Ergonomics and usability in Assistive Technology design: A scoping review protocol

REVIEW ARTICLE

Ergonomia e usabilidade no projeto de Tecnologia Assistiva: Protocolo de revisão de escopo

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ABSTRACT: Assistive technology (AT) is essential for promoting independence, autonomy, and quality of life, especially for older adults and individuals with chronic illnesses or disabilities. However, the successful use of these devices depends on their ability to address the personal and contextual dimensions of those who rely on them. Although studies on AT development, effectiveness, and usability exist, there remains a gap in the literature regarding the synthesis of information linking these factors to the design of such products. **Objective:** To explain the procedures and criteria that will guide the literature mapping and subsequent analyses involving the application of ergonomics and usability principles to AT design. **Method:** This protocol describes a scoping review outlined with the JBI and PRISMA-ScR model guidelines, focusing on the exploration of evidence to ensure the rigor and replicability of the study. The review question was constructed using the acronym Population, Concept and Context. Original studies published in peer-reviewed journals that address the relationship between AT ergonomics and/or usability will be included, with no date or language restrictions.

KEYWORDS: Self-Help Devices, Ergonomics, Usability, Design.

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RESUMO: A Tecnologia Assistiva (TA) é essencial para promover independência, autonomia e qualidade de vida, especialmente para pessoas idosas, com doenças crônicas ou deficiência. No entanto, o sucesso no uso desses dispositivos depende de sua capacidade de atender às dimensões pessoais e contextuais de quem os utiliza. Embora existam estudos sobre desenvolvimento, eficácia e usabilidade de TA, ainda há uma lacuna na literatura sobre a síntese de informações que relacionem esses fatores ao design desses produtos. Objetivos: Explicitar os procedimentos e os critérios que orientarão o mapeamento da literatura e as análises subsequentes envolvendo a aplicação dos princípios da ergonomia e usabilidade no design de tecnologia assistiva. Procedimentos Metodológicos: Este protocolo descreve uma revisão de escopo delineada com as diretrizes do modelo JBI e PRISMA-ScR, focando na exploração das evidências e visando garantir o rigor e a replicabilidade do estudo. A pergunta de revisão foi construída usando o acrônimo População, Conceito e contexto. Serão incluídos estudos originais publicados em jornais revisados por pares que abordam a relação entre TA Ergonomia e/ou Usabilidade, sem restrição de data e idiomas.

PALAVRAS-CHAVE: Tecnologia Assistiva, Ergonomia, Usabilidade, Design.

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INTRODUCTION

Assistive Technology (AT) refers to resources, products, services, strategies, practices, processes, and methods that allow individuals with an impairment to live a healthy, productive, independent, and dignified life[1,2]. World Health Organization (WHO) estimates that AT is necessary in the social and household daily lives of more than 2.5 billion people who depend on these devices to perform their activities, mostly older adults, individuals chronic diseases and people with disabilities (PWD)[3].

But despite the high demand, access to these products and services is still limited due to lack of knowledge about AT among potential users, financial constraints for product acquisition, and the lack of availability or suitability of existing products[3]. Additionally, the literature points out a significant percentage of device abandonment among those who do have access to AT, with about 30% of devices being discontinued by users during the first year of use[4].

AT abandonment is often associated with usability difficulties, lack of support and training during the dispensing process, frustration with AT appearance and functioning, inadequacy of the product to assist in performing the activities for which it was designed, management complexity, among others[4-6]. Studies that have investigated this issue suggest that reducing AT abandonment rates depends on improving the design, production, and dispensing processes of devices to increase their usability[4].

Understanding that design processes[(1)] and AT dispensing are intrinsically complex and multifaceted, this article focuses on the design phase. In this regard, the literature points out that AT design has been characterized by a technocentric approach based on generic heuristics, one that largely neglects the real demands of end users[4,7]. Such an approach can result in products that do not adequately meet the needs of those who need AT, thus contributing to high discontinuity rates[8].

From this perspective, some studies associate AT abandonment with low usability, defined as the way a product can be used by specific users to achieve certain objectives with efficiency, effectiveness, and satisfaction in a specific context[9-11]. Variables frequently associated with low AT usability include lack of user participation in device choice, ineffective performance, changes in user needs, complicated devices, lack of knowledge about AT, lack of training, and inadequacy of the devices to users' needs[12].

Most of these factors can be addressed already in the design phase. Authors who discuss product design with a focus on expanding usability highlight the importance of considering a wide range of information, from functional issues to aesthetic factors. Specifically regarding AT design, both the personal dimensions—health status, body functions and structures, user desires and expectations—and contextual aspects, including socioeconomic and cultural factors, should be addressed[4,13,14].

Considering that Ergonomics and Usability are interrelated and complementary areas, both focusing on the interaction between people and systems, several authors note that applying Ergonomics principles from the early stages of AT design can significantly increase the probability that devices will meet the specific needs of end users[14-17.] This is because, while Ergonomics seeks to adapt products, systems, and environments to users' physical, cognitive, and emotional characteristics, its application in conjunction with usability principles reinforces the development of more intuitive, comfortable, and safe devices.

Notably, despite studies on AT abandonment and usability, no comprehensive reviews have investigated, in an integrated manner, the application of Ergonomics and Usability in the design of these technologies. The available research often addresses isolated aspects, e.g. the effectiveness of certain products, or the use of devices in specific groups, like older adults or individuals with particular health conditions[16-25].

Given this scenario of high AT abandonment rate and design flaws identified in these products, the need to map how the literature has been addressing the application of Ergonomics and Usability knowledge in AT design is paramount.

To fill this gap, we outlined a scoping review was outlined to map and synthesize the application of Ergonomics and Usability principles in AT design. This type of review allows us to gather data that clarify the main concepts and definitions present in the literature, and to examine how these concepts are treated in studies[26]. With this, we intend to build a more comprehensive view on this topic and thus provide subsidies to guide the design of these products.

(1) Here, the words 'project' and 'design' will be used as synonyms, considering that both refer to the process of conceptualizing, planning and developing products, systems or services, according to the context in which they are applied. This choice seeks to simplify reading, respecting the interchangeable use of terms in various areas of knowledge.

Thus, on this article we present the protocol of said review, explaining the procedures and criteria that will guide the literature mapping and subsequent analyses.

METHODOLOGY

This article describes the protocol of a scoping review that will be conducting following Tricco et al.[27]. According to these authors, a scoping review is conducted to explore the breadth or extent of a topic in the literature, map and summarize the existing evidence on a subject and/or inform future research. This type of review is useful both in studies with little evidence on the subject, where one can identify information gaps, and in studies with an abundant amount of evidence, where one can map and synthesize the available data to clarify the concepts and definitions being investigated, as well as to examine how a particular topic has been approached in the literature. Hence, the scoping review is the one that best meets our objectives.

Research design used the Joanna Briggs Institute (JBI) guidelines and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) to ensure the rigor and replicability of the study[26,27]. This protocol was registered with OSF under the DOI https://doi.org/10.17605/OSF.IO/R9Z4J

FORMULATION OF THE REVIEW QUESTION

Our review question was formulated using the Population, Concept and Context acronym. Employing this method resulted in the question "How does the literature address ergonomic and usability aspects in assistive technology? design" to guide this review.

The following secondary research questions were selected for the review:

- Which AT devices are referenced in the studies?
- What are the study's target populations in terms of type of disability?
- Which and how are other social determinants (gender, race, social class, etc.) addressed in the studies?
- In which countries (high-income or low-income) did the studies take place?
- What activities (work, leisure, activities of daily living, self-care, etc.) practiced by the target population are addressed in the studies?

ELIGIBILITY CRITERIA

The study's eligibility criteria will be defined based on the acronym proposed by JBI[26]—"Population, Concept and context." We developed the following descriptions to guide the inclusion of studies in data collection.

Population:

People who use Assistive Technology regardless of age, gender, or health condition

Concept:

Ergonomics – Study that focuses on adaptations of the environment, tools, and systems to human capabilities.

Usability – Study that evaluates how a product can be used to achieve users' specific objectives effectively, efficiently, and satisfactorily.

Context:

No context constraints will be applied. AT use will therefore be addressed in different contexts, including school, home, work, hospital.

Thus, the eligibility criteria for the studies that will be included in this review are: Original studies published in peer-reviewed journals that address the relation between Assistive Technology, Ergonomics and/or Usability, without restriction of date and languages, available in full or subject to retrieval via the Federated Academic Community (CAFe).

Studies that will be excluded are: Duplicate records; Letters to the editor; Experimental preclinical studies; Case series and reports of experiences or studies that do not explicitly discuss the relation between Ergonomics, Usability and AT.

INFORMATION SOURCES AND SEARCH STRATEGY

Bibliographic search on electronic databases like PubMed, Web of Science, and Scopus was conducted to find studies relevant to this scoping review. These databases were chosen for their comprehensiveness and coverage. PubMed is an important source of health information and international coverage. Web Of Science and Scopus were included as two interdisciplinary bases that cover not only North America and Europe, but also part of Asia.

Between February and April 2024, weekly meetings were held with a librarian to structure the research strategy for

the study. These meetings were crucial for the choice of terms, based on the Health Sciences Descriptors (DeCS) and the Medical Subject Headings (MeSH), and were also essential for developing the keywords used in the tests (Table 1).

Table 1 – Keywords developed for database search.

Search keyword	Database
((Self-Help Devices [Mesh] OR Devices Self-Help[Title/Abstract] OR Assistive Technolog*[Title/Abstract] OR Assistive product*[Title/Abstract] OR Assistive Device*[Title/Abstract])) AND ((Ergonomics[Mesh] OR Ergonomic*[Title/Abstract] OR Human Engineering[Title/Abstract] OR Human Factors Engineering[Title/Abstract] OR User Centered Design[Mesh] OR Design Centered User [Title/Abstract] OR Usability Test* [Title/Abstract] OR Man-Machine Systems[Mesh] OR Systems Man-Machine[Title/Abstract]))	PubMed
(ergonomic* OR "Human Engineering" OR "User Center Design" OR "Design Centered User" OR "Man Machine Systems") AND (assistive AND product* OR assistive AND device* OR assistive AND technolog* OR "Self-Help Devices")	Scopus
(ergonomic* OR "Human Engineering" OR "User Center Design" OR "Design Centered User" OR "Man Machine Systems") AND (assistive AND product* OR assistive AND device* OR assistive AND technolog* OR "Self-Help Devices")	Web Of Science

To select the key search terms, an initial search was carried out on Pubmed to identify articles on the subject and study their keywords, which were then entered into DeCS and MeSH, resulting in the MeSH terms and related free terms. To decide which ones would be included, initial searches were carried out in the databases using the MeSH terms and free terms to map the number of studies published in relation to them. Our search strategy, which includes all the keywords and indexing terms identified, was adapted for each database and/or source of information included in this study.

To ensure the most comprehensive retrieval of relevant studies for this review, a bottom-up search approach will be employed. This will include reviewing the references of the included articles to identify additional documents pertinent to this scoping review.

DATA MANAGEMENT AND ARTICLE SCREENING PROCESS

Data management will be conducted in two phases using Rayyan and, consecutively, Mendeley software. The first will help with the selection of titles and abstracts, while the second will help manage the texts that will be analyzed in full.

In the first stage, Rayyan will be used by the researchers for screening, removing duplicates and allowing the team to pre-select the articles blind according to the eligibility criteria. Two collaborators will independently screen the studies, identifying them through titles and abstracts, to identify potentially eligible studies according to the eligibility criteria. Subsequently, the studies included in the selection stage will be retrieved and read in full, and then assessed according to the eligibility criteria for definitive inclusion.

In case of disagreements between the evaluators, a third party will step in to resolve potential conflicts by consensus. Once the first phase has been completed, the studies will be exported to the reference manager called Mendeley, where the texts will be read in full and, if necessary, a new selection will be made to decide whether or not the study should be included.

DATA EXTRACTION PROCESS

Data extraction and management will be conducted by two authors. For data extraction, a table will be created in Microsoft Office Excel to identify and analyze the information in Table 2.

Table 2 – Data to be extracted from the studies

Data extracted	Details
Bibliometric information	Author/Publishing year
Study design	Type of study
AT devices referenced in the studies	Which AT devices were referenced in the studies
Contextual variables	Types of disability in the target population
Social determinants	Which and how factors (gender, race, social class, etc.) were addressed in the studies
Place of the study	Countries (high, medium or low income) and city (metropolis or countryside) of intervention.
Description of activities	Description of activities (work, leisure, activities of daily living, self-care, etc.) practiced by the target population and referenced in the studies

At this step, meetings will take place weekly between the researchers to ensure that the extraction is being performed correctly and to assess any possible issues that arise in the process. The extraction table can be updated, if necessary, according to the data content being collected.

EVIDENCE ANALYSES

After reading the full articles, two of the study authors will perform a thematic analysis based on Thomas and Harden[28]. The authors describe 3 steps for conducting the qualitative analysis:

First, while reading of the articles in full, code text excerpts according to their contents and meanings. One excerpt may be linked to more than one code. Coding will be performed using a qualitative analysis software which allows translating the different concepts present in the studies and how each of them is described in different works, creating a synthesis and evaluating the consistency of the information in the literature.

Second, develop thematic groups by analyzing similarities and differences between the previously established codes, and form macro groups in which the codes are organized in a tree structure and can also be placed freely, outside the main hierarchy.

Third and lastly, generate analytical themes in which the reviewers will be responsible for summarizing the data present in the articles to create a synthesis focused on the review theme, guided by the research question. Using the thematic groups, the barriers and facilitators initially identified will be reviewed, as well as the intervention proposals. This cyclical process will be repeated until all the data extracted from the thematic groups have been synthesized and aligned with the themes initially proposed in the review.

This organization will allow future new reflections on updates or on derived research. At the same time, bibliometric data will be tabulated.

FINAL CONSIDERATIONS

This protocol shows the transparency of existing data for the scoping review, which is intended to identify how the literature portrays the consideration of ergonomic aspects in AT design and how, consequently, these aspects influence the design of devices. With this we seek to contribute to expanding knowledge on the topic and to the discussion on how AT production is currently taking place.

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