Framing the Human-Centered Artificial Intelligence concepts and methods: a scoping review.

Roberta Bevilacqua, Tania Bailoni, Elvira Maranesi, Giulio Amabili, Federico Barbarossa, Marta Ponzano, Michele Virgolesi, Teresa Rea, Maddalena Illario, Enrico Maria Piras, Matteo Lenge, Elisa Barbi, Garifallia Sakellariou

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Table of Contents

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Abstract

Background: With the rapid expansion of Artificial Intelligence (AI) applications, researchers have begun focusing on the concept of Human-Centered Artificial Intelligence (HCAI). This field is dedicated to designing AI systems that augment and improve human abilities, rather than substituting them.

Objective: The objective of the paper is to review the information on design principles, techniques, applications, methods and outcomes adopted in the field of HCAI, in order to provide some insights on the discipline, in relation with the broader concepts of Human-Centered Design and User-centered design.

Methods: Following the PRISMA Checklist Extension guidelines, we conducted a systematic review in PubMed, Sciencedirect and IEEE Xplore, including all study types, excluding scoping review and editorials.

Results: Out of the 1035 studies retrieved, 14 studies conducted between 2018 and 2023 met the inclusion criteria. The main fields of application were the health sector and artificial intelligence applications. Human-centred design methodologies were adopted in 3 studies, personas in 2 studies, while the remaining methodologies were adopted in individual studies.

Conclusions: Human-Centered Artificial Intelligence (HCAI) emphasizes designing AI systems that prioritize human needs, satisfaction, and trustworthiness, but current principles and guidelines are often vague and difficult to implement. The review highlights the importance of involving users early in the development process to enhance trust, especially in fields like healthcare, but notes that there is a lack of standardized HCAI methodologies and limited practical applications adhering to these principles. Clinical Trial: N/A

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Review

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Abstract

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Keywords: Human-Centered Artificial Intelligence; HCAI; usability; acceptability; design principles; UCD; Human-centered design; AI principles; ethics; AI applications

Introduction

User-centered design (UCD) is an iterative methodology that places the user at the center of the design of innovative solutions, allowing the information gathered since its early stages to define the product features and end-user experience. This approach is typically enabled by interdisciplinary teams and different methodologies that synergically concur to the optimization of the user experience of system, products and processes.

The interaction of users with innovation prototypes not only accelerates the identification of usability issues, highlighting improvement opportunities, but also strengthens the capacity of researchers to define cost and benefits evaluation methods that are propaedeutic to identify return of investments also in terms of economic benefit. The requirements and recommendations for human-centered design principles have been formalized in ISO 9241-210, which details the role of UCD and its benefits for human-centered design applied to interactive technologies.

The use of appropriate UCD methods, especially when tailored to specific stakeholders' contexts, can reduce the risk of a given product not meeting stakeholder requirements or being rejected by users.

Similar to UCD, Human-Centered Design (HCD) is an approach that prioritizes human needs, capabilities and behavior. Therefore, HCD aims to address problems by putting people with their human perspective at the center of the processes, involving them in all stages of problem solving, from observation to brainstorming, conceptualisation, solution development and final implementation [1]. It is believed that such an approach would improve the usability of an innovation by increasing product acceptance and user satisfaction, proving effective in all situations where solutions are needed that are not only useful, but involve the emotional sphere of users in some way [2-4].

Recently, due to the increasing growth of Artificial Intelligence (AI) applications, researchers have shifted their attention to the construct called Human-Centered Artificial Intelligence (HCAI), a discipline aimed at creating artificial intelligence systems to amplify and enhance human capabilities, rather than replace them [5]. As HCD, HCAI places people at the center by seeking to improve, experience after experience, their lives [6]. On the basis of the design phase of any technological product, there are a number of useful techniques that can be adopted to obtain quick feedback from end-users, even in the absence of a fully functioning solution, to provide creative design alternatives to fit the users' preferences and needs. If properly trained, Human-Centered Artificial Intelligence could offer useful solutions tailored on the peculiar characteristics of the final users, considering new approaches coming from the original combination of many variables, for example.

Despite the undeniable richness of HCAI, there is the need to map the main concepts and constructs behind it, as well as to understand the methods and design principles that underpin it, in order to ensure that these metrics are adequately included in the experimental methodology and understand their role in supporting UCD and HCD approach. The objective of the paper is to review the information on design principles, techniques, applications, methods and outcomes adopted in the field of HCAI, in order to provide some insights on the discipline, in relation with the broader concepts of HCD and UCD.

Methods

The scoping review was carried out according to the PRISMA Checklist Extension [7]. Prior to the start of the project, a protocol was developed to guide the review process, shared among the authors and registered on the Open Science Framework (OSF) platform. The topic of interest for the review was any application of HCAI for User-Centered Design, in any population of adults. The outcomes of interest were description of the HCAI approach, description of the HCAI design, outcomes of the application of HCAI, user involvement in HCAI, description of use cases, methods for understanding and the user's mental model, description of user needs and new working practices. Any other design methodology could serve as a comparator. All English-language studies, with the exception of narrative and editorial reviews, could be included. Clinical questions, exploring the applications of HCAI for design, were translated into epidemiological terms using the Patient, Intervention, Comparator, Outcome (PICO) methodology (Table 1).

Table 1: PICOs (Patient, Intervention, Comparator, Outcome, Study type) driving the search strategies and the inclusion criteria.

Patient	Any type of patient
Intervention	HCAI for design
Comparator	Any other technique adopted for design
Outcome	• Description of HCAI approaches • Description of HCAI design • Outcome of HCAI application • User involvement in HCAI • Description of study cases • Description of methods for understanding • Description of user's mental model • User's needs and new working practices
Study Type	All study types excluding narrative review and editorials

Based on the identified PICOs, search strategies were created and applied to the electronic PubMed, Sciencedirect and IEEE Xplore databases from 1 January 2018 until 27 October 2023. Searches were performed by a single reviewer. The complete search strategies are presented in supplementary materials 1.

The records retrieved in the searches were afterwards imported into a review management platform (Rayyan) and duplicates excluded. Four investigators (RB, EM, TB, ML) working in pairs performed screening, selection and data extraction. Specifically, two blinded reviewers assessed the title and abstracts to define eligibility for full-text assessment, and, at the subsequent step, assessed full-texts for inclusion. Disagreement was resolved by consensus. Data extraction from the included studies was performed by using a standardized extraction form, including general information on the article, field of application, design methods, adopted model, design principles and properties, technology and type of AI; extraction was performed by a reviewer and checked by a second one. Results were summarized in summary of findings tables.

Results

The search in the electronic databases retrieved a total of 1035 articles, of which 8 were duplicates. Finally, the titles and abstracts of 1027 studies were screened. Based on the inclusion criteria, 27 studies were eligible for full-text review; of these, 14 studies fulfilled the criteria and were included in the scoping review. The flow-chart showing the selection process is reported in Figure 1.

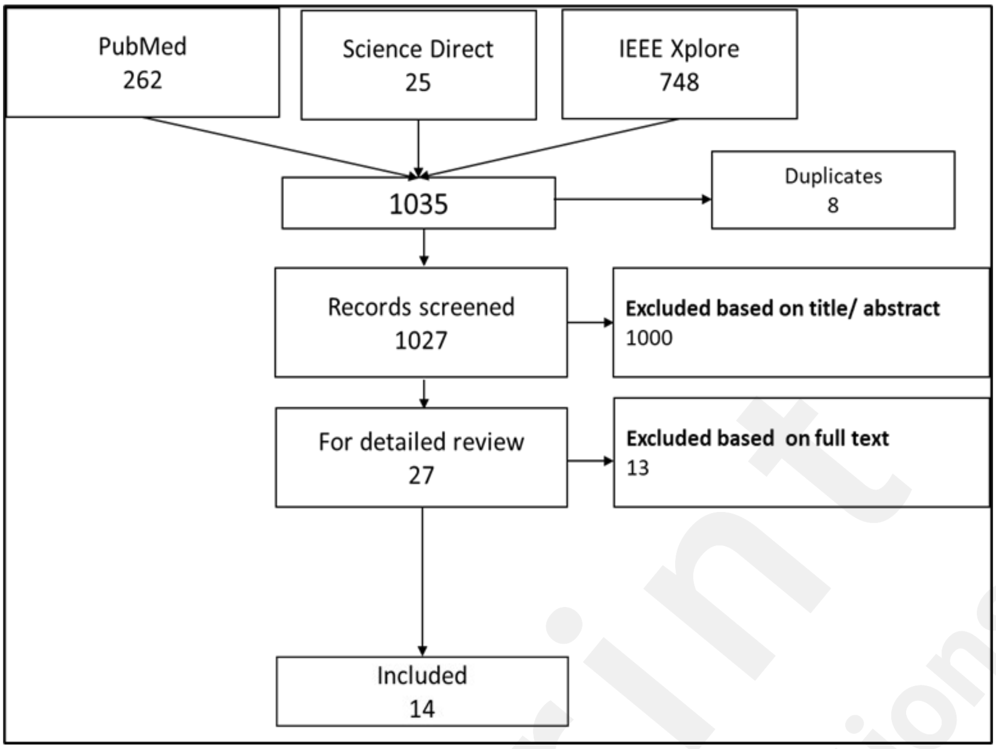

Figure 1: Flow-chart showing the selection process

Conference abstracts represented a relevant proportion of the retrieved evidence (7/15 studies), no study allowed comparison between techniques. The main fields of application were the health sector and artificial intelligence applications (Figure 2).

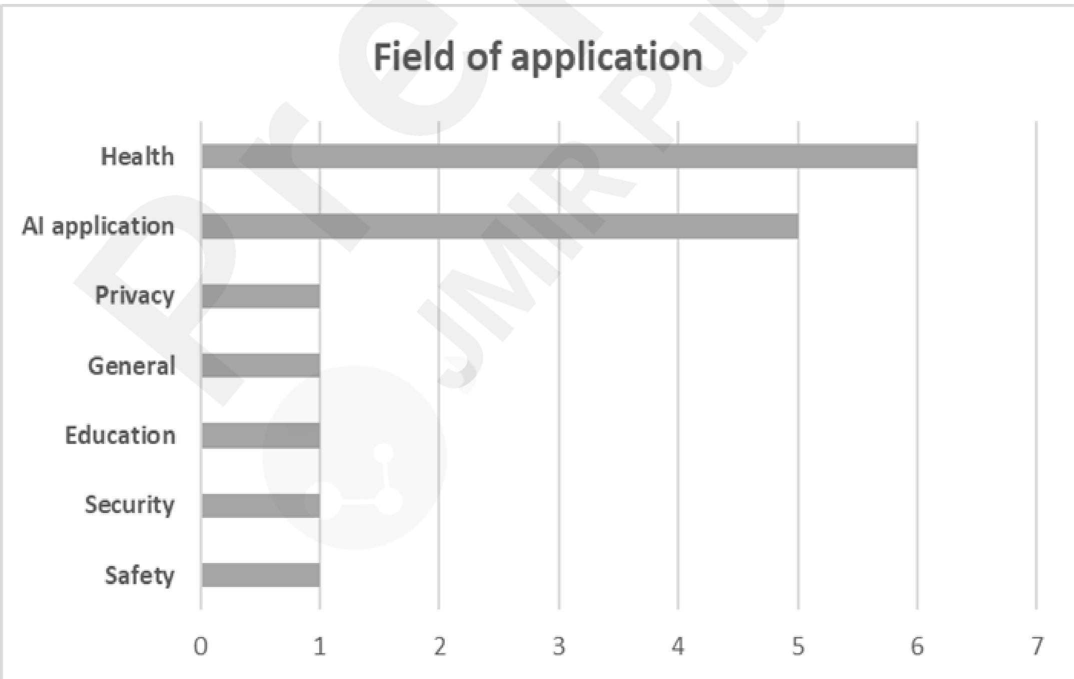

Figure 2: Different applications of HCAI for design. Number of studies.

The method adopted for design was described in 8/14 studies. In particular, human-centred design methodologies were adopted in 3 studies, personas in 2 studies, while the remaining methodologies were adopted in individual studies.

In 10/14 studies a model was adopted, while in 3 studies this was not applied. Information was not

available in a single study.
Design principles and properties were not described in 2 studies, in the remaining studies trustworthiness and explainability were the most frequently adopted principles (Figure 3).
The technology and type of AI were not described in 3 studies, while the remaining studies adopted very heterogeneous technologies.

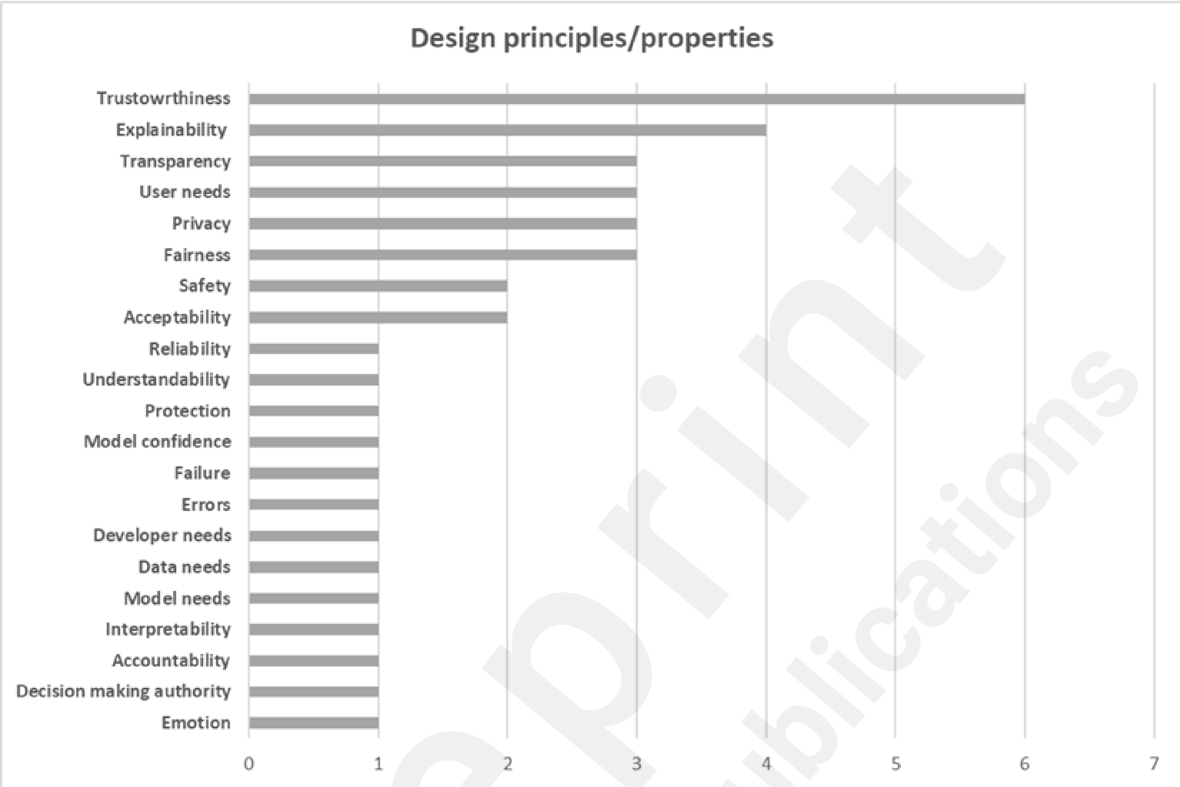

Figure 3: Design principles and properties. Number of studies.

Table 2 shows the characteristics of each study in terms of scope, presence of a model, design principles used and technology.

Table 2: Descriptive analysis of the included studies

Study	Type of publication	Field of application	UCD / Design methods	Model (Y / N)	Design principles / properties (Y / N)	Technology / Type of AI
He H. et al., 2022 [8]	Article	Safety, security, health		Y: Acceptance model of TRAS	Y: trustworthiness	SAR
Tyagi P.K. et al., 2023 [9]	Conference abstract	Education	Value-sensitive design	Y: enhanced HCAI framework	N	AIED application (Intelligent tutoring system; exploratory learning environments, dialogue-based tutoring system, automatic writing assessment)
Holzinger A. et al. 2022 [10]	Conference abstract	Health	Personas for AI (explainability)	Y: For the design and development of the personas AI	Y: emotion, decision-making authority and explainability as well as ethical issues are added in HAII	N/A
Usmani U. et al., 2023 [11]	Conference abstract	General	N/A	Y: user empowerment, ethical consideration, human AI collaboration	Y: fairness, transparency, accountability, and privacy protection	N/A
Fagbola T.M., 2019 [12]	Conference abstract	Development of AI system	N/A	N	Y: interpretability, explainability, fairness, transparency and safety	Toolkit for developing AI system (FairML, Aequitas, FairTest, IBM AIFairness 360, Mash, Concept Activation

						Vectors, LIME, DeepLIFT and Themis)
Beltrão G. et al., 2022 [13]	Conference abstract	AI-mind	Y: HCD methods: personas, scenarios, journey maps	N	N	AI-based decision-support system for clinical decision
Correia A. et al., 2021 [14]	Conference abstract	Human-AI integration	N/A	Y: Acceptance model and use of technology (UTAUT and TAM)	Y: trustworthiness and acceptability	N/A
Elahi H. etv al., 2021[15]	Article	Privacy, Health	HCD methods	Y: design shared responsibility privacy model	Y: privacy protection	AAL system (Ambient Assisted Living)
Ahmad K. et al., 2023 [16]	Article	Development of AI system using HCD	Human-Centered methods	Y: human-centered AI-based software (RE4HCAI)	Y: requirements for user need, for model needs, for data needs, explainability and trust, errors and failure	Model applied in a system of VR (Virtual Reality)
Bingley WJ et al., 2023 [17]	Article	HCAI	Qualitative survey for HCAI	N/A	Y: AI developers and user's needs (functionality, social impact, understandability, ethic, privacy, security)	N/A
Ventura S. et al., 2023 [18]	Article	Health	N/A	N	Y: user needs, acceptance of technology, perceived trustfulness	MAIA technology
Soliman A. et al., 2023 [19]	Article	Health	Y: stakeholder input, low -fidelity sketches and high-	Y: Model performance and explainability	Y: model confidence, trustworthiness,	Clinical decision support application to

			fidelity prototype for usability test		explainability	predict heart failure patient risk of readmission
Chen et al., 2023 [20]	Article	Healthcare	N/A	Y: for mitigating biases in AI life cycle	Y: Ethical, privacy protection, fairness, understandable, transparent	N/A
Kim jW et al., 2022 [21]	Article	Health (home care for older adults)	Y: focus group interviews, scenarios	Y: Human AI collaboration, user satisfaction	Y: reliable, safe and trustworthy	DORI - Older adult guided and caregiver-monitored robot

Y=Yes, N0No, N/A=Not Applicable

The study by He (2022) [8] explores the critical role of trustworthiness in the acceptance of AI systems within the domains of safety, security, and health. By employing the Trustworthiness and Reliability Assessment System (TRAS) model, the research demonstrates that user acceptance is significantly influenced by perceived trustworthiness and reliability. Socially Assistive Robots (SAR) are used as a case study, illustrating how trust can be enhanced in AI systems within these critical fields.

Tyagi (2023) [9] investigates the application of AI in education through value-sensitive design methods. The study presents an enhanced HCAI framework and explores various AI applications such as intelligent tutoring systems and dialogue-based tutoring systems. The findings underscore the importance of aligning AI systems with educational values and addressing user needs to improve acceptance.

Kim (2022) [21], Chen et al. (2023) [20], Soliman (2023) [19], Ventura (2023) [18], and Holzinger (2022) [10] focus on healthcare applications with distinct approaches. Kim examines home care for older adults, highlighting human-AI collaboration and user satisfaction as critical design principles. Chen et al. address biases in the AI lifecycle within healthcare, emphasizing ethical principles, privacy protection, fairness, and transparency. Soliman investigates clinical decision support systems for predicting heart failure patient readmission risks, emphasizing model performance, explainability, and trustworthiness. Ventura explores health applications, emphasizing user needs and technology acceptance, particularly the perceived trustworthiness of AI systems. Holzinger utilizes personas in the health sector to enhance AI explainability, integrating emotional and ethical considerations to improve user understanding and trust in AI technologies. These studies collectively contribute to advancing AI applications in healthcare by addressing various challenges and enhancing user confidence and acceptance.

Usmani (2022) [11] addresses general AI applications with an emphasis on user empowerment and ethical considerations. The research highlights the importance of human-AI collaboration and identifies design principles such as fairness, transparency, accountability, and privacy protection. These principles are crucial for developing trustworthy and ethical AI systems.

Fagbola (2019) [12] and Ahmad (2023) [16] discuss the development of AI systems from complementary perspectives. Fagbola's study emphasizes interpretability, explainability, fairness, transparency, and safety as crucial design principles, introducing tools like FairML and IBM AIFairness 360. Ahmad's research focuses on human-centered methods, presenting RE4HCAI, a software that addresses user needs, model requirements, data considerations, explainability, and trust. These approaches collectively aim to foster the development of fair, transparent, and user-centric AI systems, enhancing both usability and trust in AI applications, including virtual reality environments.

Beltrão (2022) [13] explores the use of human-centered design methods such as personas, scenarios, and journey maps in developing AI-based decision-support systems for clinical settings. The study highlights the importance of aligning AI systems with clinical user needs to improve decision-making processes.

Correia (2021) [14] delves into human-AI integration, focusing on acceptance models and technology use. The study employs models like Unified Theory of Acceptance and Use of Technology (UTAUT) and Technology Acceptance Model (TAM) to evaluate user acceptance, emphasizing trustworthiness and acceptability. These insights are vital for

designing AI systems that users are more likely to adopt.
Elahi (2021) [15] examines privacy and health applications, employing human-centered design methods. The study introduces a shared responsibility privacy model, underscoring privacy protection as a key design principle. This research highlights the importance of safeguarding user privacy in health-related AI systems.
Bingley (2023) [17] conducts a qualitative survey on human-centered AI (HCAI). The study emphasizes the needs of AI developers and users, addressing aspects such as functionality, social impact, understandability, ethics, privacy, and security. These insights are crucial for developing AI systems that meet diverse stakeholder requirements.

Discussion

Human-Centered Artificial Intelligence focuses on human experiences, satisfaction, and needs, with the goal of "amplifying, enhancing, and improving human performance in ways that make systems reliable, safe, and trustworthy". This is pivotal to "support human self-efficacy, encourage creativity, clarify responsibility, and facilitate social participation" [22].
The HCAI seeks to shift the focus in AI development from technologies to people. However, it is unclear whether existing HCAI principles and practices adequately achieve this goal.
In order to formalize these developments, several guidelines have been proposed by governments, organizations, and researchers to translate the ideals of HCAI into practice [23]. For example, the European Union lists seven key requirements that AI systems should meet to be trustworthy, including transparency, accountability, and promotion of social and environmental well-being [24].
Unfortunately, despite this proliferation of guidelines, IAE ideals have proven difficult to put into practice [22, 25, 26]. On this point, Shneiderman (2021) [27] argued that although ethical guidelines are a step in the right direction, they are often too vague to be useful to software engineers. Similarly, Mittelstadt (2019) [28] criticized AI ethics for consisting of vague principles and lofty value statements that lack the detail and precision needed to make specific recommendations to improve practice.
In line with the literature in the field, our review highlighted the need for a deeper analysis of the design principles promoted by HCAI to understand how they can be put into practice from the outset and how they differ from those proposed by human-centered design in terms of their impact on end consumers.
In general, it can be said that there is a need to raise the awareness of researchers and developers on the special issues offered by HCAI: the review showed that there are still a limited number of applications for AI design and solutions already available developed in accordance with HCAI principles, mainly in the field of social assistive robotics. This can partly be explained by the innovative nature of the proposed concept, but also by the partial overlap with the more general definition of human-centered design and user-centered design, highlighting the need for a clear definition and standardization of the framework.
In the context of AI especially, the review showed that there is a need to focus more on the concept of trustworthiness when designing a system. This concept, however, is multifaceted and not easily defined or achieved. All the articles reviewed are in

accordance by observing that a user needs to trust an AI-based system in order to use it, however, they differ in the approaches to reach this outcome.
In particular, the main concepts that are taken into consideration in the articles reviewed are explainability, transparency, privacy, and safety which contribute to making the system more trustworthy and acceptable for the user.
The way to better achieve these aspects is still an open challenge however this review demonstrates the importance of involving real users and stakeholders from the earlier stages of conceptualization and development all through the entire life-cycle and testing phases of a system. This becomes a key issue, especially in the development of applications to support the decision-making of health professionals in clinical fields.
Moreover, by incorporating user feedback into the design process, users can have a sense of ownership and control over AI systems, potentially promoting trust, acceptance, and better adherence, even if in most cases they have had no previous experience with AI solutions.
Besides the need to have specific HCAI methods and techniques for the design and development of new AI system the articles examined either didn't describe the methodologies used in the design process or used the same methods as those proposed by the user-centered design approach, such as focus groups, personification, scenarios, interviews, and others, as they are independent of the type of technology while maintaining the focus on users as a pillar.

Conclusions

Human-Centered Artificial Intelligence (HCAI) emphasizes designing AI systems that prioritize human needs, satisfaction, and trustworthiness, but current principles and guidelines are often vague and difficult to implement. The review highlights the importance of involving users early in the development process to enhance trust, especially in fields like healthcare, but notes that there is a lack of standardized HCAI methodologies and limited practical applications adhering to these principles.

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Conflicts of Interest

The authors declare that they have no competing interests

Abbreviations

AI = Artificial Intelligence
HCAI = Human-Centered Artificial Intelligence
HCD = Human-Centered Design
OSF = Open Science Framework
PICO = Patient, Intervention, Comparator, Outcome
PRISMA = Preferred Reporting Items for Systematic reviews and Meta-Analyses

SAR = Socially Assistive Robots
TAM = Technology Acceptance Model
TRAS = Trustworthiness and Reliability Assessment System
UCD = User-centered design
UTAUT = Unified Theory of Acceptance and Use of Technology

References

[1] Melles M, Albayrak A, Goossens R. Innovating health care: key characteristics of human-centered design. Int J Qual Health Care. 2021 Jan 12;33(Supplement_1):37-44. doi: 10.1093/intqhc/mzaa127.

[2] Norman D. Emotion & Design: Attractive Things Work Better. Interactions Magazine. 2002;9.

[3] Alaniz T, Biazzo S, Emotional design: the development of a process to envision emotion-centric new product ideas, Procedia Computer Science. 2019; 158: 474-484. https://doi.org/10.1016/j.procs.2019.09.078.

[4] Hanington B, Chapter 6 - Design and Emotional Experience, Editor(s): Myounghoon Jeon, Emotions and Affect in Human Factors and Human-Computer Interaction. Academic Press, 2017:165-183

[5] Schmager S, Pappas I, Vassilakopoulou P. Defining Human-Centered AI: A Comprehensive Review of HCAI Literature. 2023. MCIS 2023 Proceedings. 13. https://aisel.aisnet.org/mcis2023/13.

[6] Bingley WJ, Curtis C, Lockey S, Bialkowski A, Gillespie N, Haslam SA, Ko RKL, Steffens N, Wiles J, Worthy P. Where is the human in human-centered AI? Insights from developer priorities and user experiences. Computers in Human Behavior. 2023, 141: 107617. https://doi.org/10.1016/j.chb.2022.107617.

[7] 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. Annals of internal medicine. 2018, 169(7): 467-473.

[8] He H, Gray J, Cangelosi A, Meng Q, McGinnity TM, Mehnen J. The Challenges and Opportunities of Human-Centered AI for Trustworthy Robots and Autonomous Systems.IEEE Transactions on Cognitive and Developmental Systems, vol. 14, no. 4, pp. 1398-1412, Dec. 2022, doi: 10.1109/TCDS.2021.3132282

[9] Tyagi PK, Singh AK, Tyagi P, Chanchal HK, Gautam P et al. Human-Centred Artificial Intelligence In Education, Present And Future Opportunities. In 2023 3rd International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE). 2023: 2742-2746. IEEE.

[10] Holzinger A, Kargl M, Kipperer B, Regitnig P, Plass M, Müller H. Personas for Artificial Intelligence (AI) an Open Source Toolbox. IEEE Access. 2022, 10: 23732-23747. doi: 10.1109/ACCESS.2022.3154776.

[11] Usmani U, Happonen A, Watada J. Human-Centered Artificial Intelligence: Designing for User Empowerment and Ethical Considerations. 2023; 01-05. 10.1109/HORA58378.2023.10156761.

[12] Fagbola TM, Thakur SC. Towards the Development of Artificial Intelligence-based Systems: Human-Centered Functional Requirements and Open Problems. 2019 International Conference on Intelligent Informatics and Biomedical Sciences

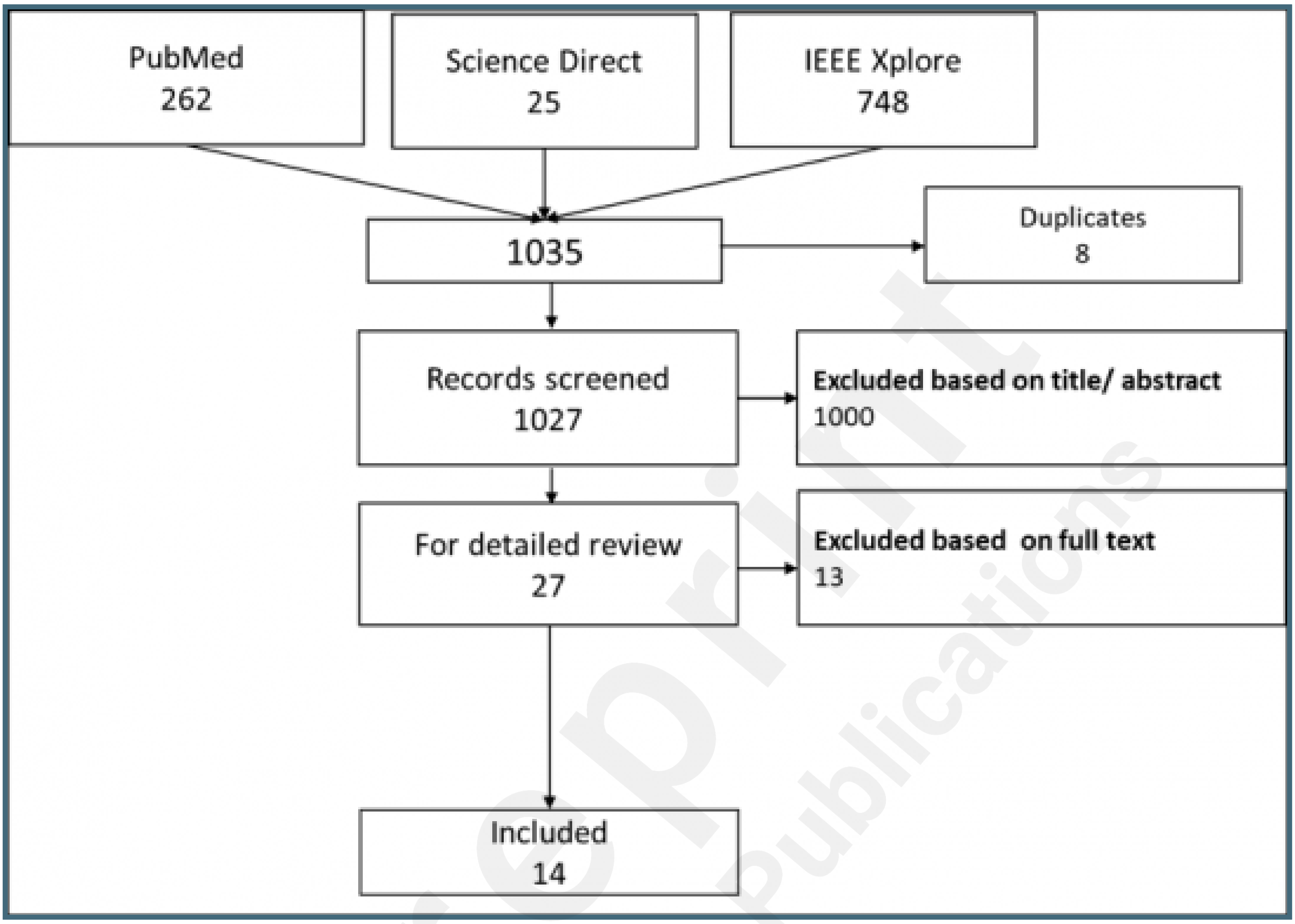
(ICIIBMS), Shanghai, China, 2019, pp. 200-204, doi: 10.1109/ICIIBMS46890.2019.8991505
[13] Beltrão G, Paramonova I, Sousa S. User Interface Design for AI-Based Clinical Decision-Support System: Preliminary Study. 2022 17th Iberian Conference on Information Systems and Technologies (CISTI), Madrid, Spain, 2022, pp. 1-4, doi: 10.23919/CISTI54924.2022.9820378
[14] Correia A, Fonseca B, Paredes H, Chaves R, Schneider D, Jameel S. Determinants and Predictors of Intentionality and Perceived Reliability in Human-AI Interaction as a Means for Innovative Scientific Discovery. 2021 IEEE International Conference on Big Data (Big Data), Orlando, FL, USA, 2021, pp. 3681-3684, doi: 10.1109/BigData52589.2021.9671358.
[15] Elahi H, Castiglione A, Wang G, Geman O. A human-centered artificial intelligence approach for privacy protection of elderly App users in smart cities. Neurocomputing, 2021; 444: 189-202.
[16] Ahmad K, Abdelrazek M, Arora C, Baniya AA, Bano M, Grundy J. Requirements engineering framework for human-centered artificial intelligence software systems. Applied Soft Computing, 2023; 143,110455.
[17] Bingley WJ, Curtis C, Lockey S, Bialkowski A, Gillespie N, Haslam SA, Ko RKL, Steffens N, Wiles J, Worthy P. Where is the human in human-centered AI? Insights from developer priorities and user experiences. Computers in Human Behavior, 2023; 141, 107617.
[18] Ventura S, Ottoboni G, Lullini G, Chattat R, Simoncini L, Magni E, Piperno R, La Porta F, Tessari A. Co-designing an interactive artificial intelligent system with post-stroke patients and caregivers to augment the lost abilities and improve their quality of life: a human-centric approach. Front Public Health. 2023 Sep 21;11:1227748.
[19] Soliman A, Nair M, Petersson M, Lundgren L, Dryselius P, Fogelberg E, Hamed O, Etminani K, Nygren J. Interdisciplinary Human-Centered AI for Hospital Readmission Prediction of Heart Failure Patients. Stud Health Technol Inform. 2023 May 18;302:556-560.
[20] Chen Y, Clayton EW, Novak LL, Anders S, Malin B. Human-centered design to address biases in artificial intelligence. Journal of medical Internet research. 2023, 25: e43251.
[21] Kim JW, Choi YL, Jeong SH, Han J. A Care Robot with Ethical Sensing System for Older Adults at Home. Sensors (Basel). 2022 Oct 3;22(19):7515
[22] Shneiderman B. Bridging the gap between ethics and practice: Guidelines for reliable, safe, and trustworthy human-centered AI systems. ACM Transact. on Interactive Intelligent Systems, 10 (4) (2020), pp. 26-31, 10.1145/3419764
[23] Jobin A, Ienca M, Vayena E. The global landscape of AI ethics guidelines. Nature Mac Intell., 1 (9) (2019), pp. 389-399, 10.1038/s42256-019-0088-2
[24] European Commission. Ethics guidelines for trustworthy AI. Futurium - European Commission (2019). https://ec.europa.eu/futurium/en/ai-alliance-consultation/guidelines/1
[25] Oppermann L, Boden A, Hofmann B, Prinz W, Decker S. Beyond HCI and CSCW: Challenges and useful practices towards a human-centred vision of AI and IA Proceed Halfway to the Future Sympos 2019 (2019), pp. 1-5,

10.1145/3363384.3363481
[26] Winfield AFT, Jirotka M. Ethical governance is essential to building trust in robotics and artificial intelligence systems. Philosophical Transactions of the Royal Society A: Mathematical, Physical & Engineering Sciences, 376 (2133) (2018), Article 20180085, 10.1098/rsta.2018.0085
[27] Shneiderman B. Human-centred AI. Iss Sci Technol., 37 (2) (2021), pp. 56-61
[28] Mittelstadt B. Principles alone cannot guarantee ethical AI. Nature Mac Intell., 1 (11) (2019), pp. 501-507, 10.1038/s42256-019-0114-4

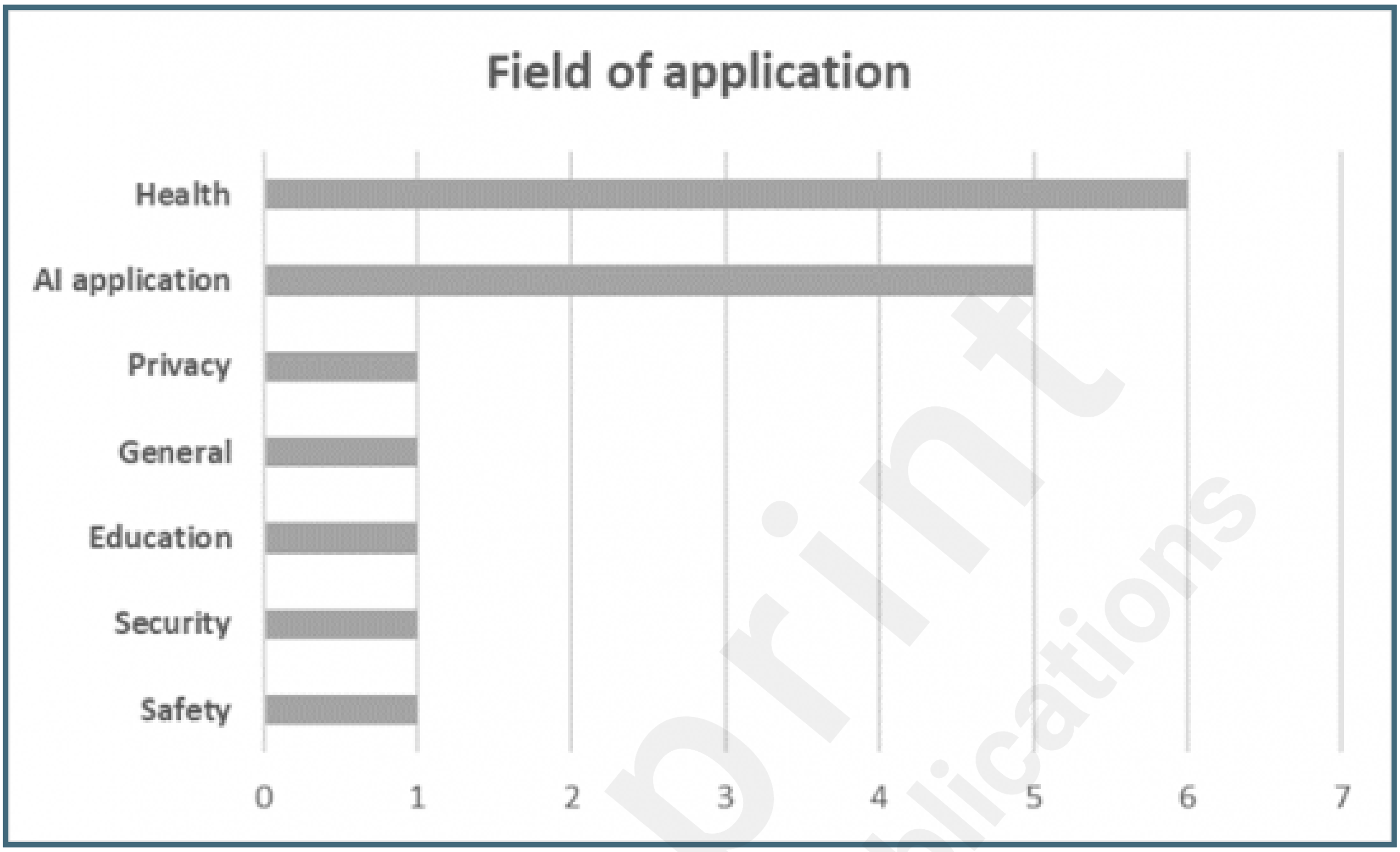
Supplementary Files

Figures

Flow-chart showing the selection process.



Different applications of HCAI for design. Number of studies.



Design principles and properties. Number of studies.