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Research Protocol—A Scoping Review of Human Factors Applications in Population Health

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A Scoping Review of Human Factors Applications in Population Health

Abstract

Introduction Population health professionals regularly engage in complex cognitive tasks and they may use various tools to help support their decision making. Human factors methods can be employed to the design of such tools in order to better support population health professionals in decision making tasks. Human Factors engineering seeks to improve the design of systems, processes, and interfaces to support human performance, improving safety, and increasing user satisfaction. While human factors methods have been applied to the design of some clinical health tools, applications of human factors are limited in the design of population health systems. The purpose of this scoping review is to develop a comprehensive understanding of how human factors techniques have been applied in the development of data-driven decision support tools in population health.

Method and analysis This scoping review will follow established review methodology in order to meet the study objective. Given that the terms "Human Factors" and "Decision Support Tools" are boadly defined, we discuss the challenges for operationalizing these concepts and developing the search strategy. We included both peer-reviewed and grey literature sources from 1980 to April 2021 in the search. Two researchers will screen the titles, abstracts, and full-text articles, and a third independent researcher will resolve conflicts. Data will be abstracted by two researchers and will be presented in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) extension for scoping reviews. As of April 2021, the scoping review is in the title and abstract screening stage. Full-text screening and data synthesis will follow, and the first results are anticipated to be submitted for publication in October 2021.

Conclusion This scoping review will attempt to provide a foundational understanding of the current landscape of human factors in the development of data-driven decision support tools within population health.

Strengths and Limitations of this Study

- While human factors have been used to inform the design of tools and processes to support individual health outcomes, to our knowledge, applications of human factors to population health decision support tools is limited. This is a novel scoping review to understand how human factors have been applied to the design and evaluation of data-driven decision support tools within population health.
- An information specialist developed the search strategies for the health science databases. An information specialist consulted on the development of search strategies for the engineering databases.
- Our methodology was devised in consultation involving several multidisciplinary experts who advised on the rigor and feasibility of this review.
- Our review is limited to articles written in English and as such, presents a bias to Western research applications.
- This scoping review does not include book chapters, theses, short papers, editorials, systematic reviews, or conference abstracts, which may limit our findings. However, we focus on casting a wide net to capture relevant human factors applications to develop decision support tools in population health.

Background

Human Factors Engineering, an interdisciplinary field at the intersection of psychology and engineering, seeks to improve the design of systems, processes, and interfaces to support human performance, improve safety, and increase user satisfaction [1]. To achieve these goals, human factors engineers employ a user-centered design methodology, which aims to: 1) understand the people and the system that they interact with, 2) create a solution that meets the needs of the user, and 3) evaluate how well the solution meets the needs of the user and achieves the human factors objectives. In evaluating the system design, human factors engineers may measure user errors, efficiency (e.g., task completion times), user stress or mental workload, the users' attentional demands and situation awareness, as well as user acceptance and satisfaction.

Human factors engineering methods have been applied to the design of complex systems within transportation [2] military [3], nuclear process control [4], and health care [5]. For instance, in health care applications, HF engineering methods have been used to enhance the clinician's decision making through the introduction of decision support tools [6-8] improve patient safety [9, 10] and assist patients and caregivers in managing various health conditions [11].

In clinical practice, decision support systems are considered as "any electronic system designed to aid directly in clinical decision making, in which characteristics of individual patients are used to generate patient-specific assessments or recommendations that are then presented to clinicians for consideration," [12]. Human factors methods have been applied to the development and evaluation of clinical decision support systems. For example, Faiola Srinivas, and Duke (2015) employed a user-centered design approach to develop a dashboard for electronic medical record data to assist physicians in clinical decision making [13]. The authors compared their prototype to paper-based medical records and demonstrated clear performance and workload benefits for the electronic dashboard. Additionally, research has demonstrated the positive impact of employing human factors methods to the design of medical systems [14]. As an example, Lin et al. (1998) redesigned a user interface for a commercially available patient-controlled analgesia pump and conducted an

evaluation that compared their redesign with the original design. Their results showed a significant decrease in errors and mental workload, thereby highlighting the importance of human factors in the design of medical equipment. Human factors has also been applied to tools designed to assist patients and caregivers in managing various health conditions. For example, Carroll, Marrero, and Downs (2007) developed a system for diabetes patients to monitor their blood glucose levels integrated with a mobile device [15]. They conducted a user evaluation of the system, demonstrating high levels of patient satisfaction and utility for the device.

While human factors in health care seeks to improve the design of systems, processes and interfaces to support health outcomes for individual patients, such applications of human factors to support population health outcomes are limited. Population health can be defined as "the health outcomes of a group of individuals, including the distribution of such outcomes within the group," [16]. The important distinction from clinical applications is that population health applications employ broader determinants that work across populations, suchas social, economic, and biology, early childhood development, and health services [17]. Accordingly, population health has a broad scope and ranges from physical and mental health, to environmental health within a population, all encompassed within the public health sector [18]. Public health professionals regularly engage in complex cognitive tasks involved in assessment (monitoring community health status; assessing health status and investigating disease outbreaks), policy development (educating the public regarding health issues; health system planning) and assurance (enforcing laws and regulations; connecting the community with health services) [18, 19]. Given that the focus is on populations and the unique functions of public health, data-driven tools will have distinct users and needs compared to clinical tools [20]. Human factors engineering approaches can be used in the development of tools to support public health professionals in these tasks. The present scoping review attempts to provide a foundational understanding of the current landscape of human factors applications within population health.

Research Question

We identified the research question following extensive discussions among the protocol authors to clarify the concept and the purpose of the review. The major research question was defined as follows: **How are human factors considered in the design and development of data-driven decision support tools for population health applications?**

Methods

This study question adheres to the population, concept, and context framework used for scoping reviews [21, 22]. In this case, the population is general and not defined. We propose conducing a scoping review of how human factors methods have been applied to population health. This reporting protocol has been informed by PRISMA-P and PRISMA-S guidelines for systematic review protocols [23, 24]. This scoping review will follow the methodological framework described by Arksey and O'Malley (2005) with refinements proposed to the framework by Levac, Colqhoun & O'Brien (2010). The reporting of this protocol and search have been informed by the PRISMA-P and PRISMA-S reporting guidelines respectively to facilitate understanding and transparency [23, 24].

Registration and Review Stage

The present research protocol will be registered with BMJ prior to beginning the study. The study is expected to commence in May 2021 with an anticipated completion date of October 2021.

Operationalizing Population Health, Human Factors and Decision Support Tools

One major challenge for this scoping review was operationalizing the concepts of population health, human factors, and decision support tools for the search strategy. As such, to aid in the codification of these concepts, our team includes an information specialist.

Population Health was operationalized to encompasses all aspects of public health in the broadest sense and is not limited to any specific aspects, such as chronic or infectious disease. Search terms included "population health," "public health," "community health," "community medicine," "health promotion," "epidemiology," and "disease prevention."

Human Factors was operationalized to encompass all aspects of human factors in the broadest of senses and is not limited to a particular method or tool. Search terms included "human factors," "ergonomics," "cognitive ergonomics," "cognitive analytics," "usability," "human engineering," "human computer interaction," "human-centered design," "interface design," "user interface," "user evaluation," "usability evaluation," "user friendly," "user experience," and "human machine interface."

Decision support tools was operationalized to encompass any electronic system to aid decision making. Search terms included "decision support," "decision support systems," "decision support tool," "information systems," "data visualizations," "visual analytics," "informatics," "data display," and "dashboard."

Search Strategy

The search strategy includes indexed databases of peer-reviewed literature, grey literature and manual searches. We discuss each of these in turn:

Peer-reviewed Literature

The published literature search will include Ovid MEDLINE: Epub Ahead of Print, In-Process and Other Non-Indexed Citations, Ovid MEDLINE Daily, and Ovid MEDLINE 1946-present; EMBASE (on Ovid), Scopus, PsycINFO (Ovid) , Compendex (Engineering Village), IEEE Xplore, and Inspec (Engineering Village). Comprehensive literature searches were developed in collaboration with a University of Toronto Librarian. The search strategies used a combination of keywords, and subject headings relevant to each database for each concept. The databases were selected based on subject area coverage and functionality

Results prior to 1990 were excluded in the search strategy to capture the most current literature. This research study only included primary studies, limited to the English language. To achieve this, a modified version of the systematic review filter developed by the Scottish Intercollegiate Guidelines Network was applied to exclude systematic reviews, scoping reviews, meta analyses as well as editorials, guidelines, letters and patient education handouts. The MEDLINE search strategy was validated against a key set of 8 articles [19, 25-31] pre-determined by the subject

experts and was peer reviewed using PRESS [32] by another information specialist, not associated with this study to ensure accuracy and comprehensiveness.

Grey Literature

Our grey literature search strategy is guided by our research question. While government or organization websites may contain dashboards and interfaces used by public health professionals to inform their population assessment and planning, information about the development and assessment of public health professional interactions with the interfaces or dashboards will not be available. In other words, the information will be about tools, but not the development or evaluation, which is needed for the human factors aspect of this review. As such, our grey literature search will be focused on capturing full-text conference proceedings papers and preprint servers in order to counter the positive reporting bias of the published article literature, ensuring the review is thorough and balanced, while identifying brand new research that has not yet been published. The grey literature will also allow the research team to discover more references to published literature that may not have been included in the peer-reviewed databases.

Manual Searches

Reviews of human factors and population health discovered in the formal peer-reviewed literature and grey literature search will be identified and their references will be manually searched to identify additional articles for inclusion. Reference lists of included articles were manually screened to identify additional studies.

Integration of Results

The results from the three search types will be integrated into Covidence, a systematic review management software, and duplicates will subsequently be removed. Screening for article inclusion will be completed using Covidence and will consist of two phases. First, the title and abstract of all identified articles will be screened independently by two reviewers on the research team and will be categorized as "include," "exclude," or "inconclusive,"[22]. Such judgments will be informed by the inclusion and exclusion criteria (see Table 1) and will be documented using a piloted standardized relevance form. Disagreements will be resolved through team discussion and may include a third, independent, reviewer if necessary. Articles identified as *include* or *inconclusive* in the first phase will be reviewed in the second phase by an additional two independent reviewers in the same manner as the first phase, which will lead to a final decision regarding inclusion.

Inclusion and Exclusion Criteria

We sought to limit the scope of our challenge by developing *a priori* eligibility criteria for the literature, detailing the types of literature to be included. The inclusion and exclusion criteria are presented in Table 1. Note that the criteria are not considered exhaustive and will be further refined during the review.

All documents created since 1990 in English that describe the development, validation, or application guided by human factors principles to any study design in the field of population health will be included.

Table 1. Exclusion Criteria for Literature Search

Exclusion Criteria
1. Articles whose outcome is unrelated to population health
2. Articles not related to human factors
3. Conference abstracts, as these may not include sufficient details on the methodology
4. Reviews
5. Articles written in languages other than English

Data Abstraction and Synthesis

A data abstraction form will be developed and pilot-tested using two researchers,working independently of each other. The data form will be tested on five to seven articles for consistency and comprehensiveness for capturing relevant study data. Changes will be made in a team meeting during which the team will compare pilot test results and discuss discrepancies.

The data will be abstracted and synthesized according to four themes described in Table 2.

Table 2. Data Abstraction Themes and Items

Study Characteristics
1. Author(s)
2. Year of publication
3. Year that study was conducted
4. Type of publication (e.g., peer-reviewed article, conference proceeding)
5. Name of Journal/conference
6. Academic discipline of authors
7. Country of publication
8. Language of dissemination
9. Population health subject area
10. Topic of Study
Study Methods
1. Study location (e.g., country)
2. Study setting (e.g., laboratory, field)
3. Study design
4. Framework/theory used to guide study
5. Types of data collected
6. Software used to analyze data
7. Population of study (e.g., who is the tool being used for)
8. Study sample size
9. Study goal (development vs validation vs application)
10. Source(s) of funding
Human Factors Characteristics
1. Needs assessment
2. Prototyping
3. Evaluation
4. Users (e.g., who is using the tool)

Results will be synthesized and will be presented in relation to the research question. Where applicable, summarized study characteristics will be presented using tables and figures. Finally, the scoping review will discuss implications and future research directions for human factors applications in population health.

Patient and Public Involvement

This is a scoping review protocol and as such it was not appropriate or possible to involve patients or the public in the design, conduct, reporting, or dissemination plans of our research. Public health representatives, the targeted user group, will be involved in the design, conduct and reporting of the next steps within our research project.

Ethics and Dissemination

The completed scoping review will be submitted for publication to a peer-reviewed, interdisciplinary journal in addition to conferences on population health and human factors.

Conclusions

This scoping review will attempt to provide a foundational understanding of the current landscape of human factors in the development of data-driven decision support tools within population health. Human factors presents tremendous potential for contributing to the development of tools to support public health professionals in complex cognitive tasks involved in assessment, policy development and assurance. Mapping how human factors has been used within this context will help promote human factors methods in the development of tools in future initiatives in population health. This scoping review protocol describes the study design for the review on human factors in the development of decision support tools within the context of population health.

Required Statements

Authors Contributions

LR and BD conceived the study. HV, LD, RS, LR and BD jointly developed the research questions and HV drafted the paper. HC provided input on the search strategy and operationalization of study concepts. All authors revised further revised the paper and approved of the final text.

Competing Interests

None declared.

Funding Statement

This study was funded by a grant from the X-Seed program at the University of Toronto, jointly held by Dr. Birsen Donmez and Dr. Laura Rosella. Dr. Donmez hold a Canada Research Chair in Human Factors and Transportation and Dr. Rosella holds a Canada Research Chair in Population Health Analytics.

Data Sharing

There is no data set available for the study protocol.

Ethics Approval
This is a scoping review protocol and as such this study does not involve human participants or animal subjects. There is no research ethics approval for this study.

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Research Protocol—A Scoping Review of Human Factors Applications in the Design of Decision Support Systems for Population Health

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A Scoping Review of Human Factors Applications in the Design of Decision Support Systems Population Health

Abstract

Introduction: Public health professionals engage in complex cognitive tasks, often using evidence-based decision support tools to bolster their decision making. Human factors methods take a user-centered approach to improve the design of systems, processes, and interfaces to better support planning and decision making. While human factors methods have been applied to the design of clinical health tools, these methods are limited in the design of tools for population health. The objective of this scoping review is to develop a comprehensive understanding of how human factors techniques have been applied in the design of population health decision support tools. **Methods and analysis:** The scoping review will follow the methodology and framework proposed by Arksey and O'Malley. We include English language documents between January 1990—August 2021 describing the development, validation, or application of human factors principles to decision support tools in population health. The search will include Ovid MEDLINE: Epub Ahead of Print, In-Process and Other Non-Indexed Citations, Ovid MEDLINE Daily, and Ovid MEDLINE 1946-present; EMBASE, Scopus, PsycINFO, Compendex, IEEE Xplore, and Inspec. The results will be integrated into Covidence. First, the abstract of all identified articles will be screened independently by two reviewers with disagreements being resolved by a third reviewer. Next, the full text for articles identified as *include* or *inconclusive* will be reviewed by two independent reviewers, leading to a final decision regarding inclusion. Reference lists of included articles will be manually screened to identify additional studies. Data will be extracted by one reviewer, verified by a second, and presented according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) extension for scoping reviews. **Ethics and dissemination:** Ethics is not required for this work as human participants are not involved. The completed review will be published in a peer-reviewed, interdisciplinary journal.

Funding: This study was funded by a University of Toronto X-Seed grant.

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Strengths and Limitations of this Study

- Our methodology was devised in consultation involving several multidisciplinary experts who advised on the rigor and feasibility of this review.
- A librarian specializing in health science developed the search strategies for the health science databases and a librarian specializing in engineering consulted on the development of search strategies for the engineering databases.
- Our review is limited to articles written in English and as such, presents a bias to Western research applications.
- This scoping review does not include book chapters, theses, short papers, editorials, systematic reviews, and conference abstracts, which may limit our findings.

Background

Human Factors Engineering (also referred to as Ergonomics, Cognitive Ergonomics, Engineering Psychology, or Cognitive Engineering), an interdisciplinary field at the intersection of psychology and engineering, seeks to improve the design of systems by providing the best match between the characteristics of users (e.g., physical, cognitive, and perceptual abilities) and the operation of the tools they use [1]. The discipline of human factors is generally considered to have originated during World War II within aviation during which more sophisticated systems were being developed, and pilot error in using such systems led to an increased interest in human capability [2]. Of particular concern was how the design of controls and displays within the cockpit could better match the pilots physical, cognitive, and perceptual abilities. Since the involvement of human factors engineers in the design of these systems, aviation has become the safest mode of transportation. Beyond aviation, human factors engineering methods have been applied to the design of complex systems in other domains, including ground transportation [3], the military [4], nuclear process control [5], and health care [6, 7].

Human factors engineers use a systematic approach to ensure that a given system meets the needs of the human, rather than forcing the human to adapt to the system. Accordingly, this allows the human to perform to the best of his or her abilities, make the best decisions possible, reducing physical and mental workload, and providing personal satisfaction. In doing so, human factors engineers employ a user-centered design methodology or design thinking, which aims to: 1) understand the people and the system that they interact with, 2) create a solution that meets the needs of the user, and 3) evaluate how well the solution meets the needs of the user and achieves the human factors objectives. Interviews, shadowing of human operators, task analysis, work domain analysis, in addition to a variety of other methods are employed for the first stage, which lead to a set of design requirements. An iterative design and evaluation process is then followed, for example, by the creation of prototype designs and their evaluation in usability studies. In evaluating the system design, human factors engineers may measure user's decision-making errors, efficiency (e.g., task completion times), user stress or mental workload, as well as user satisfaction.

Humans make decisions every day in a variety of domains, from piloting an aircraft, to diagnosing a patient, or determining whether to close in-person classes to slow the spread of the COVID-19 pandemic. Generally, these decisions will depend on ones understanding of the situation by integrating multiple sources of information, determining what the information means, and selecting the best course of action while considering the risks associated with each alternative [1].

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While normative decision theory models describe what decisions people should make (i.e., the optimal decision), descriptive decision-making models account for how people *actually* make decisions. Real-life decision making is complex in ways that normative decision models cannot account for. Real-world settings can include dynamic, uncertain, and continually changing conditions, and can require real-time decisions in high-stakes situations with significant consequences for mistakes. Limitations in human cognition and perception can contribute to decision errors. Decision support systems have the potential to support the user making better decisions and reduce decision errors. For example, clinical decision support tools have the potential in improving patient safety by improving the clinician's diagnostic decisions [6, 7]. However, the success of decision support tools in clinical settings has been limited, in part due to human factors such as poor usability and workflow integration [8–11]. Indeed, if human factors perspectives are not considered in their design (e.g., how people make decisions, their expertise, their information needs), users may not leverage the tool.

While human factors methods have been applied to the design of decision support tools to aid clinicians in decision-making tasks in healthcare settings [6, 7], applications of human factors to support public health professionals in improving *population health* outcomes are limited. Population health can be defined as "the health outcomes of a group of individuals, including the distribution of such outcomes within the group," [12]. The important distinction from clinical applications is that population health applications employ broader determinants that work across populations, such as social, economic, biology, early childhood development, and health services [13]. Accordingly, population health has a broad scope and ranges from physical and mental health to environmental health within a population, all encompassed within the public health sector [12]. Public health professionals in provincial and local health departments engage in complex cognitive tasks to make the best possible decisions for resource allocation and public health planning. They do this based on their understanding of the current health status of their population, the factors that influence the health of the population, and assess which interventions will work to address the health issues within the population based on available data [12, 14, 15]. Evidenced-based decision support tools, which utilize objective data to support the expertise of a decision maker have been employed in many domains. Such tools have the potential to support public health professionals by answering complex questions, such as, what makes certain demographic groups within a population healthier than others [14] .

There has been a proliferation of evidenced-based decision support tools in population health, particularly since the onset of the COVID-19 pandemic. For example, Afzal and colleagues developed a visual analytics platform for public health professionals to forecast COVID-19 cases and explore the effects of various interventions (e.g., school closures, stay at home orders) on cases [16]. However few studies have employed human factors methods to the design of these tools and evaluated their efficacy in supporting public health decision making. For example, Afzal and colleagues focus on the development of the user interface but did not discuss how public health professionals' needs were determined and factored into the design of the tool [16]. Moreover, the proposed tool was not evaluated with public health professionals and as such, how users interpret the COVID-19 modeling scenarios, the quality of their decision-making, workload and satisfaction with the tool were not considered. Human factors methods would ensure that the tool met public health practitioner needs (e.g., information to understand modelling assumptions or uncertainty) and facilitated optimal decision making.

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Given that the focus is on populations and unique functions in public health, evidenced-based decision support tools for public health professionals will have distinct user needs and requirements compared to other domains [15, 17]. Human factors engineers can apply user-centered design methodology in creating these decision support tools and can leverage other human factors methods in evaluating their efficacy in supporting public health professionals. By doing so, human factors can improve the design of these tools to better support public health professionals in decision making efforts. For example, Pike and colleagues used an iterative user centered design process to develop a decision support tool for child and youth injury surveillance and prevention [18]. Injury prevention practitioners and policy makers were involved in an evaluation of the tool during which they were presented with a series of fictional planning problems to solve using the tool (e.g., determine the trends for suicide and homicide for 10–19-year-olds from 2007-2010). Following this exercise users were interviewed during which they were asked to provide feedback on the tool (e.g., the dashboard, indicators, and specific visualizations) as well as provide feedback pertaining to the ease of navigating the dashboard and overall satisfaction. Results from the evaluation underscored the utility of the dashboard in injury surveillance and prevention, and highlighted painpoints and opportunities to improve upon the dashboard's design.

De Lima and colleagues developed a decision support tool for aiding public health professionals in planning and decision-making processes in the context of infectious disease [19]. Public health professionals completed a focus group session during which they interacted with the tool to build and run models for dengue fever. After interacting with the tool, users were asked to complete a questionnaire providing additional feedback. Overall, the results suggested that public health professionals could effectively use the tool for building and running models and scenarios. However, the authors noted that this process could be improved by providing users with documentation for how the model was developed and a guide on how to use the tool. Importantly, this evaluation was used to iterate upon the design of the tool.

These examples exemplify how human factors methods can be employed in the design and evaluation of evidence-based decision support tools to ensure that they meet the needs of public health professionals. The objective of the present scoping review is to build upon this and provide a foundational understanding of the current landscape of human factors applications in the design of evidenced-based decision support tools within population health.

Research Question

We identified the research question following extensive discussions among the protocol authors to clarify the concept and the purpose of the review. **How are human factors considered in the design and development of evidenced-based decision support tools for population health applications?**

Methods

This study question adheres to the population, concept, and context framework used for scoping reviews [20], [21]. In this case, the population is general and not defined. We propose conducting a scoping review of how human factors methods have been applied to evidenced-based decision support tools in the context of population health. This scoping review will follow the

methodological framework described by Arksey and O'Malley [20] with refinements proposed to the framework by Levac, Colqhoun & O'Brien [21]. The reporting of this protocol and search have been informed by the PRISMA-P and PRISMA-S reporting guidelines respectively to facilitate understanding and transparency [22, 23].

Registration and Review Stage

The present research protocol will be registered with BMJ prior to beginning the study. The study is expected to commence in May 2021 with an anticipated completion date of March 2022.

Operationalizing Population Health, Human Factors and Decision Support Tools

One major challenge for this scoping review was operationalizing the concepts of population health, human factors, and decision support tools for the search strategy. As such, to aid in the codification of these concepts, our team includes a librarian specializing in health science. Additionally, we consulted with a librarian specializing in engineering.

Population Health was operationalized to encompasses all aspects of public health in the broadest sense and is not limited to any specific aspects, such as chronic or infectious disease. Search terms included "population health," "public health," "community health," "community medicine," "health promotion," "epidemiology," and "disease prevention."

Human Factors was operationalized to encompass all aspects of human factors in the broadest of senses and is not limited to a particular method or tool. Search terms included "human factors," "ergonomics," "cognitive ergonomics," "cognitive analytics," "usability," "human engineering," "human computer interaction," "human-centered design," "interface design," "user interface," "user evaluation," "usability evaluation," "user friendly," "user experience," and "human machine interface."

Decision support tool was operationalized to encompass any electronic system to aid decision making. Search terms included "decision support," "decision support systems," "decision support tool," "information systems," "data visualizations," "visual analytics," "informatics," "data display," and "dashboard."

Search Strategy

The search strategy includes indexed databases of peer-reviewed literature, and manual searches. We discuss each of these in turn:

Peer-reviewed Literature

The published literature search will include Ovid MEDLINE: Epub Ahead of Print, In-Process and Other Non-Indexed Citations, Ovid MEDLINE Daily, and Ovid MEDLINE 1946-present; EMBASE (on Ovid), Scopus, PsycINFO (Ovid), Compendex (Engineering Village), IEEE Xplore, and Inspec (Engineering Village). Comprehensive literature searches were developed in collaboration with two librarians: one who specialized in health science and another who specialized in engineering. The search strategies used a combination of keywords, and subject headings relevant to each database for each concept. The databases were selected based on subject area coverage and functionality. See the Supplementary File for our search strategy for each database.

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Results prior to 1990 were excluded in the search strategy. We do not expect articles related to human factors to the design of digital evidenced-based decision support tools in population health as human factors applications in healthcare began to emerge in the 1990's. By including articles from 1990 we are capturing the potential evolution of the application of human factors in the public health domain. This research study only included primary studies, limited to the English language. A modified version of the systematic review filter developed by the Scottish Intercollegiate Guidelines Network was applied to exclude systematic reviews, scoping reviews, meta-analyses as well as editorials, guidelines, letters, and patient education handouts. The MEDLINE search strategy was validated against a key set of 8 articles [15, 18, 19, 24–28] pre-determined by the authors and was peer reviewed using PRESS [29]by another librarian, not associated with this study to ensure accuracy and comprehensiveness.

Grey Literature

Our grey literature search strategy is guided by our research question. While government or organization websites may contain dashboards and interfaces used by public health professionals to inform their population assessment and planning, information about the development and assessment of public health professional interactions with the interfaces or dashboards will not be available. In other words, the information will be about tools, but not the development or evaluation, which is needed for the human factors aspect of this review. As such, our grey literature search will be focused on capturing full-text conference proceedings papers identified through Compendex (Engineering Village), IEEE Xplore, and Inspec (Engineering Village) to counter the positive reporting bias of the published article literature, ensuring the review is thorough and balanced.

Manual Searches

Reviews of human factors and population health discovered in the formal peer-reviewed literature search will be identified and their references will be manually searched to identify additional articles for inclusion. Reference lists of included articles will also be manually screened to identify additional studies.

Integration of Results

The results from the two search types will be integrated into Covidence, a systematic review management software, and duplicates will subsequently be removed. Screening for article inclusion will be completed using Covidence and will consist of two phases. First, the title and abstract of all identified articles will be screened independently by two reviewers on the research team and will be categorized as "include," "exclude," or "inconclusive," [21]. Such judgments will be informed by the inclusion and exclusion criteria (see Table 1) and will be documented using a piloted standardized relevance form. Disagreements will be resolved through team discussion and may include a third, independent, reviewer if necessary. Articles identified in the title and abstract screening with will undergo full text screening by two independent reviewers, which will lead to a final decision regarding inclusion.

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Inclusion and Exclusion Criteria

We sought to limit the scope of our challenge by developing *a priori* eligibility criteria for the literature, detailing the types of literature to be included. The inclusion and exclusion criteria are presented in Table 1.

All documents created since 1990 in English that describe the development, validation, or application guided by human factors principles to any study design in the field of population health will be included. Examples of studies not related to population health include clinical applications, such as studies that discuss patient safety, monitoring of an individual's health or clinical decision support tools. Documents that have described the application of human factors in terms of the population of study and sample size, method, analysis, prototype and iteration process, end-user and intended setting will be included. Example studies not related to human factors may include studies that describe a tool as user-friendly but do not discuss the engagement of users in the design process or evaluate the tool with users (e.g., in determining design requirements through interviews or focus group or in evaluating the tool with users).

Table 1. Exclusion Criteria for Literature Search

Exclusion Criteria
1. Articles whose end user is not within population health
2. Articles not related to human factors
3. Articles that do not include a digital evidence-based decision support tool
4. Conference abstracts, as these may not include sufficient details on the methodology
5. Reviews, including commentaries and discussion pieces
6. Articles written in languages other than English

Data Abstraction and Synthesis

A data abstraction form will be developed and pilot-tested using two researchers, working independently of each other. The data form will be tested on five to seven articles for consistency and comprehensiveness for capturing relevant study data. Changes will be made in a team meeting during which the team will compare pilot test results and discuss discrepancies. Following the article screening, data will be extracted from each article included in the review by one reviewer using the data extraction form and will be verified by a second reviewer. The data will be abstracted and synthesized according to three themes: study characteristics, study methods, and human factors characteristics (see Table 2).

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Table 2. Data Abstraction Themes and Items

Study Characteristics
1. Authors
2. Academic dicipline of authors
3. Year of publication
4. Type of publication (e.g., peer-reviewed article, conference proceeding, dissertation, other)
5. Publication venue (e.g., journal or conference name)
Study Methods
1. Study location (e.g., country)
2. Study design (e.g., cross-sectional, cohort, case control, qualitative, other
3. Description of the evidenced-based decision support tool
4. Population health subject area (e.g., infectious disease, non-communicable disease)
5. Description of the subject area
6. Study goal (e.g., development, validation, application, other)
Human Factors Characteristics
1. Study sample size
2. Human factors study method (e.g., semi-structured interviews, focus groups, delphi process, survey, experiments, shadowing)
3. Human factors analysis method (e.g., descriptive, inferential, thematic)
4. Prototyping/iteration (i.e., did the study involve prototype or iterative design, yes or no)
5. Decision-maker (i.e., who is the tool being designed for)
6. Setting (e.g., hospitals, federal public health, regional public health, local public health, community health center, other)

Results will be synthesized, and summarized study characteristics will be presented using tables and figures. We will discuss key lessons learned from the use of human factors in the design of decision support tools for public health. Additionally, the scoping review will discuss implications and future research directions for human factors applications in population health.

Patient and Public Involvement

This is a scoping review protocol and as such it was not appropriate or possible to involve patients or the public in the design, conduct, reporting, or dissemination plans of our research.

Ethics approval is not required for this knowledge synthesis, as we are not involving human participants. The completed scoping review will be submitted for publication to a peer-reviewed, interdisciplinary journal in addition to conferences on population health and human factors.

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Required Statements

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Authors Contributions

LR and BD conceived the study. HV, EP, LD, RS, LR and BD jointly developed the research questions and HV drafted the paper. HC provided input on the search strategy and operationalization of study concepts. All authors revised further revised the paper and approved of the final text.

Competing Interests

None declared.

Funding Statement

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Data Sharing

There is no data set available for the study protocol.

Ethics Approval

This is a scoping review protocol and as such this study does not involve human participants or animal subjects. There is no research ethics approval for this study.

Acknowledgements

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OVID MEDLINE

Database: Ovid MEDLINE: Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE® Daily and Ovid MEDLINE® <1946-Present>

Search Strategy:

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1 Ergonomics/ (11682)

2 exp Data Display/ (44959)

3 Man-Machine Systems/ (2819)

4 human engineering/ (11682)

5 exp user-computer interface/ (37928)

6 Universal Design/ (18)

7 Interviews as Topic/ (64486)

8 Focus Groups/ (31437)

9 (think adj aloud?).ti,ab,kf. (1092)

10 concurrent verbal protocol?.ti,ab,kf. (17)

11 ergonomic*.ti,ab,kf. (10831)

12 universal design*.ti,ab,kf. (455)

13 human performance model*.ti,ab,kf. (35)

14 cognitive task* analy*.ti,ab,kf. (196)

15 (human* adj2 (factor* or engineering)).ti,ab,kf. (22796)

16 (human* adj center* adj2 (design? or interface? or experience?)).ti,ab,kf. (272)

17 (human* adj centre* adj2 (design? or interface? or experience?)).ti,ab,kf. (68)

18 (user* adj center* adj2 (design? or interface? or experience?)).ti,ab,kf. (871)

19 (user* adj centr* adj2 (design? or interface? or experience?)).ti,ab,kf. (269)

20 ((user* or interface*) adj3 (friendly or intuit* or appeal* or informat* or understand* or need*)).ti,ab,kf. (24645)

21 ((user* or usability or stakeholder* or personnel or leader*) adj4 (eval* or experience* or involve* or test* or interview* or consult* or needs or feedback or meeting* or analy*)).ti,ab,kf. (51123)

22 ((tool* or dashboard* or interface* or prototype* or pilot*) adj4 (eval* or test* or need* or consult* or involve* or feedback* or model*)).ti,ab,kf. (98473)

23 ((cognitive or organizational or visual) adj2 ergonomic*).ti,ab,kf. (196)

24 (time adj series adj2 analy*).ti,ab,kf. (8829)

25 or/1-24 [Human Factors concept] (368120)

26 1 or 2 or 3 or 4 or 5 or 6 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 [Human Factors Concept without Interviews or Focus Groups] (282541)

27 Medical Informatics/ (12204)

28 Health Information Exchange/ (934)
29 exp Medical Informatics Applications/ (445167)
30 Health Information Interoperability/ (188)
31 Information Systems/ (19000)
32 Health Information Systems/ (1372)
33 Geographic Information Systems/ (8322)
34 Integrated Advanced Information Management Systems/ (289)
35 exp Medical Informatics Computing/ (1438)
36 Big Data/ (1322)
37 Community Networks/ (7026)
38 exp Decision Support Techniques/ (78829)
39 Dental Informatics/ (167)
40 Nursing Informatics/ (1534)
41 Public Health Informatics/ (1177)
42 Informatics/ (1029)
43 Consumer Health Informatics/ (118)
44 exp Data Display/ (44959)
45 data visualization/ (240)
46 exp Decision Theory/ (12359)
47 Decision Making/ (97733)
48 Decision Making, Organizational/ (11173)
49 (decision adj2 (tool or tools or support* or aid or aids or model* or analy* or mak* or theor* or system* or process* or activit* or software*)).ti,ab,kf. (198139)
50 ((information or data or visual* or audit or feedback) adj2 (display* or interface* or support* or system* or tool? or analy*)).ti,ab,kf. (524578)
51 (((real adj2 time) or audit) adj3 feedback).ti,ab,kf. (3903)
52 (indicator* or visualization* or visualisation*).ti,ab,kf. (394132)
53 informatics.ti,ab,kf. (15643)
54 dashboard?.ti,ab,kf. (1514)
55 (predicti* adj2 model*).ti,ab,kf. (69684)
56 knowledge translation.ti,ab,kf. (3407)
57 or/27-56 [Decision Support Tool concept] (1623417)
58 Global Health/ (49512)
59 exp Population Health/ (39375)
60 Public Health/ (84274)
61 exp Public Health Practice/ (720228)
62 exp Disease Outbreaks/ (144607)

63 exp Disease Transmission, Infectious/ (72994)
64 Community Health Planning/ (5162)
65 Health Status Indicators/ (23701)
66 Chronic Disease Indicators/ (18)
67 Global Burden of Disease/ (868)
68 Preventive Health Services/ (13819)
69 exp Epidemiology/ (27240)
70 "Quality of Health Care"/ (74260)
71 Quality Indicators, Health Care/ (16164)
72 Outcome Assessment, Health Care/ (75233)
73 "Outcome and Process Assessment, Health Care"/ (27745)
74 Process Assessment, Health Care/ (4831)
75 ((population or community or public) adj2 (health or medicine or surveillance or outbreak* or transmission*)).ti,ab,kf. (351133)
76 (health adj2 (department? or agency or agencies)).ti,ab,kf. (33527)
77 or/58-76 [Population Health Concept] (1517418)
78 25 and 57 and 77 [Combining all three concepts] (11801)
79 26 and 57 and 77 [Combining all three concepts minus Interviews and Focus Groups] (8039)
80 limit 78 to yr="1990 -Current" (11668)
81 limit 79 to yr="1990 -Current" [Minus Interviews and Focus Groups] (7919)
82 (Animals/ or Models, Animals/ or Disease Models, Animal/) not Humans/ (4763193)
83 ((animal or animals or veterinary* or dog or dogs or feline) not human*).ti,ab,kf. (1030290)
84 82 or 83 (5038448)
85 80 not 84 [exclude animal studies] (11443)
86 79 not 84 [exclude animal studies and minus Interviews and Focus Groups] (7828)
87 exp Meta-Analysis as Topic/ (21211)
88 Meta-Analysis/ (127629)
89 Review Literature as Topic/ (7892)
90 Systematic Review/ (147108)
91 Systematic Reviews as Topic/ (4829)
92 (meta analy$ or metaanaly$ or systematic review$ or systematic overview$ or scoping review$ or umbrella review$).ti,ab,kf. (312668)
93 (cochrane or embase or psychlit or psyclit or psychinfo of psycinfo or cinahl or cinhal or science citation index or scopus or web of science or bids or cancerlit or ageline).ab. (167161)
94 (reference list$ or bibliograph$ or hand-search$ or relevant journal$ or manual search$).ab. (46199)

95 (review or editorial or guideline or letter or meta analysis or news* or patient education handout).pt. (4736370)

96 or/87-95 [Modified SIGN filter to retrieve systematic reviews; modified to expand to other reviews as well as non-journal articles] (4858052)

97 85 and 96 [set of reviews and non-primary literature for team to review for background information] (1184)

98 86 and 96 [set of reviews and non-primary literature for team to review for background information minus Interviews and Focus Groups] (1094)

99 85 not 96 [Remove secondary studies and non-empirical studies] (10259)

100 86 not 96 [Remove secondary studies and non-empirical studies minus Interviews and Focus Groups] (6734)

101 99 not 100 [Team to look through articles not included by not including Interviews and Focus Groups - to see if there are important or studies here that should be found/retrieved] (3637)

OVID EMBASE

Database: Embase Classic+Embase <1947 to 2021 March 09>

Search Strategy:

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1 ergonomics/ (12263)

2 human machine interface/ (164)

3 man machine interaction/ (3583)

4 human computer interaction/ (6331)

5 universal design/ (174)

6 time series analysis/ (28615)

7 (think adj aloud?).ti,ab,kw. (1326)

8 concurrent verbal protocol?.ti,ab,kw. (21)

9 ergonomic*.ti,ab,kw. (16403)

10 universal design*.ti,ab,kw. (552)

11 human performance model*.ti,ab,kw. (49)

12 cognitive task* analy*.ti,ab,kw. (269)

13 (human* adj2 (factor* or engineering)).ti,ab,kw. (28921)

14 (human* adj center* adj2 (design? or interface? or experience?)).ti,ab,kw. (333)

15 (human* adj centre* adj2 (design? or interface? or experience?)).ti,ab,kw. (100)

16 (user* adj center* adj2 (design? or interface? or experience?)).ti,ab,kw. (889)

17 (user* adj centr* adj2 (design? or interface? or experience?)).ti,ab,kw. (365)

18 ((user* or interface*) adj3 (friendly or intuit* or appeal* or informat* or understand* or need*)).ti,ab,kw. (30736)

19 ((user* or usability or stakeholder* or personnel or leader*) adj4 (eval* or experience* or involve* or test* or interview* or consult* or needs or feedback or meeting* or analy*)).ti,ab,kw. (68410)

20 ((tool* or dashboard* or interface* or prototype* or pilot*) adj4 (eval* or test* or need* or consult* or involve* or feedback* or model*)).ti,ab,kw. (137959)

21 ((cognitive or organizational or visual) adj2 ergonomic*).ti,ab,kw. (275)

22 (time adj series adj2 analy*).ti,ab,kw. (10697)

23 or/1-22 [Human Factors Concept] (315579)

24 decision making/ (245242)

25 decision support system/ (23523)

26 decision theory/ (1803)

27 "decision tree"/ (14435)

28 multicriteria decision analysis/ (378)

29 computer interface/ (32621)

30 data visualization/ (992)
31 visual display unit/ (1285)
32 expert system/ (5487)
33 information system/ (39837)
34 medical informatics/ (21188)
35 medical information system/ (21564)
36 feedback system/ (87793)
37 (decision adj2 (tool or tools or support* or aid or aids or model* or analy* or mak* or theor* or system* or process* or activit* or software*)).ti,ab,kw. (274740)
38 ((information or data or visual* or audit or feedback) adj2 (display* or interface* or support* or system* or tool? or analy*)).ti,ab,kw. (758501)
39 (((real adj2 time) or audit) adj3 feedback).ti,ab,kw. (5687)
40 (indicator* or visualization* or visualisation*).ti,ab,kw. (530927)
41 informatics.ti,ab,kw. (20484)
42 dashboard?.ti,ab,kw. (2860)
43 (predicti* adj2 model*).ti,ab,kw. (94976)
44 knowledge translation.ti,ab,kw. (4632)
45 or/24-44 [Decision Support Concept] (1909062)
46 global health/ (12046)
47 population health/ (3460)
48 population health management/ (192)
49 public health/ (203195)
50 public health service/ (76473)
51 public health systems research/ (93)
52 public health problem/ (16002)
53 global disease burden/ (3341)
54 health care planning/ (104835)
55 exp health promotion/ (103435)
56 epidemiology/ (235679)
57 exp disease surveillance/ (31920)
58 exp mass screening/ (261124)
59 preventive medicine/ (28808)
60 preventive health service/ (29836)
61 ((population or community or public or global or provincial* or national* or international* or region*) adj2 (health or medicine or surveillance or outbreak* or transmission*)).ti,ab,kw. (548142)
62 (health adj2 (department? or agency or agencies)).ti,ab,kw. (42312)

63 or/46-62 [Population Health Concept] (1380107)

64 23 and 45 and 63 [Combine all three concepts] (7385)

65 limit 64 to english language (7175)

66 limit 65 to yr="1990 -Current" (7079)

67 limit 66 to (article in press or books or chapter or conference abstract or conference paper or "conference review" or editorial or erratum or letter or note or "review" or short survey or tombstone) (2414)

68 66 not 67 (4665)

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APA PsycINFO

Database: APA PsycInfo <1806 to March Week 1 2021>

Search Strategy:

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1 human factors engineering/ (8871)

2 engineering psychology/ (982)

3 computer assisted design/ (545)

4 human computer interaction/ (11076)

5 human computer interaction measures/ (4)

6 human factors measures/ (46)

7 exp human machine systems/ (7810)

8 human technology interaction/ (170)

9 human computer interaction/ (11076)

10 human computer interaction measures/ (4)

11 (think adj aloud?).tw. (1991)

12 concurrent verbal protocol?.tw. (55)

13 ergonomic*.tw. (4413)

14 universal design*.tw. (593)

15 human performance model*.tw. (79)

16 cognitive task* analy*.tw. (305)

17 (human adj2 (factor* or engineer*)).tw. (6140)

18 (human* adj center* adj2 (design? or display* or interface? or experience?)).tw. (167)

19 (human* adj centre* adj2 (design? or display* or interface? or experience?)).tw. (55)

20 (user* adj center* adj2 (design? or display* or interface? or experience?)).tw. (442)

21 (user* adj centr* adj2 (design? or display* or interface? or experience?)).tw. (181)

22 ((user* or interface*) adj3 (friendly or intuit* or appeal* or informat* or understand* or need*)).tw. (8880)

23 ((user* or usability or stakeholder* or personnel or leader*) adj4 (eval* or experience* or involve* or test* or interview* or consult* or needs or feedback or meeting* or analy*)).tw. (38987)

24 ((tool* or dashboard* or interface* or prototype* or pilot*) adj4 (eval* or test* or need* or consult* or involve* or feedback* or model*)).tw. (25898)

25 ((cognitive or organizational or visual) adj2 ergonomic*).tw. (225)

26 (time adj series adj2 analy*).tw. (2613)

27 or/1-26 [Human Factors Concept] (100216)

28 exp decision making/ (124921)

29 decision support systems/ (3388)

30 exp displays/ (11387)

31 exp decision theory/ (1390)
32 information systems/ (5553)
33 (decision adj2 (tool or tools or support* or aid or aids or model* or analy* or mak* or theor* or system* or process* or activit* or software*)).tw. (120042)
34 ((information or data or visual* or audit or feedback) adj2 (display* or interface* or support* or system* or tool? or analy*)).tw. (171919)
35 (((real adj2 time) or audit) adj3 feedback).tw. (662)
36 (indicator* or visualization* or visualisation*).tw. (78016)
37 informatic*.tw. (1691)
38 dashboard*.tw. (321)
39 (predicti* adj2 model*).tw. (11571)
40 knowledge translation.tw. (935)
41 or/28-40 [Decision Support Concept] (430017)
42 exp population health/ (692)
43 exp public health/ (33986)
44 health promotion/ (25551)
45 global health/ (2471)
46 exp preventive health services/ (3433)
47 epidemiology/ (51345)
48 ((population or community or public) adj2 (health or medicine or surveillance or outbreak* or transmission*)).tw. (78437)
49 (health adj2 (department? or agency or agencies)).tw. (7870)
50 (outbreak* or epidemic* or pandemic* or chronic disease*).tw. (32171)
51 or/42-50 [Population Health Concept] (184237)
52 27 and 41 and 51 (977)
53 limit 52 to yr="1990 -Current" (968)
54 (dissertation abstract or edited book).pt. (866399)
55 53 not 54 (737)

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Scopus

(TITLE-ABS-KEY ("global health" OR (community OR public OR population* OR prevent*) W/2 (health OR medicine OR surveillance OR outbreak* OR transmission*) OR "health W/2 (department* OR agency OR agencies OR organisation* OR organization* OR provinc* OR federal* OR government*)" OR pandemic* OR epidemic* OR epidemiolog* OR "health promot*" OR "accident* w/2 prevent*" OR "disease* w/2 outbreak*" OR "disease* w/2 transm*" OR "mass screening*")) AND (TITLE-ABS-KEY (ergonomic* OR "human factor*" OR "human w/2 (factor* or engineer*)" OR "human w/3 (design* or interface* or display* or data)" OR "user* w/3 (design* or interface* or display* or data)" OR "concurrent verbal protocol*" OR "universal design" OR "human performance model*" OR "cogniti* task* analy*" OR "think w/1 aloud*" OR "(user* or interface*) adj3 (friendly or intuit* or appeal* or informat* or understand* or need* or design* or eval*)" OR "(tool* or dashboard* or interface* or prototype* or pilot* or display*) w/4 (eval* or test* or need* or consult* or involv* or feedback* or model*)" OR "time series analy*" OR "(user* or usability or stakeholder* or personnel or leader*) w/4 (eval* or experience* or involv* or test* or interview* or consult* or needs or feedback or meeting* or analy*)" OR "visual analy*" OR prototype* OR usability)) AND (TITLE-ABS-KEY (decision* OR dashboard* OR display* OR informatic* OR "data visual*" OR interface* OR "information system*" OR "predict* model*" OR "knowledge translation" OR "audit w/3 feedback" OR "(information or data or visual* or audit or feedback*) w/4 (display* or interface* or support* or system* or tool? or analy*)" OR model* OR simulation* OR visualization* OR visualisation* OR "real W/3 feedback*")

COMPENDEX

(((($Decision $Support $Systems OR $Decision $Making OR $Information $Systems OR $Visualization OR $Graphical $User $Interfaces OR $User $Interfaces OR $Interactive $Computer $Systems) WN CV)) OR (($Dashboard OR $Platform OR $Interface OR $Display) WN KY)) AND (1666-2022 WN YR)) AND (((($Public $Health) WN CV)) OR (($Population $Health OR $Community $Health OR $Community $Medicine) WN KY)) AND (1666-2022 WN YR)) AND (((($Human $Engineering OR $Ergonomics OR $User $Experience OR $Human $Computer $Interaction OR $Usability $Engineering) WN CV)) OR (($Human Factor* OR $Usability OR $User Friendl* OR $Cognitive Ergonomic*) WN KY)) AND (1666-2022 WN YR))

INSPEC

(((($Public $Health) WN CV)) OR (($Population $Health OR $Community $Health OR $Community $Medicine) WN KY)) AND (1896-2022 WN YR)) AND (((($Decision $Making OR $Decision $Support $Systems OR $User $Interfaces OR $Graphic $User $Interfaces OR $Interactive $Systems OR $Data $Visualization) WN CV)) OR (($Dashboard OR $Interface OR $Display OR $Decision $Support System*) WN KY)) AND (1896-2022 WN YR)) AND (((($Human $Factors OR $Ergonomics OR $Human $Computer $Interaction) WN CV)) OR (($Usability OR $User $Experience OR $User $Evaluation OR $Cognitive $Ergonomics) WN KY)) AND (1896-2022 WN YR))

IEEE Xplore

"All Metadata":Human Factors OR "All Metadata":Ergonomics OR "All Metadata":Cognitive Ergonomics OR "All Metadata":Human Computer Interaction OR "All Metadata":User Experience OR "All Metadata":Usability OR "All Metadata":User Friendly) AND ("All Metadata":Dashboard OR "All Metadata":Interface OR "All Metadata":Data Visualization OR "All Metadata":Decision Support) AND ("All Metadata":Public Health OR "All Metadata":Population Health OR "All Metadata":Community Health)

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.	Pg 1
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.	Pg 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.	Pg 3 - 5
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.	Pg 5
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.	N/A. The manuscript details the protocol.
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.	Pg 7 - 8
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.	Pg. 6 - 7
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Included as supplementary material
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	Pg 7
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.	Pg 8 - 9
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	Pg 9
Critical appraisal of individual	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe	N/A

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
sources of evidence§		the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	Pg 9
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.	N/A
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	N/A
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	N/A
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.	N/A
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	N/A
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.	N/A
Limitations	20	Discuss the limitations of the scoping review process.	N/A
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.	N/A
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.	Pg 12

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 (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.