Engagement with Conversational Agent-Enabled Interventions in Cardiometabolic Disease Self-Management: A Systematic Review

Nick Kashyap, Ann Sebastian, Chris Lynch, Paul Jansons, Ralph Maddison, Tilman Dingler, Brian Oldenburg

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Abstract

Background: Well-designed conversational agents can improve healthcare capacity to meet the dynamic and complex needs of people self-managing cardiometabolic diseases (CMD). However, a lack of empirical evidence on conversational agent-enabled intervention design features and their impact on engagement make it challenging to comprehensively evaluate effectiveness. This review synthesizes evidence on conversational agent-enabled intervention design features and how they impact on engagement, to inform the development of more engaging conversational agent-enabled interventions that effectively help people with CMD to self-manage their condition.

Objective: To synthesize evidence pertaining to conversational agent-enabled intervention design features and their impact on engagement of people self-managing cardiometabolic disease.

Methods: Searches were conducted in Ovid (Medline), Web of Science, and Scopus databases. Inclusion criteria were; Primary research studies; Reporting on conversational agent-enabled interventions; That included measures of engagement; In adults with CMD. Data extraction captured perspectives of people with CMD on various design features of conversational agent-enabled interventions.

Results: Of 1366 studies identified for screening, 20 were included in the review. 18 of these were qualitative or quasi-experimental evaluations of conversational agent-enabled intervention prototypes. Five domains of design features that impact user engagement with conversational agent-enabled interventions emerged; Communication style, Functionality; Accessibility; Visual appearance; and Personality.

Conclusions: Across all five domains, integrating redundancy and anthropomorphism were identified as effective strategies for improving engagement by increasing user autonomy and investment. Future research should adopt design strategies that are inclusive and adaptive to the diverse needs of users and aligned with the unique considerations relevant to conversational agent-enabled interventions. Clinical Trial: PROSPERO CRD42023431579

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Abstract

Background: Well-designed conversational agents can improve healthcare capacity to meet the dynamic and complex needs of people self-managing cardiometabolic diseases (CMD). However, a lack of empirical evidence on conversational agent-enabled intervention design features and their impact on engagement make it challenging to comprehensively evaluate effectiveness. This review synthesizes evidence on conversational agent-enabled intervention design features and how they impact on engagement, to inform the development of more engaging conversational agent-enabled interventions that effectively help people with CMD to self-manage their condition.

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Conclusions: Across all five domains, integrating redundancy and anthropomorphism were identified as effective strategies for improving engagement by increasing user autonomy and investment. Future research should adopt design strategies that are inclusive and adaptive to the diverse needs of users and aligned with the unique considerations relevant to conversational agent-enabled interventions.

Trial Registration: PROSPERO CRD42023431579

Keywords: User experience; cardiovascular disease; diabetes; chronic disease; mHealth; eHealth; chatbot; virtual assistant; qualitative; digital health

Introduction

Supporting effective self-management is crucial for reducing both the health and economic impacts of cardiometabolic diseases (CMD), but is challenged by the dynamic and complex nature of CMDs and limitations faced by healthcare providers [1–3]. Encompassing a set of interrelated conditions which affect the cardiovascular system and metabolic health, such as hypertension and diabetes, CMDs are a significant health concern [4]. Globally, CMDs cause approximately 20 million deaths each year, with morbidity and mortality rates continuing to increase [5–7]. It has been estimated that nearly 80% of CMD deaths and a significant proportion of associated healthcare costs could be prevented with optimal self-management [2,8]. Self-management describes the ability of patients to monitor their symptoms and circumstances, and understand how these factors affect health [9]. Due to the individualized and chronic course of CMDs, sustaining effective self-management requires people to continuously adjust to changing symptoms and personal circumstances [10–12]. Interventions supporting people self-managing CMDs must be continuously customized to align with the dynamic and complex experience of each individual [13]. However, limitations in time, resources, expertise, or confidence often hinder the capacity of healthcare providers to deliver this level of care [3,12].

Conversational agents, technologies that interact with people using natural language, can overcome some of the limitations faced by healthcare providers [14–16]. Conversational agents are typically accessed through app-based platforms, websites, or text messaging services and can interact with the user via text, speech, or visually as embodied avatars. When incorporated into digital care delivery, conversational agents can enable continuous monitoring and alignment of interventions with the dynamic circumstances of people self-managing CMD through providing contextually relevant assistance [15,17]. Conversational agents can assess user comprehension, offer real-time emotional and motivational support, translate specialized language into familiar terms, integrate relevant dialogues with on-screen instructions, and provide voice-based interaction options [14,16]. Such capabilities have been advancing as conversational agents have undergone rapid progress since their emergence in the 1960s [18,19]. Despite this progress, the ongoing challenge of sustaining user engagement, a common issue in digital health, continues to limit the use of conversational agents in clinical contexts, since sustained interaction is key to their effectiveness [20–22].

The effectiveness of conversational agent-enabled interventions in supporting self-management is dependent on user engagement, which describes the depth and frequency of a

user's interactions with an intervention [23–25]. While engagement is a well-recognized concept, its application in digital health often varies based on different perspectives and methodologies for measurement [26–28]. For example, some researchers equate engagement directly with user activity, while others consider how well an intervention aligns with a user's cognitive beliefs [27]. To achieve a change in health-related behaviors, digital health interventions require sufficient participant engagement so users not only understand and apply intervention content but also develop the skills, motivation, and confidence necessary to make sustainable lifestyle changes [24,29,30]. However, the low rates of engagement with most digital health interventions for self-management of chronic diseases are well known [21,31,32]. The design features of digital health interventions are important determinants of user engagement and are typically informed by theory and empirical evidence [25,33]. For example, limited input options and unintuitive navigation can lead to disengagement [25,34]. Theories and models, such as the self-reference encoding model, often inform the design strategies of developers, as demonstrated in a smoking cessation intervention that embedded self-relevant cues like user names and smoking histories [23,35–37]. Furthermore, the researchers observed that when these self-relevant cues were used explicitly to refer to users smoking habits, rather than using them implicitly to tailor content, improved smoking cessation outcomes occurred [23]. This work demonstrates the benefits, but also the limits of applying theory towards design, reflecting on the empirical application of theory contributed to a more nuanced perspective on the design choice to embed self-relevant cues [23].

The design of conversational agent-enabled interventions can benefit from empirical evidence on design features and their impacts on engagement in people self-managing CMDs [23,25]. Empirical evidence of this kind is sparse, primarily found in evaluations of prototypes within qualitative and quasi-experimental studies [38–41]. Synthesizing the empirical evidence could enable the recognition of broad trends, reduce bias in design reflections, and contribute to more nuanced applications of theories and models. This synthesis can facilitate the development of more engaging and effective conversational agent-enabled interventions for supporting people with CMDs to self-manage their condition.

Objective: To synthesize evidence pertaining to conversational agent-enabled intervention design features and their impact on engagement of people self-managing cardiometabolic disease.

Methods

Protocol and Registration

The methodology used in this study has been detailed in the protocol paper [42]. This review was conducted in accordance with the Cochrane Handbook for Systematic Reviews of Interventions and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis checklist [43,44]. The review was initiated in May 2023 and registered in PROSPERO (CRD42023431579).

Information Sources

We systematically searched Ovid (Medline), Web of Science, and Scopus databases for relevant articles from inception until April 2024. Ovid (Medline) was selected for its medical and health science focus, to capture studies that included CMDs. Web of Science and Scopus were selected for their broader focus, useful for capturing research on conversational agents and engagement topics. We excluded certain databases after preliminary assessments. For example, Embase was excluded due to its significant content overlap with Medline, and the Cochrane Library was excluded because it lacked a significant number of relevant exemplar papers found in the other databases. As this is a rapidly developing field, final searches were conducted prior to the submission of this manuscript. Reference list searches were conducted on all articles included in full-text review.

Search Strategy

An extensive set of search terms were used related to the three central topics of the review; CMD, conversational agents, and engagement. Boolean operators were used to combine search terms, including; (“Cardiovascular Diseases”[MeSH Terms] OR metabolic) AND ("conversational agent*" OR chatbot*) AND (accept* OR perceived). This approach was intended to yield a comprehensive collection of literature that explores the intersection of these central topics. The complete search strategy can be found in Appendix I.

Eligibility Criteria

Population

Studies included adult participants (≥18 years) with a cardiometabolic disease (CMD) diagnosis. Populations reported with comorbidities, such as mental health disorders or multiple CMDs, were also included.

Intervention

Studies reported on conversational agent-enabled interventions, which supported people with

CMD to self-manage their condition. For example, by offering emotional or educational support, or assisting individuals in monitoring their symptoms.

Outcomes

Studies reported on engagement outcomes, such as ratings, interviews, analytics, and focus groups.

Study Design

Studies were primary research, including qualitative studies, quasi-experimental studies, and randomized controlled trials. Reviews, editorials, protocols, and non-English publications were excluded.

Data Management

All search results were imported into PaperPile (Paperpile LLC) and duplicates were automatically removed. The search results were then imported into Covidence (Veritas Health Innovation, Melbourne, Australia) where 53 more duplicates were removed. Covidence was used to store PDF files of articles considered during the full-text review, and to conduct study selection, data extraction, and quality appraisal, with data then being exported to Excel (Microsoft Corp).

Study Selection

During initial screening, two reviewers independently examined the titles and abstracts of all studies collected from the search strategy. Screening was based on the defined inclusion and exclusion criteria. Conflict was resolved by meetings between the two reviewers. If a conflict was not able to be resolved, it was to be arbitrated by a third reviewer to achieve consensus, though this did not occur. Remaining studies were independently assessed by two reviewers in full-text screening, using the defined inclusion and exclusion criteria. Any conflict between the two reviewers was settled during meetings, with arbitration by a third reviewer if required.

Data Extraction

Data extraction from all included studies, including any supplementary material was conducted and documented by two reviewers independently. Where further information was required, study authors were contacted for clarification. The data extraction form was designed to capture a wide array of details necessary to capture the perspectives of people with CMD on the engagement of various design features of conversational agent-enabled interventions. Details included bibliographic information, study design, participants and population, intervention features, and how design features influenced engagement outcomes.

Quality Appraisal

Due to the mixed study designs of included literature, the following Joanna Briggs Institute critical appraisal tools were used; 'Checklist for Qualitative Research'; 'Checklist for Quasi-Experimental Studies'; and 'Assessment of Risk of Bias for Randomized Controlled Trials' [45–47].

Data Synthesis

An adapted version of the thematic synthesis analysis method developed by Thomas and Harden was employed [48]. This method focused on data extracted from studies that detailed design features and engagement outcomes. During the initial phase, data were categorized under multiple domains. Following the extraction, domains were iteratively consolidated until further merging would compromise the descriptive accuracy of each dataset. Then within each domain, data were categorized under multiple sub-domains. Analysis of these domains and sub-domains contributed to informing design choices for conversational agent-enabled interventions and identifying research gaps in how engagement is reported in the literature.

Results

Of 1366 studies imported for screening, 20 studies were included in the review (Figure 1). All included studies were published between 2015 and 2023 (Table 1). 10 studies focused on cardiovascular disease (eg, heart failure, atrial fibrillation, acute coronary syndrome, hypertension, stroke), 9 studies focused on diabetes (type 2 diabetes, gestational diabetes mellitus), and 1 study focused on chronic kidney disease (Appendix I). The sample sizes ranged from 8 to 187, and the age of the participants ranged from 21 to 87 years (Appendix I). 11 of the conversational agents were embodied (ranging from simple, cartoon-like avatars in a digital interface to sophisticated, humanoid robots capable of mimicking human gestures and expressions), 7 were chatbots (text-only interface), and 2 were voice assistants (capable of voice-based interactions) (Appendix I).

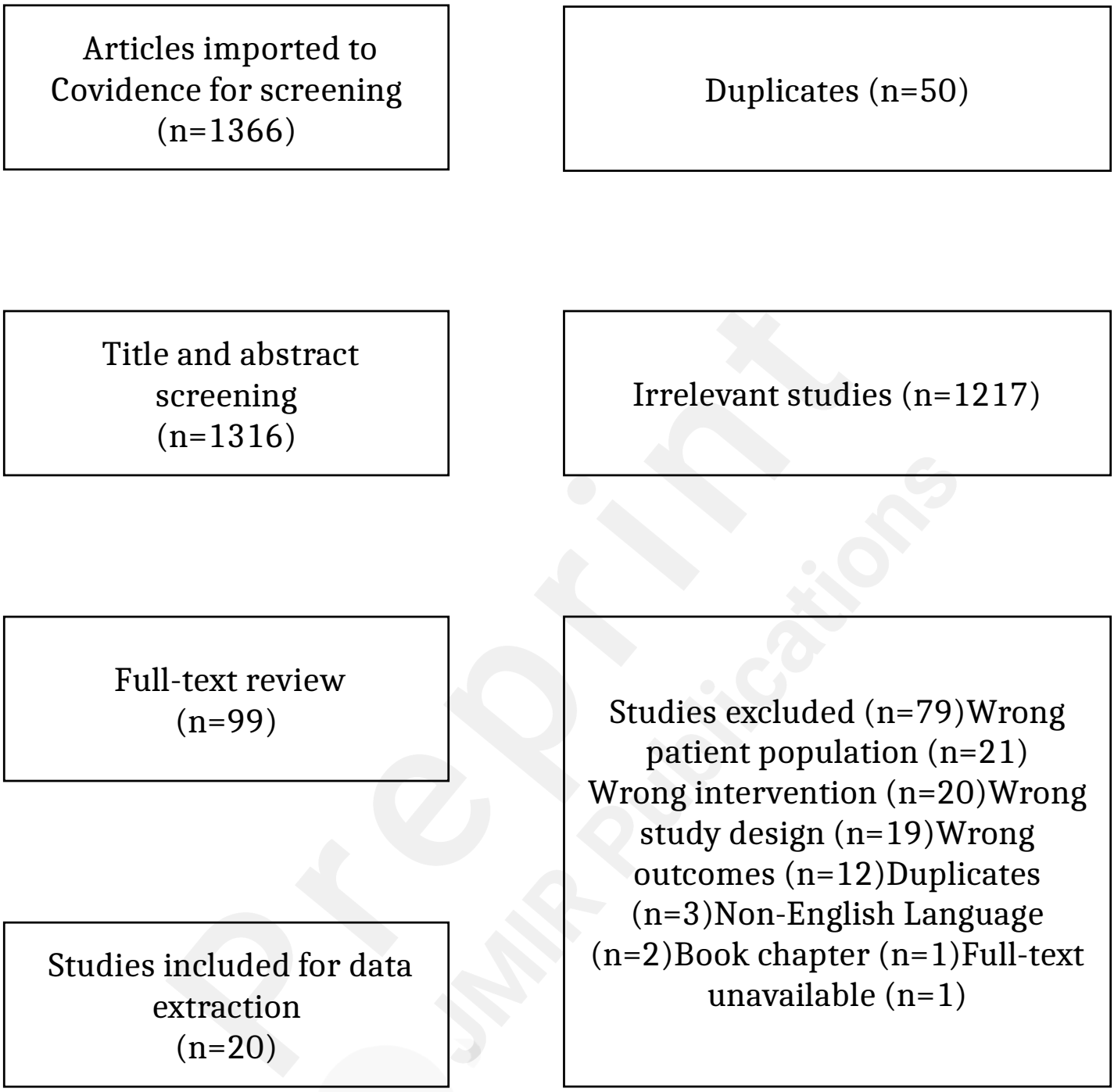

Figure 1: Flowchart illustrating the study selection process

Table 1: Characteristics of included studies

Author Year	Study design	Conversational agent role	Measures of engagement (Total sample size)	Contribution to each theme*				
				1	2	3	4	5
Apergi 2021 [40]	Quasi-experimental	To ask the patients the same series of questions related to their heart failure treatment and symptoms and provide feedback.	Surveys, questionnaires, analytics (n=30)		X			
Balsa 2019 [49]	Qualitative	To assist older people with type 2 diabetes mellitus in medication adherence and lifestyle changes.	Self-administered questionnaire (n=28)			X	X	
Balsa 2020 [50]	Qualitative	To support older people with type 2 diabetes mellitus in medication adherence and lifestyle changes.	Questionnaire, open questions, diaries, digital notes, telephone follow-ups (n=20)	X				
Baptista 2020 [39]	Quasi-experimental	To deliver self-management education and support to adults with type 2 diabetes mellitus.	Web-based surveys, Interview (n=93)	X	X		X	X
Cheng 2018 [38]	Qualitative	To allow for a less cumbersome way for geriatric type 2 diabetes mellitus patients to effectively adhere to guidelines.	Subjective tests for qualitative assessment of effectiveness and satisfaction, gathering feedback from elder-care experts and potential users (n=10)	X		X		
Echeazarra 2021 [51]	Randomized controlled trial	To help patients with hypertension to self-monitor their blood pressure	Satisfaction survey (n=112)	X		X		
Epalte 2023 [41]	Qualitative	To counsel, educate, and train the stroke patient and patients family on stroke, rehabilitation, care, and other related issues	Semi-structured interviews (n=12)	X		X		
Gingele 2023 [52]	Qualitative	To evaluate patients health status, provide patient education, and enable communication with heart failure nurses.	System usability scale, self-developed patient satisfaction scale, general feedback form (n=37)	X		X		
Gong 2020 [53]	Randomized controlled	To provide more accessible and engaging self-management support, monitoring, and coaching to adults with type 2	Data analytics, and process evaluation (n=187)		X			

	trial	diabetes mellitus in Australia.

** Themes; 1) Communication style; 2) Functionality; 3) Accessibility; 4) Visual appearance; 5) Personality*

Table 1 (Continued): Characteristics of included studies

Author Year	Study design	Conversational agent role	Data collection relevant to engagement outcomes (Total sample size)	Contribution to each theme*				
				1	2	3	4	5
Guhl 2020 [54]	Quasi-experimental	To augment patient-centered health care by providing health education, monitoring, and problem-solving for users.	Measures, self-reports (n=120)	X	X			X
Kimani 2016 [55]	Quasi-experimental	To provide education on atrial fibrillation and promote adherence to daily heart rhythm monitor readings.	Data analytics, self-report scale, and semi-structured interview (n=16)					
Magnani 2017 [56]	Quasi-experimental	To promote education, motivation, and monitor patient symptoms and adherence to behaviors.	Qualitative interviews, and questionnaire (n=31)					
Nassar 2023 [57]	Quasi-experimental	To deliver education and support to adults with type 2 diabetes mellitus.	App data analytics, and surveys, (n=150)	X	X			
Pienkowska 2023 [58]	Qualitative	To educate adults living with type 2 diabetes about their condition	Web-based survey, and structured interview (n=8)	X			X	X
Roca 2021 [59]	Quasi-experimental	To improve medication adherence in patients with comorbid type 2 diabetes mellitus and depressive disorder.	Interviews, and questionnaires (n=19)	X	X	X		
Sagstad 2022 [60]	Qualitative	An informational chatbot addition to established care for women with gestational diabetes mellitus	Chatbot dialogues, data analytics (n=NA)	X				
ter Stal 2021 [61]	Qualitative	To support users in self-management of chronic diseases in a long-term, daily life setting	Ratings, data analytics, and semi-structured interviews (n=11)	X	X		X	X
Tongpeth 2018 [62]	Qualitative	To improve patients knowledge of, and response to, acute coronary syndrome symptoms.	Focus groups, and Satisfaction questionnaire (n=22)	X	X		X	X
Tsai 2022 [63]	Qualitative	To support patients with chronic kidney disease manage their condition	Structured questionnaire, one-on-one interviews (n=26)	X		X		
Zhang 2015 [64]	Qualitative	To counsel patients on their diagnoses and medications specified by a clinician, as well as increasing physical activity, improving diet, decreasing stress, and motivating them to be more involved and proactive in their own care.	Scales (n=10)					

** Themes; 1) Communication style; 2) Functionality; 3) Accessibility; 4) Visual appearance; 5) Personality*

Study Quality

Included studies met most criteria outlined in the relevant Joana Briggs Institute critical appraisal tools with two exceptions, Echeazarra *et al.* 2021 and Tsai *et al.* 2022 (Appendix I). The most common unmet criteria for randomized controlled trials was a lack of ensured blindness, for quasi-experimental studies it was a lack of pre-post measurements, and for qualitative studies it was unaddressed researcher influence (Appendix I).

Domains of design features

Five domains and thirteen sub-domains pertaining to design features that impact user engagement with conversational agent-enabled interventions emerged (Table 1). The five domains (and corresponding sub-domains) were; Communication style (anthropomorphism, multiple choice, pacing, redundancy); Functionality (miscellaneous, embodiment, personalization); Accessibility (platforms, tutorials); Visual appearance (anthropomorphism, gender); and Personality (anthropomorphism, mentorship). Data that reported on design features or user engagement separately were used to identify proposed features, and research gaps. Some studies did not directly address the impact of design features on user engagement, but were useful in identifying research gaps [55,56,64]. Key findings are reported here, for comprehensive descriptions of how design features impacted engagement, refer to Appendix II.

Communication style

Communication style describes how a conversational agent interacts with the user. A natural flow of conversation was credited by most participants with a favorable view of the intervention by Cheng *et al.* as the reason for its high usability [38]. Additionally, voice quality, including factors like tone, cadence, and pronunciation impacted user satisfaction and the perceived anthropomorphism of the agent [39,50]. Users appreciated being able to ask agents about information already provided by the healthcare service or the internet, “You can bring up information on [atrial fibrillation] on the internet and read most of the same stuff on your own, but with Tanya you have a structured presentation that you're led through, so you end up getting the information you should be getting” [54,60]. Many users found multiple choice dialogues limiting and expressed frustration, leading to early disengagement [38,59,61]. Inundating users with “too much reading” or “repetitive” content caused burnout or disinterest [41,50,61]. Preferences regarding communication frequency varied among users, with a tendency for users preferring weekly communications [52].

Functionality

Functionality describes the practical capabilities of the agent. A range of functions improved user engagement, including gamification elements, agent-enabled quizzes, and weather forecasting [39,59,62]. There were conflicting reports pertaining to voice assistant functionality conversational agents, with one study showing no effect and another had users reporting voice added depth to

communications “instead of reading it, you’re hearing it” [39,40]. Agents which did not account for user context and time constraints lead to user dissatisfaction, with irrelevant content reducing user engagement, “When I have to go to work, I do not have time to watch a 15-minute video” [54,61].

Accessibility

Accessibility describes the measures taken to ensure different types of users can interact with the agent. Technical challenges and a lack of familiarity with technology was an issue among some users [38,49]. Low digital literacy resulted in various barriers to engaging with interventions, like users accidentally disabling the sound of reminders and then being unable to unmute them [41,59]. Even with thorough out-patient tutorials, certain demographics, such as older patients with limited digital experience, still faced challenges using the technology independently at home [52]. Elderly users tended to prefer voice-activated platforms like Google Home over smartphones for conversational agents, but they faced challenges like physical inconvenience, language barriers, and tech support needs [38]. A platform that minimized installation requirements, by hosting their agent on an app users already had downloaded was appreciated by users [63].

Visual appearance

Visual appearance describes the physical design and visual representation of the agent. While some users favored anthropomorphic agents due to their perceived credibility, others leant towards cartoon figures for a more "fun" and user-friendly experience [39]. A photo-realistic design, especially one that fits the context, such as a nurse in a healthcare setting, was reported to make interactions feel more genuine and personal [61]. Ensuring human-like facial expressions and gestures was important for avoiding negative impacts to the user experience [39,49,62]. Sylvia’s female identity provoked mixed reactions with one user calling her a “stupid woman”, while another liked her identity as they “hated” listening to men [61].

Personality

Personality describes the character and demeanor that the agent embodies. Incorporating human-like mannerisms increased users’ engagement with Laura, but her backstory led to frustration for some users who felt that is was excessive and a waste of time as Laura was not real [39]. Several users who perceived Laura to be authoritative developed feelings of guilt, leading some to temporarily cease communications and others to consider reporting only their best readings [39]. Whereas users who viewed Laura as friendly and supportive tended to be more engaged during communications [39]. Users attributed Tanya and Nurse Cora not saying “very drastic things” to feeling like they could “do something simple daily” [54,62]. One user expressed a preference for an authoritative agent over a friendly agent, “She could be your girl next door...If I have medical complaints, I prefer an authority to explain what to do or not to do” [61].

Proposed features

Proposed features describe features suggested by users which they felt would enhance their impression of or engagement with the intervention and represent ideas for further exploration. While in-app navigation was intuitive for most users of Nurse Cora, some users indicated they would have liked instructions on how to navigate the app containing Nurse Cora at the beginning of the trial [62]. Multiple-choice only functionality was frequently a point of frustration for users of conversational agent-enabled interventions, making one participant "consider [them]self a passive participant" in the conversation [38,41,50,57–59,61,63]. Molly users suggested she omit punctuation when speaking and incorporate voice recognition [52]. Users of Nurse Cora wanted her to emphasize keywords using larger font sizes and to provide the option to repeat dialogues [62]. Vitória users suggested developing a “strategy to remind users to use the app”, and offering specialized content such as “recipes for people with diabetes” [50]. Sylvia users desired more follow-up and checks on prior interactions, “Did you read that? Did you do this?” [61]. This sentiment was also expressed by Nurse Cora users who desired more feedback during the quizzes [62].

Research gaps

Research gaps were found in the way engagement of conversational agent-enabled interventions tended to be reported. Conversational agent-enabled interventions were frequently rated in terms of their engagement, but the rationale behind these ratings were not explored except for the study by Cheng *et al* [38,41,49,51,53–57,59,61,62,64]. For this study a natural flow of conversation was credited by most participant with a favorable view of the app as the reason for its high usability [38]. Additionally, differing levels of engagement, trust, or perceived care based on ethnicity, medication regimes, age, education, and computer literacy were identified but not explained [40,64].

Discussion

Principal Results

This systematic review synthesized evidence pertaining to conversational agent-enabled intervention design features and their impacts on the engagement of people self-managing cardiometabolic disease (CMD). Integrating redundancy and anthropomorphism to increase user autonomy and investment, respectively, emerged as two strategies for improving engagement relevant to all five emergent domains. However, care must be taken to avoid inundating users with excessive redundancy or anthropomorphism, as these were common frustrations among users across studies. The findings from this review can be applied to optimizing the development and evaluation of conversational agent-enabled interventions, facilitating more engaging and effective strategies for supporting people self-managing CMDs. Additionally, this review establishes a foundation for upcoming research by identifying research gaps and synthesizing an array of innovative design features suggested by users.

Redundant design features are those that offer additional input options and delivery channels of content. Redundancy is relevant to all five emergent domains as it can be incorporated into modes of communication, offering overlapping functions and inputs, supporting adaptive interaction styles, and various other aspects of intervention design. By offering redundant design features, users are empowered to interact with interventions on their own terms, thereby improving sustained engagement. For example, Roca *et al.* (2021) observed that a patient was not able to answer medication reminders confirming they had taken their medicine, this was because the agent did not understand their messages, the authors observed 34 interactions that were not understood between the specific patient and the agent [59]. Despite this issue, the patient managed to manually log their medication adherence, illustrating the critical role of redundancy within interaction options [59]. A lack of redundancy in accessibility led to problems for Gingele *et al.* (2022), who found that despite providing comprehensive outpatient tutorials, users encountered significant challenges when attempting to use conversational agent-enabled interventions independently at home [52]. These challenges could be addressed by offering additional tutorial options like helplines, outpatient sessions, and in-app guides [52]. Despite the benefits of redundancy in promoting user autonomy, empirical evidence identified within this review also underscored the importance of ensuring users are not inundated with irrelevant content [41,50,61]. For example, ter Stal (2021) highlighted instances where participants felt overwhelmed by excessive and inappropriate communication frequency, leading to frustration and disengagement, “When I have to go to work, I do not have time to watch a 15-minute video” [61]. Furthermore, Epalte *et al.* (2020) reported a participant complaining of “too much reading”, and Balsa *et al.* (2020) reported users identifying information overload and excessive queries as areas for improvement [41,50].

The assertion that offering redundant design features improves user engagement by enabling

flexibility in interaction aligns with findings grounded in self-determination theory from a tutorial paper by Yardley *et al.* (2015) [26]. Self-determination theory posits that engagement can be improved by supporting user autonomy, competence, and relatedness [35]. By providing redundancy in options and content, users are empowered to choose their interaction methods, access alternative options, and find content that feels personally relevant, thereby supporting user autonomy, competence, and relatedness [26]. An alternative explanation for why redundant design features improved user engagement is that they create a more consistent user environment where repeated exposures to similar content can make new information more familiar and accessible [65]. This explanation links into the concept of omnichannel engagement, describing uniformity between content channels, which is elaborated in a viewpoint paper by Blasiak (2022) [65]. There were several examples where users appreciated interventions providing content which they could access elsewhere [54,59,60]. For example, Sagstad *et al.* (2022) and Guhl *et al.* (2020) reported that users appreciated accessing information through the conversational agents within the interventions which they knew they could access online or from their doctor [54,60]. Furthermore, all participants within the study by Roca *et al.* (2021) gave an affirmative response to the statement, "From a certain moment, the virtual assistant began to give the weather forecast. Has this helped you to use the virtual assistant more frequently?" [59].

Anthropomorphic design features are those that contribute to users attributing human traits, emotions, or intentions to the intervention. Anthropomorphism is relevant to all five emergent domains as it can be incorporated into the conversational style, personality, visual design, and various other aspects of intervention design. By offering anthropomorphic design features, users can become more invested into interventions, thereby improving sustained engagement. For example, ter Stal *et al.* (2021) reported a participant stating that the realistic depiction of the conversational agent made the interaction more personal [61]. Similarly, Baptista *et al.* (2020) reported user preference for Laura's human character over a cartoon character, "I'm not sure I would have given the same level of credibility to, for example, a dog or a cat or something like that" [39]. Furthermore, a common point of frustration among users across studies was with conversational agents which were "not human enough", these issues pertained to the speech, mannerisms, gestures, and expressions of conversational agents [39,49,62]. Despite the benefits of anthropomorphism in promoting user investment, empirical evidence identified within this review also identified instances where efforts towards this goal were excessive or came at the expense of other functionalities [39,61]. An example of an excessive pursuit of anthropomorphism was identified by Baptista *et al.* (2020) who observed that providing a backstory for their conversational agent led to frustration for some users [39]. Furthermore, ter Stal (2021) reported most participants expressed they were not interested in the small talk from their conversational agent [61].

The contention that offering anthropomorphic design features improves user engagement by promoting user investment in interactions aligns with the Computers are Social Actors framework. The Computers are Social Actors framework posits that engagement can be improved by supporting user investment by exploiting users' innate social expectations to make interactions more meaningful [37]. However, the Computers are Social Actors framework fails to explain why excessive anthropomorphism leads to user frustration. Excessive anthropomorphism was identified as an issue by Ruslana and Ning (2023) as being due to causing confusion for users, who also proposed an alternative mechanism for anthropomorphisms positive effect on engagement, that anthropomorphic design features can make interventions more approachable and less formal [66]. This suggests that developers should carefully consider the function of anthropomorphism and be willing to forego it if simpler methods can achieve more approachable interventions. For example, Baptista *et al* (2020) observed certain users favoring cartoon figures over anthropomorphic agents as they were more "fun" [39].

Limitations

This systematic review faced limitations primarily due to the heterogeneity of included interventions, outcomes, and study types. In terms of interventions, the field of conversational agent-enabled interventions is rapidly evolving, with new technologies and platforms emerging regularly. This resulted in a wide variety of conversational agent-enabled interventions included in the review, ranging from basic chatbots with multiple choice responses to embodied conversational agents. In terms of outcomes, engagement in digital health lacks a standardized definition leading to different evaluations and operationalizations between studies. For example, some studies equated it directly with usage while others conceptualized it as a composite of behavioral, cognitive, and affective components. The diversity in how engagement was defined and measured across studies limited the synthesis of findings, pointing towards the need for a standardized operationalization of engagement within digital health contexts, to enable more precise and comparable measurements. In terms of study types, articles included in this review were primarily qualitative or quasi-experimental studies, restricting our ability to compare design features with quantitative user engagement metrics through meta-analysis. Together these heterogeneities limited our ability to compare results across studies and draw definitive conclusions about the impacts of certain design features on engagement. However, the review proceeded with these limitations as more specific inclusion criteria for interventions, outcomes, and study types would have reduced the sensitivity of this systematic review in identifying insights pertaining to design features and their impacts on engagement, and the identification of research gaps and opportunities for further research.

Areas for further research were identified based on the proposed features, research gaps, and limitations identified within this systematic review. A research gap which was consistently identified

across studies was that engagement ratings from participants were frequently collected, though the qualitative processes underlying these ratings were rarely explored, hindering a deeper understanding of engagement. For example, Echeazarra *et al.* (2021) asked users to rate ease of use and usefulness of their intervention on a Likert scale but did not ask users to explain which features contributed to these ratings [51]. The study by Cheng *et al.* (2018) provided a protocol for addressing this research gap, users were prompted to explain which features contributed to their ratings [38]. Another research gap was that clear and unexplained disparities in how different demographics engage with conversational agent-enabled interventions were identified in multiple studies [40,64]. For example, differing levels of engagement, trust, or perceived care were observed based on ethnicity, medication regimes, age, education, and computer literacy [40,64].

Conclusions

This systematic review provides key insights and rationales for developing conversational agent-enabled interventions for people self-managing CMD. Designing conversational agent-enabled interventions requires a balance of redundancy and personalization, to support user autonomy without overwhelming users. Additionally, a balance between anthropomorphism and functionality is required, to support user investment without frustrating users. Maintaining these balances is key to improving engagement with conversational agent-enabled interventions and supporting people with CMD to self-manage their condition.

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Conflicts of Interest

None declared

Abbreviations

CMD: Cardiometabolic disease

Ethical approval

Ethical approval was not required for this systematic review, as it involved the analysis of anonymized data from previously published studies where informed consent had already been obtained.

Guarantor

Nick Kashyap accepts full responsibility for the work and conduct of this study.

Contributorship

All authors contributed significantly to the research project and manuscript. Nick Kashyap and Ann Sebastian performed the data collection. Nick Kashyap conducted the data analysis. All authors were involved in writing the manuscript and had final approval of the submitted and published versions.

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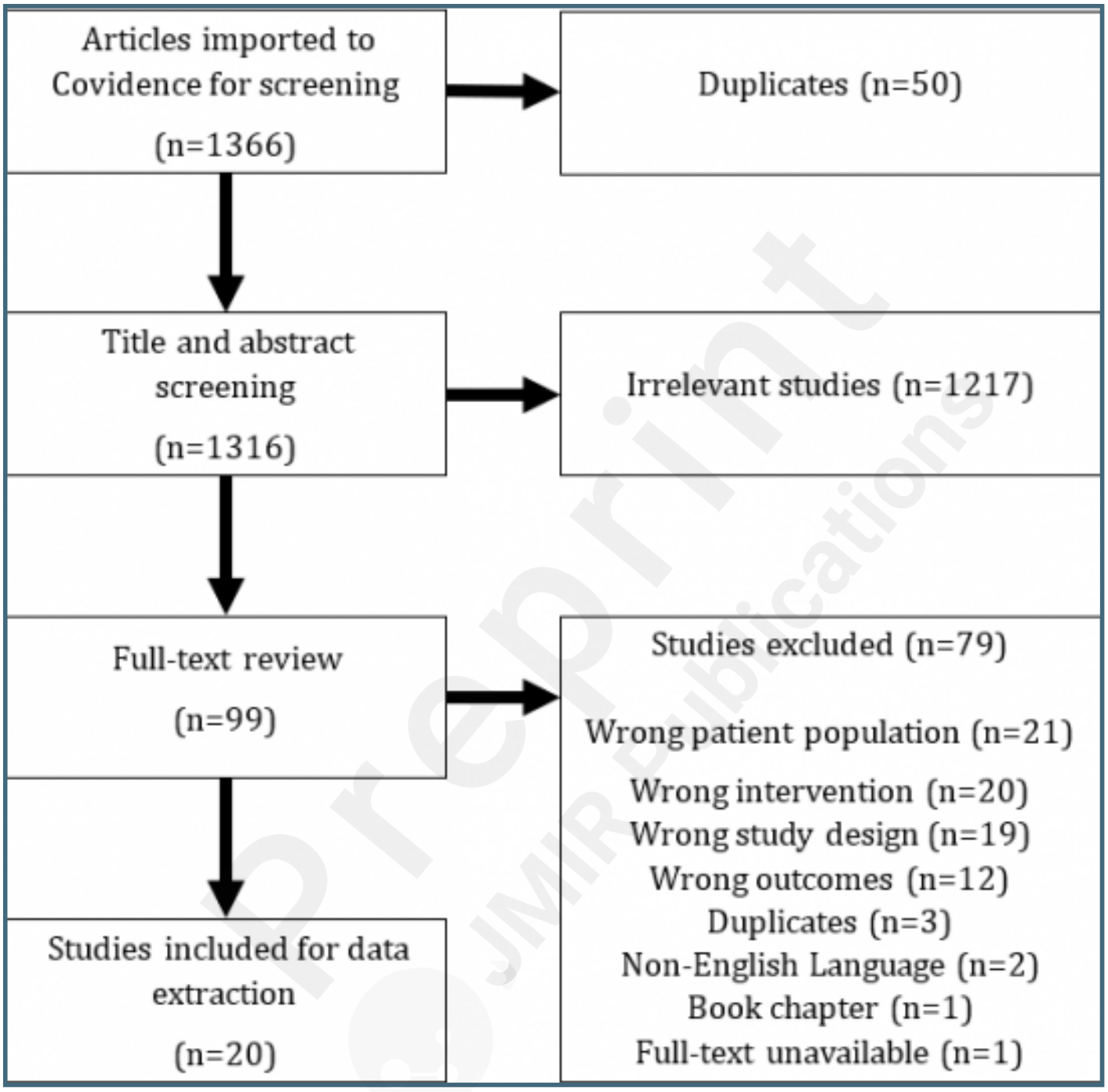
Supplementary Files

Figures

Flowchart illustrating the study selection process.



Multimedia Appendixes

The complete search strategy.
URL: http://asset.jmir.pub/assets/d57bca38d50e5c28fb7128573d6a4f84.docx

Comprehensive descriptions of how design features impacted engagement.
URL: http://asset.jmir.pub/assets/ca2e9bbf252acdfe767bf6e46b8acafb.docx