients and its relation with their awareness about COVID-19. *Psychiatry Research*. 2020; 291.
36. Alkhotani A, Siddiqui MI, Almontashri F, Baothman R. The effect of COVID-19 pandemic on seizure control and self-reported stress on patient with epilepsy. *Epilepsy and Behavior*. 2020; 112.

37. Beaudoin CE. News, social capital, and health in the context of Katrina. Baltimore, MD: Johns Hopkins University Press; 2009. p. 203-15.
38. Peters RJ, Jr., Meshack A, Amos C, Scott-Gurnell K, Savage C, Ford K. The association of drug use and post-traumatic stress reactions due to Hurricane Ike among fifth ward Houstonian youth. *Journal of Ethnicity in Substance Abuse*. 2010; 9:143-51.
39. Datar A, Liu J, Linnemayr S, Stecher C. The impact of natural disasters on child health and investments in rural India. *Social Science & Medicine*. 2013; 76:83-91.
40. Ghosh TS, Patnaik JL, Vogt RL. Rapid needs assessment among Hurricane Katrina evacuees in metro-Denver. *Journal of Health Care for the Poor and Underserved*. 2007; 18:362-8.
41. Jhung MA, Shehab N, Rohr-Allegri C, Pollock DA, Sanchez R, Guerra F, et al. Chronic disease and disasters medication demands of Hurricane Katrina evacuees. *American journal of preventive medicine*. 2007; 33:207-10.
42. Sibai AM, Kteily MN, Barazi R, Chartouni M, Ghanem M, Afifi RA. Lessons learned in the provision NCD primary care to Syrian refugee and host communities in Lebanon: the need to 'act locally and think globally'. *Journal of Public Health*. 2020; 42:e361-e8.
43. Matusow H, Benoit E, Elliott L, Dunlap E, Rosenblum A. Challenges to opioid treatment programs after Hurricane Sandy: Patient and provider perspectives on preparation, impact, and recovery. *Substance Use & Misuse*. 2018; 53:206-19.
44. Pouget ER, Sandoval M, Nikolopoulos GK, Friedman SR. Immediate impact of Hurricane Sandy on people who inject drugs in New York City. *Substance Use & Misuse*. 2015; 50:878-84.
45. Subaiya SMDM, Stillman JMDMPHF, Pumpalova Y. A modified Community Assessment for Public Health Emergency Response (CASPER) four months after Hurricane Sandy. *Disasters*. 2019; 43:206-17.
46. Tofighi B, Grossman E, Williams AR, Biary R, Rotrosen J, Lee JD. Outcomes among buprenorphine-naloxone primary care patients after Hurricane Sandy. *Addiction science & clinical practice*. 2014; 9:3.
47. Thorpe J, Ashby S, Hallab A, Ding D, Andraus M, Dugan P, et al. Evaluating risk to people with epilepsy during the COVID-19 pandemic: Preliminary findings from the COV-E study. *Epilepsy and Behavior*. 2020.
48. Sanchez TH, Zlotorzynska M, Rai M, Baral SD. Characterizing the Impact of COVID-19 on Men Who Have Sex with Men Across the United States in April, 2020. *AIDS and behavior*. 2020; 24:2024-32.
49. Lovegrove MC, Shehab N, Hales CM, Poneleit K, Crane E, Budnitz DS. Emergency department visits for antiviral adverse events during the 2009 H1N1 influenza pandemic. *Public health reports*. 2011; 126:312-7.
50. Haroon SMM, Barbosa GP, Saunders PJ. The determinants of health-seeking behaviour during the A/H1N1 influenza pandemic: An ecological study. *Journal of Public Health*. 2011; 33:503-10.
51. Karacin C, Bilgetekin I, Basal F, Oksuzoglu OB. How does COVID-19 fear and anxiety affect chemotherapy adherence in patients with cancer. *Future Oncology*. 2020; 16:2283-93.
52. Brite J, Friedman S, de la Hoz RE, Reibman J, Cone J. Mental health, long-term medication adherence, and the control of asthma symptoms among persons exposed to the WTC 9/11 disaster. *Journal of Asthma*. 2019.
53. Krousel-Wood MA, Islam T, Muntner P, Stanley E, Phillips A, Webber LS, et al. Medication adherence in older clinic patients with hypertension after Hurricane Katrina: implications for clinical practice and disaster management. *The American journal of the medical sciences*. 2008; 336:99-104.
54. Efe C, Simşek C, Batıbay E, Çalışkan AR, Wahlin S. Feasibility of telehealth in the management of autoimmune hepatitis before and during the COVID-19 pandemic. *Expert Review of Gastroenterology and Hepatology*. 2020; 14:1215-9.

55. Verma A, Rajput R, Verma S, Balania VKB, Jangra B. Impact of lockdown in COVID 19 on glycemic control in patients with type 1 Diabetes Mellitus. *Diabetes & metabolic syndrome*. 2020; 14:1213-6.
56. Hassen LM, Almaghlouth IA, Hassen IM, Daghestani MH, Almohisen AA, Alqurtas EM, et al. Impact of COVID-19 outbreak on rheumatic patients' perceptions and behaviors: A cross-sectional study. *International Journal of Rheumatic Diseases*. 2020; 23:1541-9.
57. Jiao Z, Kakoulides SV, Moscona J, Whittier J, Srivastav S, Delafontaine P, et al. Effect of Hurricane Katrina on incidence of acute myocardial infarction in New Orleans three years after the storm. *American Journal of Cardiology*. 2012; 109:502-5.
58. Khabbazi A, Kavandi H, Paribanaem R, Khabbazi R, Malek Mahdavi A. Adherence to medication in patients with rheumatic diseases during COVID-19 pandemic. *Annals of the Rheumatic Diseases*. 2020.
59. Mir N, Cheesbrough J, Troth T, Hussain N, Hopkins LJ, Shi J, et al. COVID-19-related health anxieties and impact of specific interventions in patients with inflammatory bowel disease in the UK. *Frontline Gastroenterology*. 2020.
60. Boehnke KF, McAfee J, Ackerman JM, Kruger DJ. Medication and substance use increases among people using cannabis medically during the COVID-19 pandemic. *International Journal of Drug Policy*. 2020.
61. Polat Ekinci A, Pehlivan G, Gökalp MO. Surveillance of psoriatic patients on biologic treatment during the COVID-19 pandemic: A single-center experience. *Dermatologic Therapy*. 2020.
62. Banerjee S, George M, Young K, Venkatachalam S, Gordon J, Burroughs C, et al. Effects of the COVID-19 Pandemic on Patients Living With Vasculitis. *ACR Open Rheumatology*. 2021; 3:17-24.
63. Georgakopoulos JR, Mufti A, Vender R, Yeung J. Treatment discontinuation and rate of disease transmission in psoriasis patients receiving biologic therapy during the COVID-19 pandemic: A Canadian multicenter retrospective study. *New York, New York: Elsevier B.V.*; 2020. p. 1212-4.
64. Koker O, Demirkan FG, Kayaalp G, Cakmak F, Tanatar A, Karadag SG, et al. Does immunosuppressive treatment entail an additional risk for children with rheumatic diseases? A survey-based study in the era of COVID-19. *Rheumatology international*. 2020; 40:1613-23.
65. Burger J, Gochfeld M, Lacy C. Ethnic differences in risk: experiences, medical needs, and access to care after hurricane Sandy in new jersey. *Journal of toxicology and environmental health Part A*. 2019; 82:128-41.
66. Sankar P, Ahmed WN, Mariam Koshy V, Jacob R, Sasidharan S. Effects of COVID-19 lockdown on type 2 diabetes, lifestyle and psychosocial health: A hospital-based cross-sectional survey from South India. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*. 2020; 14:1815-9.
67. Mori K, Ugai K, Nonami Y, Kirimura T, Kondo C, Nakamura T, et al. Health Needs of Patients With Chronic Diseases Who Lived Through the Great Hanshin Earthquake. *Disaster Management and Response*. 2007; 5:8-13.
68. Alshareef R, Al Zahrani A, Alzahrani A, Ghandoura L. Impact of the COVID-19 lockdown on diabetes patients in Jeddah, Saudi Arabia. *Diabetes & metabolic syndrome*. 2020; 14:1583-7.
69. Al-Hashel JY, Ismail II. Impact of coronavirus disease 2019 (COVID-19) pandemic on patients with migraine: a web-based survey study. *The journal of headache and pain*. 2020; 21:115.
70. Li X, Buxton OM, Hikichi H, Haneuse S, Aida J, Kondo K, et al. Predictors of persistent sleep problems among older disaster survivors: A natural experiment from the 2011 Great East Japan earthquake and tsunami. *Sleep: Journal of Sleep and Sleep Disorders Research*. 2018; 41:1-11.
71. Sanchez-Larsen A, Gonzalez-Villar E, Díaz-Maroto I, Layos-Romero A, Martínez-Martín Á, Alcahut-Rodríguez C, et al. Influence of the COVID-19 outbreak in people with epilepsy: Analysis of a Spanish population (EPICOVID registry). *Epilepsy and Behavior*. 2020; 112.
72. McAuley H, Hadley K, Elneima O, Brightling CE, Evans RA, Steiner MC, et al. COPD in the time of COVID-19: An analysis of acute exacerbations and reported behavioural changes in patients with COPD. *ERJ Open Research*. 2021; 7:1-8.

73. Ziadé N, el Kibbi L, Hmamouchi I, Abdulateef N, Halabi H, Hamdi W, et al. Impact of the COVID-19 pandemic on patients with chronic rheumatic diseases: A study in 15 Arab countries. *International Journal of Rheumatic Diseases*. 2020.
74. Samargandy SA, Al Garni TA, Almoghairi A, Alahmari M, Alshehri B, Mosaad M, et al. Effect of covid-19 pandemic on the cardiac outpatients' perception of seeking medical advice. *Journal of the Saudi Heart Association*. 2020; 32:377-82.
75. Rojano B, West E, Goodman E, Weiss JJ, de la Hoz RE, Crane M, et al. Self-management behaviors in World Trade Center rescue and recovery workers with asthma. *Journal of Asthma*. 2019; 56:411-21.
76. Islam T, Muntner P, Webber LS, Morisky DE, Krousel-Wood MA. Cohort study of medication adherence in older adults (CoSMO): extended effects of Hurricane Katrina on medication adherence among older adults. *The American journal of the medical sciences*. 2008; 336:105-10.
77. Tao J, Gao L, Liu Q, Dong K, Huang J, Peng X, et al. Factors contributing to glycemic control in diabetes mellitus patients complying with home quarantine during the coronavirus disease 2019 (COVID-19) epidemic. *Diabetes Research and Clinical Practice*. 2020; 170.
78. Zakaria OM, Alshar FA, Aljarrash KM, Alkhalaf GI, Alsheef NJ, Daoud MYI. Does COVID-19 pandemic affect medication compliance among chronic patients? *Sapporo Medical journal*. 2020; 54:1-12.
79. Wang PS, Gruber MJ, Powers RE, Schoenbaum M, Speier AH, Wells KB, et al. Disruption of existing mental health treatments and failure to initiate new treatment after hurricane Katrina. *The American journal of psychiatry*. 2008; 165:34-41.
80. Ahmad J, Ahmad MM. Assessing the public health impacts of disasters: A retrospective study of the October 2015 Hindu Kush earthquake in Pakistan. *International Journal of Disaster Risk Reduction*. 2018; 28:555-64.
81. Gul ZB, Atakli HD. Effect of the COVID-19 pandemic on drug compliance and stigmatization in patients with epilepsy. *Epilepsy and Behavior*. 2021; 114.
82. Zhang HQ, Lin JY, Guo Y, Pang S, Jiang R, Cheng QJ. Medication adherence among patients with chronic obstructive pulmonary disease treated in a primary general hospital during the COVID-19 pandemic. *Annals of translational medicine*. 2020; 8.
83. Zhang B, Jin R, Guan R, Lin R, Chang D, Zhang L, et al. Evaluation of the efficacy of Chinese Children's Asthma Action Plan on the long-term management of children with asthma at home. *National Medical Journal of China*. 2020; 100:3702-5.
84. Yuan J, Zhang L, Xu W, Shen J, Zhang P, Ma H. Reported changes in health-related behaviours in Chinese urban residents in response to an influenza pandemic. *Epidemiology and Infection*. 2009; 137:988-93.
85. Cherniack EP, Sandals L, Brooks L, Mintzer MJ. Trial of a survey instrument to establish the hurricane preparedness of and medical impact on a vulnerable, older population. *Prehospital and disaster medicine*. 2008; 23:242-9.
86. Mandelkorn U, Genzer S, Choshen-Hillel S, Reiter J, Meira E Cruz M, Hochner H, et al. Escalation of sleep disturbances amid the COVID-19 pandemic: a cross-sectional international study. *Journal of clinical sleep medicine : JCSM : official publication of the American Academy of Sleep Medicine*. 2021; 17:45-53.
87. Sharawat IK, Panda PK. Caregiver Satisfaction and Effectiveness of Teleconsultation in Children and Adolescents With Migraine During the Ongoing COVID-19 Pandemic. *Journal of Child Neurology*. 2020.
88. Antony A, Connelly K, De Silva T, Eades L, Tillett W, Ayoub S, et al. Perspectives of Patients With Rheumatic Diseases in the Early Phase of COVID-19. *Arthritis Care and Research*. 2020; 72:1189-95.
89. Saleem T, Sheikh N, Abbasi MH, Javed I, khawar MB. COVID-19 containment and its unrestrained impact on epilepsy management in resource-limited areas of Pakistan. *Epilepsy and Behavior*. 2020; 112.

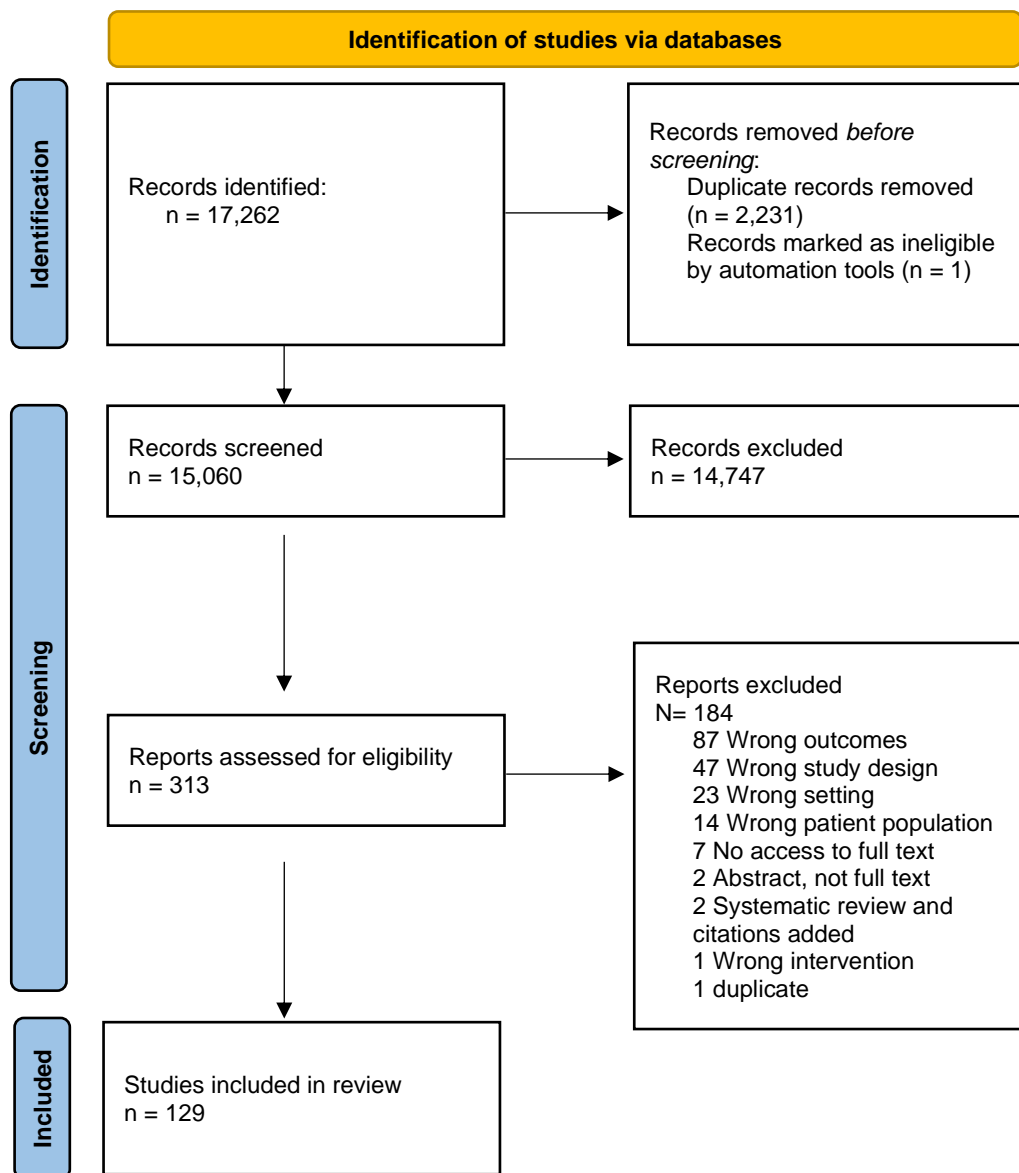
90. Rath M, Singh P, Bi HP, Shivanna A, Kavadiachanda C, Tripathy SR, et al. Impact of the COVID-19 pandemic on patients with systemic lupus erythematosus: Observations from an Indian inception cohort. *Lupus*. 2021; 30:158-64.
91. Andrade-Campos M, Escuder-Azuara B, de Frutos LL, Serrano-Gonzalo I, Giraldo P, Geedl, et al. Direct and indirect effects of the SARS-CoV-2 pandemic on Gaucher Disease patients in Spain: Time to reconsider home-based therapies? *Blood cells, molecules & diseases*. 2020; 85:102478.
92. Ferraro FR, Morton M, Knutson S, Zink J, Jacobson B. Impact of the 1997 flood on cognitive performance in the elderly. *Clinical Gerontologist: The Journal of Aging and Mental Health*. 1999; 20:79-82.
93. Lowe SR, Kwok RK, Payne J, Engel LS, Galea S, Sandler DP. Mental health service use by cleanup workers in the aftermath of the Deepwater Horizon oil spill. *Social Science & Medicine*. 2015; 130:125-34.
94. Howe E, Victor D, Price EG. Chief complaints, diagnoses, and medications prescribed seven weeks post-Katrina in New Orleans. *Prehospital and disaster medicine*. 2008; 23:41-7.
95. Onchonga D, Omwoyo J, Nyamamba D. Assessing the prevalence of self-medication among healthcare workers before and during the 2019 SARS-CoV-2 (COVID-19) pandemic in Kenya. *Saudi Pharmaceutical Journal*. 2020; 28:1149-54.
96. Meng H, Liao Q, Suen LKP, O'Donoghue M, Wong CM, Yang L. Healthcare seeking behavior of patients with influenza like illness: Comparison of the summer and winter influenza epidemics. *BMC Infectious Diseases*. 2016; 16.
97. Leyser-Whalen O, Rahman M, Berenson AB. Natural and social disasters: Racial inequality in access to contraceptives after Hurricane Ike. *Journal of Women's Health*. 2011; 20:1861-6.
98. Davidow AL, Thomas P, Kim S, Passannante M, Tsai S, Tan C. Access to Care in the Wake of Hurricane Sandy, New Jersey, 2012. *Disaster medicine and public health preparedness*. 2016; 10:485-91.
99. Salas-Nicás S, Moncada S, Llorens C, Navarro A. Working conditions and health in Spain during the COVID-19 pandemic: Minding the gap. *Safety Science*. 2021; 134.
100. Branford D, Gerrard D, Saleem N, Shaw C, Webster A. Stopping over-medication of people with intellectual disability, autism or both (STOMP) in England Part 1—history and background of STOMP. *Advances in Mental Health and Intellectual Disabilities*. 2018.
101. Burger J, Gochfeld M, Lacy C. Concerns and future preparedness plans of a vulnerable population in New Jersey following Hurricane Sandy. *Disasters*. 2019; 43:658-85.
102. Fiumara A, Lanzafame G, Arena A, Sapuppo A, Raudino F, Praticò A, et al. COVID-19 pandemic outbreak and its psychological impact on patients with rare lysosomal diseases. *Journal of Clinical Medicine*. 2020; 9:1-7.
103. Gasink LB, Linkin DR, Fishman NO, Bilker WB, Weiner MG, Lautenbach E. Stockpiling drugs for an avian influenza outbreak: examining the surge in oseltamivir prescriptions during heightened media coverage of the potential for a worldwide pandemic. *Infection Control & Hospital Epidemiology*. 2009; 30:370-6.
104. Kaye L, Theye B, Smeenk I, Gondalia R, Barrett MA, Stempel DA. Changes in medication adherence among patients with asthma and COPD during the COVID-19 pandemic. *Journal of Allergy and Clinical Immunology: In Practice*. 2020; 8:2384-5.
105. Trivisano M, Specchio N, Pietrafusa N, Calabrese C, Ferretti A, Ricci R, et al. Impact of COVID-19 pandemic on pediatric patients with epilepsy – The caregiver perspective. *Epilepsy and Behavior*. 2020; 113.
106. Chagué F, Boulin M, Eicher JC, Bichat F, Saint Jalmes M, Cransac-Miet A, et al. Impact of lockdown on patients with congestive heart failure during the coronavirus disease 2019 pandemic. *ESC Heart Failure*. 2020; 7:4420-3.
107. Abualfadi E, Ismail F, Shereef RRE, Hassan E, Tharwat S, Mohamed EF, et al. Impact of COVID-19 pandemic on rheumatoid arthritis from a Multi-Centre patient-reported questionnaire

survey: influence of gender, rural–urban gap and north–south gradient. *Rheumatology International*. 2020.

108. Tomio J, Sato H, Mizumura H. Interruption of medication among outpatients with chronic conditions after a flood. *Prehospital and disaster medicine*. 2010; 25:42-50.
109. Kyota K, Tsukasaki K, Itatani T. Disaster preparedness among families of older adults taking oral medications. *Home Health Care Services Quarterly*. 2018; 37:325-35.
110. Murakami N, Siktel HB, Lucido D, Winchester JF, Harbord NB. Disaster Preparedness and Awareness of Patients on Hemodialysis after Hurricane Sandy. *Clinical journal of the American Society of Nephrology : CJASN*. 2015; 10:1389-96.
111. McLean KE, Abramowitz SA, Ball JD, Monger J, Tehoungue K, McKune SL, et al. Community-based reports of morbidity, mortality, and health-seeking behaviours in four Monrovia communities during the West African Ebola epidemic. *Global public health*. 2018; 13:528-44.
112. Teramoto C, Nagata S, Okamoto R, Suzuki R, Kishi E, Nomura M, et al. Identifying residents' health issues six weeks after the Great East Japan Earthquake. *Public Health Nursing*. 2015; 32:654-61.
113. Zen M, Fuzzi E, Astorri D, Saccon F, Padoan R, Ienna L, et al. SARS-CoV-2 infection in patients with autoimmune rheumatic diseases in northeast Italy: A cross-sectional study on 916 patients. *Journal of autoimmunity*. 2020; 112:102502.
114. Dorfman L, Nassar R, Binjamin Ohana D, Oseran I, Matar M, Shamir R, et al. Pediatric inflammatory bowel disease and the effect of COVID-19 pandemic on treatment adherence and patients' behavior. *Pediatric Research*. 2021.
115. Wang Q, Luo Y, Lv C, Zheng X, Zhu W, Chen X, et al. Nonadherence to treatment and patient-reported outcomes of psoriasis during the covid-19 epidemic: A web-based survey. *Patient Preference and Adherence*. 2020; 14:1403-9.
116. Schmeiser T, Broll M, Dormann A, Fräbel C, Hermann W, Hudowenz O, et al. A cross sectional study on patients with inflammatory rheumatic diseases in terms of their compliance to their immunosuppressive medication during COVID-19 pandemic. *Zeitschrift fur Rheumatologie*. 2020; 79:379-84.
117. Potash MN, West JA, Corrigan S, Keyes MD. Pain management after Hurricane Katrina: Outcomes of veterans enrolled in a New Orleans VA pain management program. *Pain Medicine*. 2009; 10:440-6.
118. Bayleyegn T, Wolkin A, Oberst K, Young S, Sanchez C, Phelps A, et al. Rapid assessment of the needs and health status in Santa Rosa and Escambia counties, Florida, after Hurricane Ivan, September 2004. *Disaster management & response : DMR : an official publication of the Emergency Nurses Association*. 2006; 4:12-8.
119. Beaudoin CE. News, social capital and health in the context of Katrina. *Journal of Health Care for the Poor and Underserved*. 2007; 18:418-30.
120. Okumura J, Nishita Y, Kimura K. Pharmaceutical supply for disaster victims who need chronic disease management in region with aging population based on lessons learned from the Noto Peninsula Earthquake in 2007. *Yakugaku zasshi : Journal of the Pharmaceutical Society of Japan*. 2008; 128:1275-83.
121. Erdem Y, Polat Ekinici A, Altunay IK, Sivaz O, Inal S, Gokalp MO, et al. The impact of COVID-19 pandemic on the management of patients with chronic urticaria: An observational two-center study from Turkey. *Dermatologic Therapy*. 2020.
122. Boscarino JA, Hoffman SN, Adams RE, Figley CR, Solhkhah R. Mental health outcomes among vulnerable residents after Hurricane Sandy: implications for disaster research and planning. *American journal of disaster medicine*. 2014; 9:107-20.
123. Missildine K, Varnell G, Williams J, Grover KH, Ballard N, Stanley-Hermanns M. Comfort in the eye of the storm: a survey of evacuees with special medical needs. *Journal of emergency nursing: JEN : official publication of the Emergency Department Nurses Association*. 2009; 35:515-20.

124. Paasi A. Globalisation, academic capitalism, and the uneven geographies of international journal publishing spaces. *Environment and Planning A*. 2005; 37:769-89.
125. Sheikh A, Rudan I, Cresswell K, Dhingra-Kumar N, Tan ML, Hakkinen ML, et al. Agreeing on global research priorities for medication safety: an international prioritisation exercise. *J Glob Health*. 2019; 9:010422.
126. Rath B, Donato J, Duggan A, Perrin K, Bronfin DR, Ratard R, et al. Adverse health outcomes after Hurricane Katrina among children and adolescents with chronic conditions. *Journal of health care for the poor and underserved*. 2007; 18:405-17.
127. Maghlah SF, Zarif HA, Althubaiti A, Sabban MF. Managing Type 1 Diabetes among Saudi adults on insulin pump therapy during the COVID-19 lockdown. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*. 2021; 15:63-8.
128. Garfield S, Furniss D, Husson F, Etkind M, Williams M, Norton J, et al. How can patient-held lists of medication enhance patient safety? A mixed-methods study with a focus on user experience. *BMJ quality & safety*. 2020; 29:764-73.
129. Wills BSH, Morse JM. Responses of Chinese elderly to the threat of severe acute respiratory syndrome (SARS) in a Canadian community. *Public Health Nursing*. 2008; 25:57-68.
130. Oyeyemi OT, Oladoyin VO, Okunlola OA, Mosobalaje A, Oyeyemi IT, Adebimpe WO, et al. COVID-19 pandemic: an online-based survey of knowledge, perception, and adherence to preventive measures among educated Nigerian adults. *Journal of Public Health (Germany)*. 2021.
131. Agbabiaka TB, Wider B, Watson LK, Goodman C. Concurrent use of prescription drugs and herbal medicinal products in older adults: a systematic review. *Drugs & aging*. 2017; 34:891-905.
132. De Geest S, Zullig LL, Dunbar-Jacob J, Helmy R, Hughes DA, Wilson IB, et al. ESPACOMP medication adherence reporting guideline (EMERGE). *Annals of internal medicine*. 2018; 169:30-5.
133. Osterberg L, Urquhart J, Blaschke T. Understanding forgiveness: minding and mining the gaps between pharmacokinetics and therapeutics. *Clinical Pharmacology & Therapeutics*. 2010; 88:457-9.
134. Global Research Collaboration for Infectious Disease Preparedness. Novel Coronavirus Global Research and Innovation Forum: Towards a Research Roadmap [Webpage]. Geneva, Switzerland: . Switzerland: World Health Organisation 2019.
135. Pollock A, Campbell P, Struthers C, Synnot A, Nunn J, Hill S, et al. Development of the ACTIVE framework to describe stakeholder involvement in systematic reviews. *Journal of health services research & policy*. 2019; 24:245-55.
136. INVOLVE. INVOLVE. Briefing notes for researchers: involving the public in NHS, public health and social care research. Eastleigh: INVOLVE 2012.
137. Yadav R, Somashekar D, Sodha SV, Laserson KF, Venkatesh S, Chauhan H. Post-Flood Rapid Needs Assessment in Srinagar City, Jammu and Kashmir State, India, September, 2014. *Disaster medicine and public health preparedness*. 2019; 13:133-7.

Figure 1: PRISMA Flow Diagram



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For more information, visit: <http://www.prisma-statement.org/>

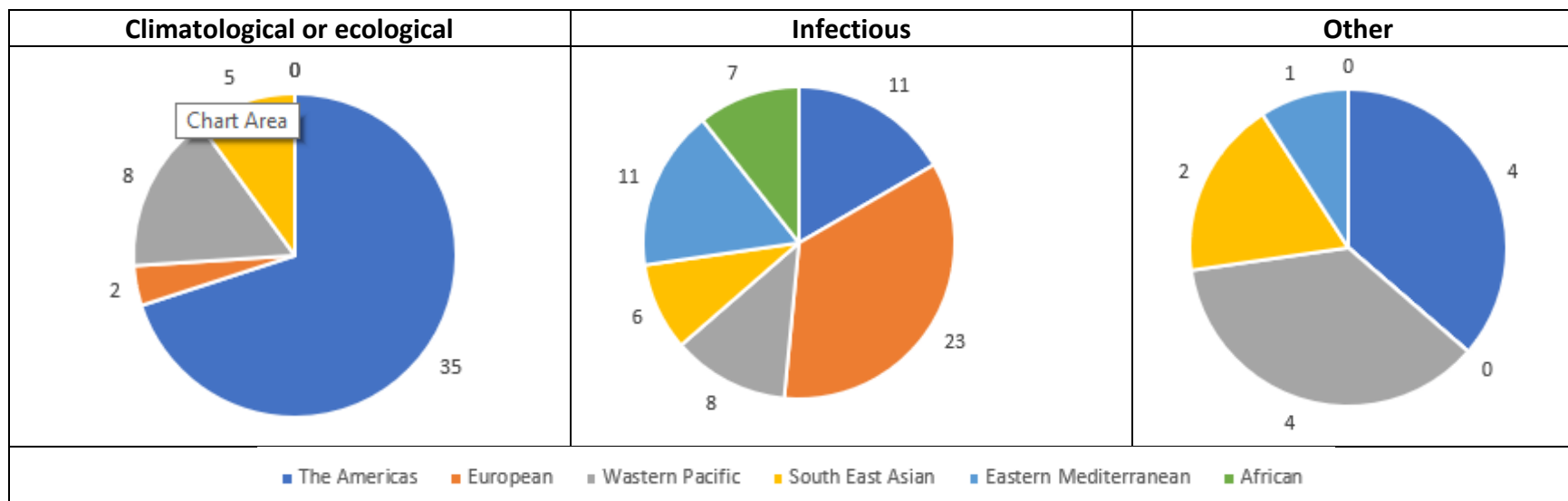
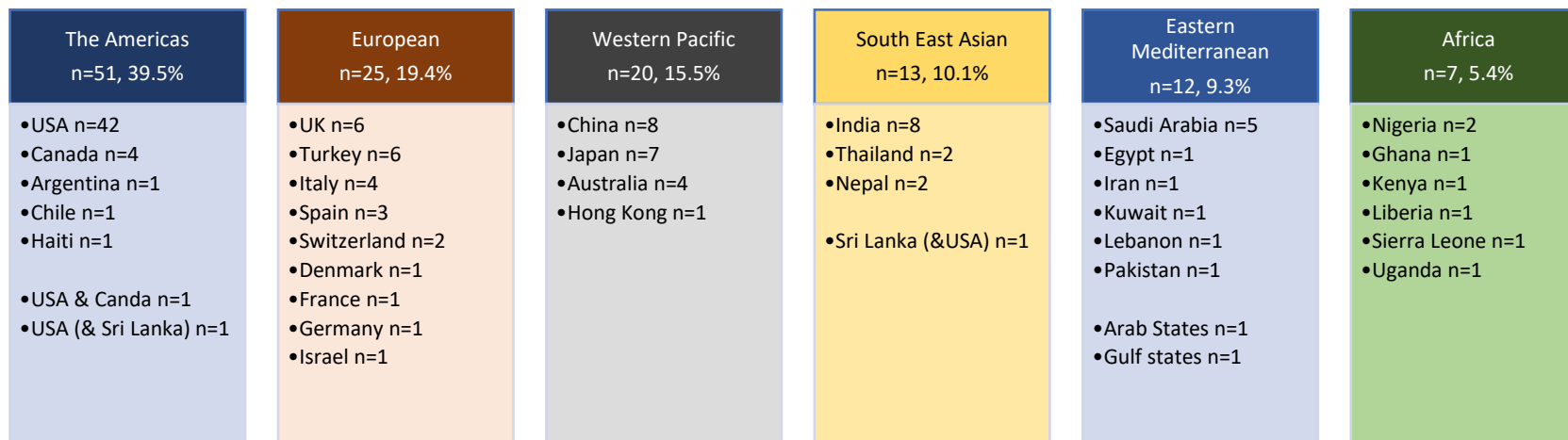


Figure 2: A visual representation of the included studies.

Figure A) Frequency of publication per year by public health emergency type (presenting 2021 data to April). Figure B) Type of study participants. Figure C) Age profile of study population. Figure D) Healthcare condition or body system investigated.

Infectious event n=68, 53%	Climatological or ecological event n=50, 39%	Other event N=11, 8%
<ul style="list-style-type: none"> • COVID-19, n=57, 44% • Influenza, n=6, 5% • Ebola, n=4, 3% • Severe acute respiratory syndrome (SARS), n=1, <1% 	<ul style="list-style-type: none"> • Hurricanes, tornados, cyclones or storms, n=32, 25% • Earthquakes, n=11, 9% • Floods, n=5, 4% • Tsunamis, n=1, <1% • Mixture, n=1, <1% 	<ul style="list-style-type: none"> • 9/11 terrorist attacks, n=3, 2.5% • Oil spill, n=1, <1% • A hypothetical disaster, (n=2, 1% • War, n=1, <1% • Multiple disasters, n=4, 3%

Figure 3. Type of public health emergency studied



*2 studies of infectious events were undertaken across multiple regions

Figure 4. Public health emergencies studied by geographic region and type

Supplementary materials

Overview

Supplementary Document 1: Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

Supplementary Document 2: Study Protocol and Search Strategy

Supplementary Document 3: Overview of included studies

Supplementary Document 4: A summary of findings of studies reporting difficulty accessing medications during PHE

Supplementary Document 5: A summary of studies describing adherence or compliance to medications during PHE

Supplementary Document 1: Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	Title page 1,2
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	3
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	3
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	4
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	4,5
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	4
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	4, 31-33
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	4
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	5-6, 37-56
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	5
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Not done
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	5, 6

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	34, 6
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	6, 7, 37
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Not done
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	6-12
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	6-12
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	12-14
Limitations	20	Discuss the limitations of the scoping review process.	14-15
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	15
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	16

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018;169:467–473. doi: [10.7326/M18-0850](https://doi.org/10.7326/M18-0850).

Supplementary Document 2: Study Protocol and Search Strategy

Study protocol

Design: Systematic scoping review.

Rigour: The review was conducted in line with methodological guidance¹ and reported in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR)².

Concept: Non-professional medication practices and medication safety vulnerabilities.

Context: Events of major public health concern, including ecological, climate, infectious, disaster or conflict. For the purpose of this study, such an event is defined as “An event, condition or agent which has the potential to rapidly harm an exposed population sufficiently to lead to a crisis and which may involve the government to declare a state of emergency, suspend state regulations and change the function of state agencies.”

Objective and review questions:

The objective of this scoping review is to provide an overview of the extent, range and nature of the available research on non-professional medication practices and medication safety vulnerabilities at times of events of major public health concern. It is led by the following review questions (RQ):

- RQ1. What study designs and characteristics have been used to examine medication safety vulnerabilities and non-professional medication practices before, during or after PHEs?
- RQ2. What public and patient involvement in conduct of research occurred?
- RQ3. What study populations and events were examined?
- RQ4. What outcomes related to medication safety outcomes and non-professional medication practices/ behaviours were described?
- RQ5. What were the main findings of these studies?
- RQ6. What interventions have been evaluated to address medication behaviours and outcomes during PHEs?
- RQ7. What outcomes were measured to assess these interventions?

Inclusion criteria:

Published articles will be eligible for inclusion in this review if they satisfy all of the following:

- Article type: Published manuscript or journal article.
- Study design: All research designs.
- Study population: All people, regardless of demographic or clinical characteristics.

- Study setting: Before, during or after an event of major public health concern. All event types, including ecological, climate, infectious or conflict (see definition).
- Outcomes:

- Any qualitative or quantitative outcome reporting on non-professional medication use, practices or behaviours. Medication includes prescribed or otherwise (including herbals, supplements, over-the-counter medicines, complementary and alternative medicines).
- OR**
- Any qualitative or quantitative outcome reporting on medication safety measures (adverse drug event, adverse drug reaction, medication error, adherence, compliance, consumption, drug-related problems).
- Language: no restriction.

Exclusion criteria

- Article types:
 - Commentaries, editorials, opinion pieces, non-systematic literature reviews
 - Clinical trials of medicinal products, including vaccines
 - Published abstracts
- Population and setting:
 - Studies reporting on opioid, obesity, tobacco, diabetes or antimicrobial resistance related epidemics or emergencies, in the absence of exposure to an event of major public health concern, as defined for the purpose of this study.
- Outcomes:
 - Vaccination coverage or adherence.

Search strategy:

- The search string will explore subject headings, keywords and synonyms for the concepts:
 - medication practices or behaviours;
 - medication safety outcomes;
 - public health emergency.
- Preliminary search has been undertaken in Ovid Medline.
- A second search will be carried out using the preferred search string, adapted to each database syntax, in CINAHL, PsychInfo, Embase, Global Health and in the systematic review or evidence synthesis databases: the Cochrane Library, Prospero, Joanna Briggs Institute and TRIP database.
- Depending on the yield from the above searches, forward and backward citation chasing of identified studies may be performed.

Study selection:

Title/abstract screening, followed by full text review, independently by two reviewers, conflicts resolved by discussion or with a third reviewer.

Data abstraction / extraction:

Create an extraction template.

Data abstraction, or charting, will be undertaken independently by two reviewers, with conflicts resolved by consensus or discussion with third reviewer. This will use a purposefully developed data abstraction form.

Data fields to be extracted include:

- study characteristics (e.g., country, funder, design, extent of public or patient involvement, defined as 'research carried out 'with' or 'by' members of the public rather than 'to', 'about' or 'for' them'¹³⁶,
- PHE characteristics (e.g., emergency type, region, impact on healthcare system, region, timing of study with respect to emergency),
- study participant characteristics (e.g., focus on disease or drug class),
- non-professional medication practice or behaviour outcomes,
- medication safety outcomes (e.g., adherence, harm, error),

- key findings relevant to medication use or medication safety outcomes,
- recommendations for policy, practice, education, research and Interventions implemented to address the issues and associated outcomes.

Charting this abstracted data will enable a logical and organised summary of the data to answer the review questions.

A PRISMA flow chart, demonstrating study eligibility, screening, selection and inclusion will be reported.

References

1. Peters MDJ, Godfrey C, Mclnerney P, Munn Z, Tricco AC, Khalil, H. Chapter 11: Scoping Reviews (2020 version). In: Aromataris E, Munn Z (Editors). JBI Reviewer's Manual, JBI, 2020. Available from <https://reviewersmanual.joannabriggs.org/>. <https://doi.org/10.46658/JBIRM-20-01>
2. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, Moher D, Peters MD, Horsley T, Weeks L, Hempel S. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Annals of internal medicine*. 2018 Oct 2;169(7):467-73.

Search strategy

<p>Preliminary search OVID MEDLINE</p>	<p>Database: Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R) <1946 to April 22, 2020> Search Strategy:</p> <p>-----</p> <ol style="list-style-type: none"> 1 Medication Errors/ or Medication Adherence/ or Medication Reconciliation/ (32270) 2 "Drug-Related Side Effects and Adverse Reactions"/ (31657) 3 medication*.mp. (341073) 4 medicine*.mp. (873572) 5 drug*.mp. (5839065) 6 pharmac*.mp. (3859868) 7 3 or 4 or 5 or 6 (7654648) 8 error*.mp. (374690) 9 Patient Harm/ or harm*.mp. (180513) 10 adverse*.mp. (2104667) 11 adhere*.mp. (216098) 12 complian*.mp. (174203) 13 8 or 9 or 10 or 11 or 12 (2907937) 14 7 and 13 (1208707) 15 pandemic.mp. or Pandemics/ (25953) 16 epidemic*.mp. (107444) 17 Natural Disasters/ or Disasters/ (19156) 18 disaster*.mp. (41966) 19 war.mp. or Armed Conflicts/ (45872) 20 hurricane.mp. or Cyclonic Storms/ (3943) 21 Floods/ (2659) 22 Nuclear Warfare/ or Fukushima Nuclear Accident/ or Radioactive Hazard Release/ (10306) 23 public health crisis.mp. (962) 24 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 (225470) 25 1 or 2 or 14 (1209112) 26 24 and 25 (7276) 27 limit 26 to english language (6691)
<p>Embase</p>	<p>('adverse drug reaction'/de OR 'side effect'/de OR 'medication compliance'/de OR 'attitude to health'/de OR 'patient safety'/de OR ((error* OR harm* OR adverse* OR adhere* OR complian*) AND (medication* OR medicine* OR drug* OR pharmac* OR 'drug therapy'/de))) AND ('pandemic'/de OR 'epidemic'/de OR 'disaster planning'/de OR 'disaster medicine'/de OR 'relief work'/de OR 'public health crisis' OR 'public health emergency') AND 'article'/it AND [embase]/lim AND ([article]/lim OR [article in press]/lim) AND [abstracts]/lim</p>
<p>Psychinfo</p>	<p>(DE "Health Knowledge" OR DE "Health Attitudes" OR DE "Health Behavior") OR (error* OR harm* OR adverse* OR adhere* OR complian*) OR (DE "Errors" OR DE "Patient Safety" OR DE "Side Effects (Drug)" OR DE "Treatment Compliance") AND</p>

	(DE "Drug Therapy" OR medication* OR medicine* OR drug* OR pharmac*) AND (DE "Pandemics" OR DE "Epidemics" OR (DE "EmergencyPreparedness" OR DE "Natural Disasters" OR DE "Disasters") OR "public health emergency" OR "public health crisis")
Cinahl	(MH "Medication Compliance") OR (MH "Medication History") OR (MH "Medication Reconciliation") OR (MH "Medication Side Effects (Saba CCC)") OR (MH "Medication Management") OR (MH "Noncompliance of Medication Regimen (Saba CCC)") OR (MH "Medication Risk (Saba CCC)") OR (MH "Medication Errors") OR (MH "Knowledge Deficit of Medication Regimen (Saba CCC)") OR (MH "Compliance with Medication Regimen (Saba CCC)") OR (medication* OR medicine* OR drug* OR pharmac*) OR (error* OR harm* OR adverse* OR adhere* OR complian*) AND ((MH "Influenza, Pandemic (H1N1) 2009") OR (MH "DiseaseOutbreaks") OR (MH "Influenza, Swine") OR (MH "Disaster Planning") OR (MH "Natural Disasters") OR (MH "Disasters") OR (MH "Humanitarian Aid") OR "public health emergency" OR "public health crisis")
Global Health	Database: Global Health <1973 to 2020 Week 17> Search Strategy: ----- 1 pharmaceutical products/ (10932) 2 (multiple drug therapy or drug therapy).sh. (196690) 3 prescriptions/ (8880) 4 nonprescription drugs.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes] (79) 5 drug interactions/ (1441) 6 (medication* or medicine* or drug* or pharmac* or polypharm* or remedy or remedies or "self-medic*" or prescri*).mp. (821136) 7 1 or 2 or 3 or 4 or 5 or 6 (821136) 8 health behaviour.sh. (12328) 9 health beliefs.sh. (4552) 10 (knowledge and health).sh. (1165) 11 (safety and patients).sh. (825) 12 (adverse* or error* or harm* or adhere* or complian* or knowledge or attitude* or practice* or behavio* or safe* or "adverse reaction" or "side effect" or reconcil*).mp. (778928) 13 8 or 9 or 10 or 11 or 12 (779271) 14 7 and 13 (211658)

- 15 (errors and drug therapy).sh. (46)
- 16 patient compliance.sh. (4856)
- 17 adverse effects/ (51482)
- 18 'self medication'.mp. (1315)
- 19 16 or 17 or 18 (57111)
- 20 14 or 19 (230181)
- 21 natural disasters/ (3653)
- 22 disasters/ (1767)
- 23 pandemics/ (2697)
- 24 floods/ (1457)
- 25 emergencies.sh. (4126)
- 26 outbreaks.sh. (36359)
- 27 emergency relief.sh. (369)
- 28 (emergencies and public health).sh. (1116)
- 29 "public health cris*".mp. (399)
- 30 "public health emergenc*".mp. (1406)
- 31 (Disaster* or pandemic* or epidemic* or flood* or outbreak* or cyclon* or hurricane*).hw. (60304)
- 32 ("emergency prepar*" or "relief work").mp. (829)
- 33 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 (64538)
- 34 20 and 33 (3841)
- 35 limit 34 to journal article (3541)

Supplementary Document 3: Overview of included studies

Study ID	Country	Study population	Types of public health emergency	Disease area	Study design or data type	Sample size
Abualfa dl 2020	Egypt	RA cases aged 18 years and older diagnosed according to the 2010 American College of Rheuma-tology/European League Against Rheumatism classification criteria	COVID-19 Pandemic	Rheumatoid arthritis	Cross sectional study	1037
Adong 2016	Ghana	Adults 18 years or older	Ebola outbreak	Public health: prevention and containment	Qualitative	235 in focus groups, 40 interviews.
Ahmad 2018	Thailand	adults	earthquake	access; health seeking behaviour, including medication use	retrospective secondary data analyses	1998
Al- Hashel 2020	Kuwait	We recruited a sample of patients with migraine from headache clinic registry and via social media to complete an anonymous survey	COVID-19	Migraines	Cross sectional study	1018
Alkhota ni 2020	Saudi Arabia	People with epilepsy in Saudi Arabia	COVID-19 Pandemic	Epilepsy	Cross sectional study	156
Alshare ef 2020	Saudi Arabia	Type 2 diabetes	COVID-19 pandemic	Type 2 diabetes	Cross sectional study	394
Anderso n 2020	Australia	Asthmatics	Hurricane; thunderstorm	Asthma	Retrospective audit	318
Andrade - Campos 2020	Spain	Spanish Gaucher Disease	COVID-19 Pandemic	Spanish Gaucher Disease	cross sectional study, quant survey	113

Antony 2020	Australia	Patients with rheumatic disease	COVID-19 Pandemic	Patients with rheumatic disease	Cross sectional study, quant	550
Appavo o 2016	Canada	Adults and children presented to study site ED	Hurricane or tornado	Access; community ED utilization	Retrospective secondary data analyses	1310
Arrieta 2009	USA	Adults with chronic illness	Hurricane	Medication: Chronic disease continuity of care in disasters	Qualitative	28
Bali 2016	Nigeria	adults	Ebola outbreak	access private healthcare	Mixed methods	119
Ballivian 2020	Argentina	HIV population	COVID-19 Pandemic	Mental Health	Combined Cohort Study	1336
Banerje e 2021	USA and Canada	Vasculitis patients	COVID-19 Pandemic	Vasculitis	Cross sectional study	662
Bayleye gn 2006	USA	Adults	Hurricane	Access to basic utilities, access to health services, health status, and immediate needs	Mixed methods	420
Beaudoi n 2009	USA	Adults who were hurricane shelter residents in the state of Louisiana	Hurricane	Media and public health	Qualitative	57
Boehnk e 2020	USA	People using cannabis medically	COVID-19 Pandemic	Medicinal cannabis users	Cross sectional study	353
Boscarin o 2004	USA	Adults (18 years or older) who reported receiving mental health treatment	9/11 terrorist attack	Mental health	Cross Sectional	2368
Boscarin o 2014	USA	Adults, 18 years old or older, who were permanent residents in a shore community in Monmouth County,	Hurricane	mental health services	Cross sectional	200
Brite 2019	USA	adults	9/11 terrorist attack	mental health, asthma	Cross Sectional	1293

Burger 2019	USA	Adults	Hurricane	Access; medical needs and access to care, concerns, evacuation status,	Cross sectional study	584
Burger 2019	USA	Adults	Hurricane	Access; medical needs and access to care, concerns, evacuation status,	cross sectional interviewer administered survey	599
Chaguã © 2020	France	CHF patients	COVID-19 Pandemic	Congestive heart failure	Cross sectional study	124
Chan 2014	China	Adults	Hypothetical disaster	Disaster preparedness, access to materials and health services	Qualitative	133
Cherniack 2008	USA	older adults	Hurricane	Disaster preparedness	Cross Sectional	547
Ciurea 2021	Switzerland	Inflammatory Rheumatic Patients	COVID-19	Inflammatory rheumatic diseases:	Cohort study	666
Clay 2020	USA	General Household	Hurricane category: SuperStorm	Household Preparedness to Disaster & medical services use	Retrospective study	1114 households
Cousino 2020	Multiple	Coronary heart disease	COVID-19 Pandemic	Heart disease	Cross-sectional	1220
Datar 2013	India	Children under 5 years old	Various: T	Access: paediatric; immunization disruptions and acute illness med availability	Retrospective secondary data analyses	80000
Davidow 2016	USA	Adults	Hurricane	Access to medical care, including medication interruption	Cross sectional	Estimates 2.7 million represented in database
Dorfman 2021	Israel	Children with inflammatory bowel disease	COVID-19 Pandemic	Inflammatory bowel disease	Cross-sectional telephone interview	244

Duggan 2010	USA and Sri-Lanka	older adults	Various disasters included tsunamis, floods, wind storms and earthquakes	Disaster preparedness including access to medications	Qualitative	17
Efe 2020	Turkey	Autoimmune hepatitis	COVID-19 Pandemic	Autoimmune hepatitis	Cohort study	46
Erdem 2020	Turkey	Patients with chronic urticaria (CU) in the allergy units of two dermatology departments.	COVID-19 pandemic	Dermatology	Other: prospective, observational study	194
Ferraro 1999	USA	Older adults	Flood	Access and needs, including medication use	Cross sectional	68
Fiumara 2020	Italy	lysosomal disease	COVID-19 Pandemic	Lysosomal storage diseases	Qualitative	15
Garfin 2014	Chile	Ages 15-90	Earthquake	Dependence: substance abuse & healthcare service use	Cross sectional study	2108
Gasink 2009	USA	People who obtained oseltamivir and control subjects,	Influenza Outbreak	Stockpiling of antiviral medications	Cross Sectional	68
Georgakopoulos 2020	Canada	Moderate to severe psoriasis	COVID-19 Pandemic	Psoriasis	Cross sectional study	2095
Ghose 2013	Haiti	Adults with HIV	Earthquake	Medication: antiviral adherence (HIV/AIDS)	Qualitative	33
Ghosh 2007	USA	Head of household	Hurricane	Access; needs assessment	Cross sectional	106
Glintborg 2021	Denmark	Inflammatory rheumatic diseases	COVID-19 Pandemic	Rheumatic diseases	Cross sectional study	12789
Guetti 2011	Italy	Resident in 4 tent cities	Earthquake	Medication: headaches and painkiller use	Cross sectional	53

Gul 2021	Turkey	Epilepsy	COVID-19 Pandemic	Epilepsy	Cross sectional study, quant	110
Haroon 2011	UK	Adults who sought and collected an antiviral drug between 23 July 2009 and 7 February 2010.	Influenza pandemic 2009/2010 A/H1N1	Medication: antiviral drug accessibility	Retrospective secondary data analyses	10655
Hassen 2020	Saudi Arabia	Rheumatic diseases	COVID-19 Pandemic	Rheumatic diseases	Cross sectional study, quant	637
He 2018	Nepal	Adults	Earthquake	Accessibility and services	Qualitative	82
Hochstatter 2021	USA	HIV & Substance abuse Users	COVID-19 Pandemic	Substance misuse	Retrospective chart review	112
Howe 2008	USA	Adults and children who visited the site clinic	Hurricane	Access; disaster relief care	Retrospective secondary data analyses	465
Islam 2008	USA	Older adults taking medication	Hurricane	Medication: Anti-hypertensive medication adherence	Cross sectional	2194
Jhung 2007	USA	Evacuees attending clinic	Hurricane	Medicine dispensing during hurricane	Retrospective secondary data analyses	4229
Jiao 2012	USA	Adults with AMI	Hurricane	Access; outcomes cardiovascular effects on natural disaster	Retrospective secondary data analyses	418
Kalichman 2020	USA	Men and women living with HIV (N = 162) aged 20â€³37years	COVID-19 pandemic	COVID-19	Other: Longitudinal study	162
Kamoi 2006	Japan	Adults with endocrine disorders	Earthquake	Access; needs endocrine disorder management	Prospective, uncontrolled study	229
Karacin 2020	Turkey	Cancer patients	COVID-19 Pandemic	Cancer patients	Cross sectional study, quant retrospective	3661

Kaye 2020	USA	People with asthma and COPD	COVID-19 Pandemic	Asthma and COPD	retrospective study observational	7578
Khabbazi 2020	Iran	Adults with rheumatic diseases, treated with non-steroidal anti-inflammatory drugs, colchicine, glucocorticoids, synthetic disease-modifying antirheumatic drugs and biologic DMARDs	COVID-19 Pandemic	Rheumatic diseases	Cross sectional study	858
Khawcharoenporn 2013	Thailand	Adults with HIV-infected adults (aged ≥15 years old)	Flood	Medication: antiviral adherence (HIV/AIDS)	Qualitative	217
Kobayashi 2016	Japan	Children and adults with epilepsy and physical and intellectual disabilities	Earthquake	Medication availability epilepsy	Cross sectional	161
Koker 2020	Turkey	Children with rheumatic diseases	COVID-19 Pandemic	Children with rheumatic diseases	Cross sectional study, quant survey	414
Krousel-Wood 2008	USA	Adults with hypertension	Hurricane	Medication non-adherence in anti-hypertensive meds	Cross sectional	210
Kyota 2018	Japan	Carers of older adults	Various	Medication: carers medication storage preparedness	Cross sectional	58
Leyser-Whalen 2011	USA	Women reproductive health	Hurricane	Access; reproductive health	Cross sectional	3181
Li 2018	China	Adults	Various	Disaster preparedness, materials and medications prep	Qualitative	133
Li 2021	China	Psychiatric disorders	COVID-19 Pandemic	Psychiatric illnesses	Cross sectional	1063
Linnema yr 2021	Uganda	HIV	COVID-19 Pandemic	HIV	Cross sectional	100

Lovegrove 2011	USA	Adults and children who attended 25 participating EDs	Influenza pandemic 2009 H1N1	Medication: adverse events for drugs	Retrospective secondary data analyses	2006-2007: n=77 2007-2008: n=130 2008-2009: n=261 2009-2010: n=411
Lowe 2015	USA	Adults aged 21 or over and capable of completing an interview in English, Spanish, or Vietnamese) and had reasonably good contact information were identified.	Oil spill	Mental health services	Cross Sectional	8931
Maghlah 2021	Saudi Arabia	Adults (>18 years old) with T1DM on insulin pump therapy	COVID-19 pandemic	COVID-19	Cross sectional study	65
Mahmud 2014	India	Adults with disabilities	Various	Access and needs, concern and coping; people with disabilities	Cross sectional	50
Mandelkorn 2021	Multiple	Adults	COVID-19 Pandemic	N/A	Cross sectional study	2562 +971
Marbaniang 2020	India	People living with HIV (PLHIV) registered for care at a publicly funded antiretroviral therapy (ART) center in Pune, India	COVID-19	HIV patients	Cohort study; interview	167
Matusow 2018	USA	Adults who use opioid drugs	Hurricane	Dependence opioid treatment medication access	Qualitative	82
McAuley 2021	UK	COPD	COVID-19 Pandemic	COPD	Cross sectional study, quant	160

McLean 2018	Liberia	Adults poor and middle class	Ebola outbreak	access to basic utilities, access to health services, health status, and immediate needs	Qualitative	505
Meng 2016	Hong Kong	Adults >18 years	Influenza epidemics	Access; health seeking behaviour, including medication use	Cross sectional	516
Mir 2020	UK	Inflammatory bowel disease	COVID-19 Pandemic	Inflammatory bowel disease	Cross sectional study, quant	228
Missildine 2009	USA	Adults >17 years	Hurricane	Access meds and overall experience; shelter experience of evacuees with special medical needs	Cross sectional	2269
Mori 2007	Japan	Adults with chronic illness	Earthquake	Medication: chronic disease medication interruption	Qualitative	29
Moscona 2019	USA	Adults registered with hospital site	Hurricane	Access to medical care, including medication interruption	Retrospective secondary data analyses	2341
Murakami 2015	USA	Adults receiving dialysis	Hurricane	Access; dialysis patients (service interruption)	Cross sectional systematic	357
Muruganandam 2020	India	Patients with severe mental illness	COVID-19 Pandemic	Severe mental illness	Cross sectional study, quant	132
Negi 2018	Nepal	Aged 18 years and older HIV positive	Earthquake	Mental health and med adherence	Cross sectional study	305
Okumura 2008	Japan	Older adults	Earthquake	Medication; chronic disease; medication availability and use	Mixed methods	110
Onchonga 2020	Kenya	Healthcare workers	COVID-19 Pandemic	General population	Cross sectional study	379

Oyeyemi 2021	Nigeria	Adults living in Nigeria	COVID-19 Pandemic	General population	Cross sectional study	1022
Peters 2010	USA	9 and 19 years old.	Hurricane	Mental health PTSD & substance abuse	Cross sectional	170
PolatEkin 2020	turkey	Psoriasis	COVID-19 Pandemic	Dermatology	Cross sectional study	133
Potash 2009	USA	Older adults; veterans enrolled in a chronic pain program	Hurricane	Mental health services	Qualitative	42
Pouget 2015	USA	Adults who use IV drugs	Hurricane	Dependence IV drug addiction	Cross sectional study	300
Quaill 2019	Australia	Adults with physical disabilities	Hurricane or Cyclone	Mental health and public health	Qualitative	20
Quast 2018	USA	Children who were ages 18 or younger at the time Hurricane Katrina struck with a diagnosis for psychiatric conditions that are relatively chronic, require long-term treatment	Hurricane	Mental health services - Paediatric - (psychotropic medications prescription fills)	Retrospective secondary data analyses	101950
Rath 2007	USA	0 to 24 years of age ID attending clinic	Hurricane	Medication: asthma med shortage	Cross sectional	531
Rathi 2021	India	Systemic lupus erythematosus	COVID-19 Pandemic	Systemic lupus erythematosus	Cross sectional study, quant	1040
Reilly 2009	USA	Adults with HIV/AIDS in the New Orleans metropolitan area	Hurricane	Access HIV care	Qualitative	145
Rhodes 2021	USA	HIV and men who have sex with men	COVID-19 Pandemic	HIV	Cross sectional study	15
Rojano 2019	USA	Asthmatics	September 2011 World Trade Centre attack	Asthma	Cross sectional study	381

Rutter 2014	UK	Children or adults who received telephone or internet consultation	Influenza pandemic	Medication: antiviral medication collection	Retrospective secondary data analyses	2.73 million unique patient contact; 429 000 GP consultations
Sahni 2016	Canada	Adults and children who had medication dispensed at study site	Flood	Access; needs assessment including medical	Retrospective secondary data analyses	N/A (“per 100 000 population” calculations)
Salas-NicÃ¡s 2021	Spain	All wage-earners residing in Spain who had a job on 14 March 2020 (the day the state of alert began), including people who were subsequently fired, or affected by a temporary lay-off procedure	COVID-19 Pandemic	General population	Cross sectional study	20328
Saleem 2020	Pakistan	Epilepsy	COVID-19 Pandemic	Epilepsy	Cross sectional study, quantitative	213
Samargandy 2020	Saudi Arabia	Cardiac outpatients	COVID-19 Pandemic	Cardiac disease	Cross sectional study	388
Sanchez 2020	UK	Men who have Sex with men	COVID-19 Pandemic	Sexual health	Cross-sectional	1051
Sanchez-Larsen 2020	Spain	People with epilepsy	COVID-19 Pandemic	Epilepsy	Retrospective observational study	100
Sankar 2020	India	Type 2 diabetes	COVID-19 Pandemic	Type 2 diabetes	Cross sectional study, quantitative	110
Schmeiser 2020	Germany	Patients with inflammatory rheumatic disease	COVID-19 Pandemic	Patients with inflammatory rheumatic disease	Cross sectional study	656

Sharawat 2020	India	Children and adolescents with migraine	COVID-19 Pandemic	Migraine	Cross sectional study, quant	51
Sibai 2020	Lebanon	Adults aged 40 years and above were screened by the nurse or social worker. The majority were Syrian refugees (77%), females (72.2%), with equal distribution across age bands.	The Syrian war	Not specified	Mixed method approach, with qualitative and quantitative data	1876
Subaiya 2019	USA	Adults	Hurricane	Access to medical care, including medication interruption	Cross sectional	87
Tao 2020	China	Patients with type 1 diabetes mellitus and type 2 diabetes mellitus	COVID-19	Diabetes mellitus (endocrine)	Cross sectional study	1253
Teh 2012	Australia	Adults who tested positive by RT-PCR for seasonal influenza A (265 pH1N1 and 53 non-H1N1) and 500 controls	Influenza H1N1	Public health containment measures and access to medical treatments including antivirals	Cross sectional	265 pH1N1 and 53 non-H1N1) and 500 controls
Teramoto 2015	Japan	Adults	Earthquake	Access; needs healthcare assistance	Qualitative	296
Thorpe 2020	UK	Epilepsy	COVID-19 Pandemic	Epilepsy	Cross sectional study	463
Tofghi 2014	USA	Adults who use opioid drugs	Hurricane	Dependence on opioid use	Mixed methods	91
Tomio 2010	Japan	Outpatients in a flood-affected area	Flood	Medication: chronic disease medication interruption	Cross Sectional	309

Trivisano 2020	Italy	Children with epilepsy	COVID-19 Pandemic	Epilepsy	Cross sectional study	3321
Verma 2020	India	T1DM who were on regular follow up in Endocrinology Outpatient department (adult and child)	COVID-19 Pandemic	Type 1 diabetes	Cross sectional study	52
Vetter 2008	Switzerland	Adults	Tsunami	Mental health substance use	Cross sectional	2921
Wang 2008	USA	Adults (>18 years of age)	Hurricane	Mental health	Cross sectional study	1043
Wang 2020	China	Chinese patients with psoriasis who were diagnosed by one or more experienced dermatologists.	COVID-19 Pandemic	Dermatology	Cross sectional study	926
Wills 2008	Canada	Older adults in residential care setting	SARS outbreak	Disaster preparedness	Qualitative	19
Yadav 2019	USA	Adults	Flood	Access; needs assessment	Cross sectional	210
Yamanis 2016	Sierra Leone	Adults	Ebola outbreak	Disease Perception	Qualitative	16
Yuan 2009	China	Person aged >15 years	Hypothetical pandemic	Disaster preparedness	Cross sectional	256
Zakaria 2020	Multiple	Chronic disease	COVID-19 Pandemic	Chronic disease	Cross sectional study, quant	1066
Zen 2020	Italy	Rheumatic diseases	COVID-19 Pandemic	Rheumatic diseases	Cohort study	916

Zhang 2020	China	Chronic obstructive pulmonary disease (COPD)	COVID-19 Pandemic	COPD	Cross sectional study	84
Zhang 2020	China	Asthmatics	cCOVID-19 Pandemic	Asthma	Cross sectional study	422
ZiadÃ© 2020	Multiple	Adults with chronic rheumatic diseases	COVID-19 Pandemic	Chronic rheumatic diseases	Cross sectional study	2163

Supplementary Document 4: A summary of findings of studies reporting difficulty accessing medications during PHE

Study author, year	Emergency type	Participants	Reported rate
Abualfadl 2020 ¹⁰⁷	COVID-19	Adults with RA	Difficulty to obtain the drug 608 (58.6%)
Al-Hashel 2020 ⁶⁹	COVID-19	Adults with migraine	difficulty in getting medications (179 patients (29.5%))
Andrade-Campos 2020 ⁹¹	COVID-19	Spanish Gaucher Disease	Missed several doses due to rescheduling and reorganization of their hospital infusion center
Ballivian 2020 ²⁹	COVID-19	HIV population	a few (n = 52, 3.9%) reported having problems obtaining HIV medication, and 122 (9.1%) reported difficulty obtaining other medication
Bayleyegn 2006 ¹¹⁸	Hurricane	Adults	9-10% of households had problems obtaining medication. [19040]
Gul 2021 ⁸¹	COVID-19	Epilepsy	2 patients (1.8%) experienced difficulty obtaining drugs during the pandemic.
Hassen 2020 ⁵⁶	COVID-19	Adults with rheumatic disease	48% of patients experienced difficulty obtaining medications
He 2018	Earthquake	Adults	Qualitative report of delayed treatment [5007]
Kobayashi 2016	Earthquake	Children and adults with epilepsy and physical and intellectual disabilities	29% respondents experienced a lack of medication or near-lack during the acute phase of the disaster. Six patients were forced to stop taking medication.
Koker 2020 ⁶⁴	COVID-19	Children with rheumatic disease	Fourteen patients particularly using hydroxy-chloroquine
Leyser-Whalen 2011 ⁹⁷	Hurricane	Adult females	13% women reported an inability to access their birth control method due to the hurricane [13380]
Magliah 2021 ¹²⁷	COVID-19	T1DM	difficulty obtaining medical supplies was re-reported in 24 patients (36.9%) for insulin, 26 patients (40%) for insulin reservoir, 26 patients (40%) for infusion set, 11 patients (16.9%) for lancets, test strips, and/or alcohol swabs, and 5 patients (7.7%) for glucometer device
Matusow 2018 ⁴³	Hurricane	Adults who use opioid drugs	10% reported they could not obtain their medication the week immediately following the storm [14932]
Missildine 2009 ¹²³	Hurricane	adults >17 years	63% respondents required assistance with medication [19741]
Mori 2017	Earthquake	Adults	Qualitative report of running out of medication [11878]
Muruganandam 2020 ³⁵	COVID-19	Patients with severe mental illness	Non availability of meds (6%)

Potash 2009 ¹¹⁷	Hurricane	older adults; veterans enrolled in a chronic pain program	4.8% (2/42) respondents ran out of pain medication briefly [13599]
Rath 2007 ¹²⁶	Hurricane	0-24 years of age attending an infectious disease clinic	Nearly half (43.9%) of the participants had experienced one or more disruptions in medical care (including but not only missed medications) [19289]
Rathi 2021 ⁹⁰	COVID-19	Systemic lupus erythematosus	hydroxychloroquine, and 190 patients (21.9%) responded that they had faced difficult in the availability of the drug, and 69 patients (6.6%) had been forced to miss several doses
Reilly 2009 ²⁴	Hurricane	adults with HIV/AIDS	38.5% ran out of medication [13926]
Saleem 2020 ⁸⁹	COVID-19	Adults with epilepsy	17.4% had medication disruptions
Sharawat 2020 ⁸⁷	COVID-19	Children with migraine	Significantly reduced across both drug classes, requesting change to Rx. 7.8% requested a Rx change due to unavailability of medication
Sibai 2020 ⁴²	Syrian war	Adults who were refugees	Shortage in a variety of medications for extended periods of time ranging from days to weeks; this was attributed to the increase in patient load and the rise in demand
Subaiya 2019 ⁴⁵	Hurricane	Adults	24.7% respondents experiencing difficulty in acquiring prescription medications in the 4 months' post disaster [16758]
Teramoto 2015 ¹¹²	Earthquake	Adults	interruption of treatment affecting 36.5% respondents (n=19) [14658]
Tomio 2010 ¹⁰⁸	Flood	People with chronic conditions	Only 52% brought medications of evacuees brought their medicines with them during evacuation [18335]
Trivisano 2020 ¹⁰⁵	COVID-19	Children with epilepsy	12.6% of responders reported difficulties in obtaining ASMs, 7.9% because ASMs were not available in pharmacy, 2.7% for problems in reaching the pharmacy, and 2.0% for lack of prescription.
Verma 2020 ⁵⁵	COVID-19	T1DM	8/19 patients having hyperglycemia were not getting insulin injections due to non-availability during lockdown; not monitoring blood glucose were non availability of glucostrips (13 out of 20)
Yadav 2019 ¹³⁷	Flood	Adults	40% did not have a 1 week supply of medicines with them at the time of interview [16891]

Ziadé 2020 ⁷³	COVID-19	Rheumatology patients	negative impact on access to hydroxychloroquine (47%) Shortage of HCQ n=297, 18% Difficulty to access HCQ n=481 29. 2%
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Supplementary Document 5: A summary of studies describing adherence or compliance to medications during PHE

Study author, year	Emergency type	Participants	Measure used	Timing of measurement	Reported rate of non-adherence
Abualfadl 2020 ¹⁰⁷	COVID-19	Adults with RA	Self-report	During	Stopped or reduced taking NSAIDs n= 171 (16.5%)
Ahmad 2018	Earthquake	Adults with tuberculosis	Direct Observation of Treatment data	Before and after	During the intensive phase of the disaster, TB-DOTS remained stable in those in areas less affected by the earthquake and deteriorated in highly affected areas.
Al-Hashel 2020 ⁶⁹	COVID-19	Adults taking migraine treatment	Self-report	During	54.4% non-compliant, 59% reported overuse
Alkhotani 2020	COVID-19	People with epilepsy	Self-report	During	Self-reported change to adherence for 5% but remaining 95% remained unchanged.
Alshareef 2020	COVID-19	People experiencing T2DM	Self-report	Before and after lockdown	89.6% and 88.3% took medications regularly and on time before the lockdown, respectively
Ciurea 2021 ¹⁶	COVID-19	Adults with axial spondyloarthritis (axSpA), rheumatoid arthritis (RA) or psoriatic arthritis (PsA)	Self-report	Before and during	The pre-pandemic proportion of patients with non-compliance to the prescribed medication was around 15%. Non-compliance increased slightly during the pandemic reaching statistical significance in people with axial spondyloarthritis (19.9% vs 13.2% p=0.003).
Efe 2020	COVID-19	People experiencing autoimmune hepatitis	Self-report	Before and during	Those in the telehealth group had better adherence and less relapse than standard care
Ghose 2013	Earthquake	Adults with HIV	Qualitative reports	After	Reports from encampment residents who were living with HIV/AIDS about difficulties accessing medicines and remaining adherent while in the camps.
Gul 2021	COVID-19	Patients aged 18–65 with epilepsy	Modified Morisky Scale	Before and during	Increases in the subscales of motivation and knowledge during compared to before the PHE were reported. Total MMS score not reported.
Hassen 2020 ⁵⁶	COVID-19	Adults with rheumatic disease	Self-report	During	14% were non-adherent
Hochstatter 2021 ³⁰	COVID-19	Adults with HIV and substance abuse users	Self-report	Before and during	Proportion of participants missing their HIV medications 2 or more days per week significantly increased from 5% to 12%
Islam 2008	Hurricane	Older adults	Self-report	After	Prevalence of low adherence was reported

					but no comparison with baseline pre-PHE. Low medication adherence was associated with lower scores on the hurricane coping self-efficacy scale.
Jiao 2012	Hurricane	Adults	Healthcare recorded history data	Before and after	post-PHE patients were more likely to be non-adherent and to present to hospital with an AMI than before the PHE.
Kalichman 2020	COVID-19	People living with HIV	Self-report	During	Practicing protective behaviours was related to an inability to access medications but not to ART adherence in the month before, or the month during, the COVID-19 assessment. Adherence improved in the month since the onset protective actions.
Kaye 2020	COVID-19	People experiencing asthma or COPD	Electronic inhaler use monitoring data	During	14.5% relative increase (53.7% to 61.5%) in mean daily controller medication adherence
Krousel-Wood 2008 ⁵³	Hurricane	Adults taking antihypertensive medications	Self-report, the Hill Bone medication-taking subscale	During	46% of the patients had less-than-perfect adherence
Li 2020	COVID-19	Older people experiencing psychiatric disorders	Self-report	During	Poor adherence to treatment was associated with anxiety and depression symptoms
Linnemayr 2021 ³²	COVID-19	HIV	Self-report	During	14% said decreased compliance (due to stay at home orders, restrictions)
Marbaniang 2020	COVID-19	People living with HIV	Remaining days' medication supply	During	Evidence that adherence is related to anxiety and access to mental health treatments
Muruganandam 2020 ³⁵	COVID-19	Patients with severe mental illness	Self-report	During	22% of patients missed psychiatric medicines during lockdown. 18% of patients missed medication for comorbid illness
McAuley 2021	COVID-19	People with COPD	Self-report of use of maintenance inhalers	Prior to and during lockdown compared to stable state	Prior to lockdown 83% reported the same frequency, 14% increased use and 2.5% less frequent use than normal. During lockdown 26% reported increased, 71% the same and 2.5% less regular use than baseline ($p < 0.001$)
Negi 2018	Earthquake	People living with HIV	Adapted from the Adult AIDS Clinical Trials Group, self-report	6 and 12 months after the earthquake	Adherence rates declined after the earthquake and this may have resulted in treatment failure and emergence of resistance strains for some.

			measure, based on previous 4 days		
PolatEkinci 2020	COVID-19	patients with moderate-to severe psoriasis receiving maintenance biological treatment	Self-report	During	39% suspended biological treatment.
Reilly 2009	Hurricane	People living with HIV	Medication supply interruptions and missed doses	After	No association identified between medication “adherence” and PTSD. 39% ran out of medication within one month of the hurricane.
Rojano 2019	Disaster	Rescue and recovery workers with asthma	Medication Adherence Rating Scale (MARS)	After	44% non-adherent
Samargandy 2020	COVID-19	Cardiac patients	Self-report	Perceived change from before to during	No change (72.7%), improved compliance (17.8%), disimproved compliance (9.5%).
Sanchez-Larsen 2020	COVID-19	People with epilepsy	Self-report	During	No change 98%, improved 2%
Tao 2020 ⁷⁷	COVID-19	T1DM and T2DM	Self-report and hospital records	During	22.3% of T2 and 75% of T1DM reported being non-compliant.
Thorpe 2020 ⁴⁷	COVID-19	Epilepsy	Self-report	During	13% reported greater difficulties in adherence
Wang 2020 ¹¹⁵	COVID-19	Adults with psoriasis	Self-report	During	The prevalence of nonadherence was 37.3%, 63.7%, and 71.2% for biological, systemic, and topical treatment, respectively
Zakaria 2020 ⁷⁸	COVID-19	Adults with chronic disease	Self-report	During	29.2% were not adherent during pandemic,
Zhang 2020 (#25596)	COVID-19	People experiencing COPD	Dispensed medication data	Before and during	No change in adherence rates between the two periods.
Zhang 2020 (#25925)	COVID-19	Asthma	Scale unclear	During	Average score 4.56 reported.
Ziade 2020	COVID-19	People with chronic rheumatoid disease	Medication persistency	During	The pandemic had a negative association with medication persistence.