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Research paper

Evaluation of chatbot-delivered interventions for self-management of depression: Content analysis

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ABSTRACT

Background: Conversational agents (CAs) or chatbots are increasingly used for depression, anxiety, and wellbeing management. CAs are considered acceptable and helpful. However, little is known about the adequacy of CA responses. This study assessed the structure, content, and user-customization of mental health CA dialogues with users with depression or at risk of suicide.

Methods: We used content analysis to examine the dialogues of CAs previously included in three assessments of mental health apps (depression education, self-guided cognitive behavioural therapy, and suicide prevention) performed between 2019 and 2020. Two standardized user personas with depression were developed to interact with the CA. All conversations were saved as screenshots, transcribed verbatim, and coded inductively.

Results: Nine CAs were included. Seven CAs (78%) had Android and iOS versions; five CAs (56%) had at least 500,000 downloads. The analysis generated eight categories: self-introduction, personalization, appropriateness of CA responses, conveying empathy, guiding users through mood-boosting activities, mood monitoring, suicide risk management, and others. CAs could engage in empathic, non-judgemental conversations with users, offer support, and guide psychotherapeutic exercises.

Limitations: CA evaluations were performed using standardized personas, not real-world users. CAs were included for evaluation only if retrieved in the search strategies associated with the previous assessment studies.

Conclusion: Assessed CAs offered anonymous, empathic, non-judgemental interactions that align with evidence for face-to-face psychotherapy. CAs from app stores are not suited to provide comprehensive suicide risk management. Further research should evaluate the effectiveness of CA-led interventions in mental health care and in enhancing suicide risk management strategies.

1. Introduction

Conversational agents (CAs) or chatbots are computer programs that mimic human conversations (Kocaballi et al., 2019; Tudor Car et al., 2020). They are increasingly ubiquitous across all industries, including education, customer service, banking, and healthcare (Adamopoulou and Moussiades, 2020). In healthcare, CAs are extensively used in behavioural change interventions to promote a healthy lifestyle (Casas et al., 2018), self-management of chronic conditions such as diabetes (Cheng et al., 2018), asthma (Kowatsch et al., 2021), cardiovascular disease (Echeazarra et al., 2021), or mental health disorders (Fitzpatrick et al., 2017; Fulmer et al., 2018; Inkster et al., 2018), healthcare service support (Gilbert et al., 2020; Jungmann et al., 2019), or provision of health education (Crutzen et al., 2011). Mental health CAs are predominant (Laranjo et al., 2018; Milne-Ives et al., 2020; Tudor Car et al., 2020), offering management support for people with depression and anxiety, or interventions to improve general wellbeing (Abd-Alrazaq et al., 2019; Gaffney et al., 2019; Vaidyam et al., 2019).

Studies on the functionalities (Laranjo et al., 2018; Tudor Car et al., 2020), effectiveness (Milne-Ives et al., 2020), personalization (Kocaballi et al., 2019), and acceptability (Palanica et al., 2019) of healthcare CAs describe an emergent field of rule-based and task-oriented CAs, using a variety of communication channels and delivery interfaces, such as websites, proprietary messaging platforms or smartphone apps (Laranjo

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Table 1
Characteristics of included conversational agents.

CA	CA name (app name)	App store category	Platform	Downloads (Android)	Cost	Country	App type	Project
CA1	Noni (7 cups)	Health & fitness	Android/ iOS	500,000+	Free	US	Peer support communities + CA	SP
CA2	Anna (Happify)	Health & fitness	Android/ iOS	500,000+	In-app purchases	US	Gamified app + CA	CBT
CA3	Allie (InnerHour)	Health & fitness	Android	500,000+	In-app purchases	India	Diary-style app + CA	CBT
CA4	Marvin	Health & fitness	Android	100+	Free	US	CA	CBT
CA5	Serenity	Health & fitness	Android/ iOS	5,000+	Free	US	CA	CBT
CA6	Tomo	Health & fitness	Android/ iOS	10+	In-app purchases	UK	CA	–
CA7	Woebot	Medical/health & fitness	Android/ iOS	100,000+	Free	US	CA	CBT/SP
CA8	Wysa	Health & fitness	Android/ iOS	1,000,000+	In-app purchases	India	CA	CBT/SP
CA9	Youper	Medical/health & fitness	Android/ iOS	1,000,000+	In-app purchases	US	CA	Educ/CBT/ SP

CBT: self-guided CBT app assessment; Educ: depression education assessment; SP: Suicide prevention app assessment; –: the app was assessed for the self-guided CBT app project but excluded (offered behavioural activation exercises).
The analyses were conducted on the version of the app available at the point of the study. Apps may have been modified or improved over time.

et al., 2018; Tudor Car et al., 2020). CAs are generally well accepted by users, particularly if they engage in empathic dialogues (Abd-Alrazaq et al., 2021; Milne-Ives et al., 2020) and allow customization to fit individual needs (Milne-Ives et al., 2020).

Mental health CAs appear effective in reducing distress in affected individuals when compared to no intervention or information-only control groups, although their effectiveness in improving the general well-being of healthy individuals is less clear (Gaffney et al., 2019). Research participants consider mental health CAs acceptable, helpful, attractive, trustworthy, and easy to use, and view real-time feedback, weekly summaries, continuous monitoring, and journaling especially useful (Abd-Alrazaq et al., 2021; Milne-Ives et al., 2020). However, they consider repetitive statements and frequent misunderstandings the most important barriers to adoption (Abd-Alrazaq et al., 2021).

CAs to support mental health care are increasingly investigated (Fitzpatrick et al., 2017; Fulmer et al., 2018; Inkster et al., 2018; Jack et al., 2020; Ly et al., 2017). For example, recent studies evaluated the feasibility of interventions (Gabrielli et al., 2020), usage data (Dosovitsky et al., 2020; Inkster et al., 2018), or assessed their effectiveness in randomized clinical trials (Fitzpatrick et al., 2017; Fulmer et al., 2018), but no study has analysed user-CA dialogues. This study aimed to assess the structure, content, and user-customization of dialogues between mental health CAs and standardized users with depression or at risk of suicide. Specifically, we aimed to explore the following research question: "Do conversational agents currently available in the leading app stores offer people with depression an intuitive and personalized platform for the management of depression and suicide risk?

2. Methods

Qualitative content analysis, as described by Elo and Kyngäs (2008), was used to evaluate the dialogues between standardized users and CAs included in systematic assessments of direct-to-consumer depression and mental health apps (Martinengo et al., 2021; Martinengo et al., 2019).

2.1. Identifying conversational agents

Thorough assessments of mental health apps were performed between January 2019 and November 2020 to evaluate congruence with evidence-based clinical guidelines of three distinct aspects of depression management. Study 1 assessed suicide prevention strategies (Martinengo et al., 2019), study 2 evaluated self-guided CBT-based interventions (Martinengo et al., 2021), and study 3 assessed depression education content (Martinengo et al., 2022). Three systematic searches for Google Play and Apple's App Store apps were conducted in 42matters (42matters). For study 1, in January 2019 we used the search terms "depression", "depressive", "depress", "mood disorders", "suicide" and "self-harm"; for study 2, in February 2020 we searched the terms "cognitive behavioral therapy", "cognitive behavioural therapy", "cognitive therapy", "CBT", "behavioral therapy", "behavioural therapy", "behavioral activation", "behavioural activation", "online therapy", "psychotherapy", "counselling", and "talking therapy"; and for study 3, in July 2020 we searched the terms "depression", "depressive", "depressed", "mood disorder", "sadness", and "melancholia". Apps were screened against stringent inclusion and exclusion criteria and were evaluated using a comprehensive assessment checklist including the general characteristics, technical aspects and quality assurance of the apps, and a depression management section. All apps were downloaded onto iOS and Android phones and assessed by the first author. CAs were evaluated by engaging in one or more two-way conversations to ask for information about depression, follow instructions to perform CBT-related tasks or report suicidal thoughts for suicide risk-related scenarios.

All CAs, either standalone or within a more comprehensive mental health app, identified in those three studies, were included in the content analysis reported in this paper.

2.2. Assessing conversational agents

The CAs were assessed using two standardized user personas, constructed according to global demographic and risk factor profiles of people with depression (Kessler and Bromet, 2013; Malhi and Mann, 2018; Subramaniam et al., 2019). They comprised a male and a female user of similar age, medical history, responses to assessment questionnaires, and opening statements for the dialogues, but of distinct educational backgrounds, employment, and hobbies (see Appendix 1) to evaluate the level of personalization provided by the CA. Two researchers conducted the suicide risk-related and depression educational content assessments (Martinengo et al., 2022; Martinengo et al., 2019), while one researcher appraised CBT-related features (Martinengo et al., 2021).

Conversation records were stored as screenshots of all dialogue entries and subsequently transcribed verbatim to facilitate data analysis and remove duplicated statements captured in successive screenshots. For CAs with Android and iOS versions, the conversations were merged

and analysed concurrently. Only CA inputs were coded for this analysis. Users' free-text contributions were examined to assess the relevance and appropriateness of the CA responses. CAs were categorized as rule-based if they accepted only predetermined responses from users, or AI-based if they responded to users' free-text statements.

2.3. Content analysis

The analysis aimed to reflect the CA appropriateness in supporting self-management interventions in users with depression. Therefore, we evaluated the CA's response to the user's inputs, and the self-management interventions recommended by the CA, including monitoring of the user's mood, CBT-based exercises, and the recommendation of suicide prevention strategies. One researcher (LM) repeatedly read all the transcribed conversations to immerse herself in the data, and initially coded all CA statements using inductive coding (Elo and Kyngäs, 2008). Initial codes were subsequently revised and modified, if needed, in the context of the whole dialogue. Finally, codes of similar meaning units were grouped into sub-categories and overarching main categories (Elo and Kyngäs, 2008).

3. Results

Table 1 presents a summary of all included CAs. In total nine CAs were identified from previous app assessment studies and included in this analysis. Five CAs were assessed only once, either in study 1, assessing suicide prevention strategies in mental health apps (n = 1), or in study 2, evaluating self-guided CBT-based apps (n = 4). Two CAs were evaluated twice, as part of study 1 and study 2. Another CA was assessed three times, in each of the studies assessing suicide prevention strategies in mental health apps (study 1), self-guided CBT-based apps (study 2), and depression education in mental health apps (study 3). Finally, one CA was assessed but excluded from study 2, self-guided CBT-based app assessment, as it did not fit the inclusion criteria.

3.1. Characteristics of included conversational agents

Seven CAs (78%) had an Android and iOS version, while two CAs (22%) were only available in Android. All CAs were categorized as Health and Fitness in the app store, except the Android version of two standalone CAs, categorized as Medical. The Android versions of three CAs (33%) were downloaded at least 500,000 times (7 cups.; Happify.; InnerHour.), and two (22%) had at least 1,000,000 downloads (Wysa.; Youper). Three CAs (33%) were an added feature within a multifunctional mental health app, and the other six CAs (67%) were standalone. All CAs were free to download, of which three standalone CAs (33%) and two mental health apps featuring a CA (22%) required in-app payments to unlock extra features. Table 1 presents the characteristics of each CA.

All CAs had a name, and all but two (7/9, 78%) included a cartoon-like avatar. Two CAs (22%) had a definite female name associated with a female cartoon avatar in one CA; another CA (11%) had a distinctive male name and cartoon avatar. The remaining six CAs (67%) had androgynous names accompanied by a non-human avatar in five. All CAs communicated exclusively in English.

All CAs were task-oriented and focused on supporting self-management of depression or other mental health disorders. They offered a variety of activities. One CA, included within a peer support app, provided guidance to use the app and responded to users' suicidal thoughts. Two CAs included in more comprehensive mental health apps, guided users through the app activities, including CBT exercises. The other six CAs were standalone apps offering mood tracking (5/6, 83%), CBT exercises (5/6, 83%), or behavioural activation (1/6, 17%).

Six CAs (67%) accepted a combination of free text and fixed, pre-set inputs from users, while the other three CAs (33%) used one or more predetermined responses. Furthermore, all CAs used pre-set options to guide users through interventions or exercises and elicit responses to questions requiring specific answers, such as assessing suicide risk.

Table 2
List of categories and subcategories of the data derived from content analysis.

Main category	Subcategory
Self-introduction	Introduction to the app and its functions
	Initiates dialogue
Personalization	Requests information regarding the user
	Offers to check in again to promote compliance with activity
	Presents activity options
	Presents options for notifications and reminders
Appropriateness of conversational agent responses	Generic response
	Change conversation topic
	Gives a "personal" example
	Recall previous conversations
	CA statements aligned with the user's previous statements
	Does not understand the statement
	CA statement not aligned with user's previous statement
Conveying empathy	Empathic statement
	Offers support
	Encourage completion of an activity
	Congratulate user for action
Guiding users to engage or complete mood-boosting activities	Introduce activity
	Suggest activities
	Guides user during an activity
	End of activity
	How to apply the learning
	Feedback on completed activities
Mood monitoring	Ask about current mood
	Screening questionnaire
Suicide risk management	Confirms user is in crisis
	Direct user to crisis helpline numbers
Others	COVID-19 info
	Request for feedback on the app
	Request participation in research

3.2. Content analysis of conversational agent-user interactions

The analysis generated eight distinct categories, and 25 subcategories, from an initial pool of 49 codes. The number of subcategories included in each main category varied from two to seven. Table 2 summarizes these findings. The abstraction process from initial codes to main categories is summarized in Appendix 2.

3.2.1. Self-introduction

During the initial dialogue, most CAs introduced themselves, assuming a well-defined persona, and presented the CA functionalities and limitations:

> "Before we get started, let me introduce myself. I'm [name of CA], a digital coach powered by artificial intelligence and I'll be helping to guide you through the activities in this track"
>
> (CA2)

> "I'm [name of CA], your personal therapy bot! I want to help you deal with any stress, anxiety, or depression you have"
>
> (CA5)

Four CAs (44%) included a disclaimer not to use the CA for emergencies:

> "I would also like to let you know that this chat is not designed for crisis assistance. Currently, I am not equipped to support you in case you are experiencing abuse, suicidal thoughts, self-harm, medical emergencies or severe mental illnesses such as psychosis. If any of these apply to you, I urge you to seek medical help in person or reach out to a crisis hotline"
>
> (CA3)

"This is not a crisis service or a replacement of a human. [name of CA] is a self-help tool that is not intended to be a medical intervention for in-person therapy"

(CA7)

Finally, three CAs (33%) also provided information on the safeguards to protect users' personal data and the customization of privacy settings:

"Everything you share with me in this chat helps me learn more about you and develop a better understanding of you. Storing this information will help me personalise your experience. However, if you are uncomfortable with this, you can delete the chat whenever you want"

(CA3)

"All conversations and data are private. Nothing is shared with anyone at any time.

(CA8)

3.2.2. Personalization

CAs offered limited personalized features. All CAs enquired about the user's name, which was used in their interactions. They could also infer the time zone of the individual's location and used it for customized greetings:

"Hi [user name]! Welcome back. It's good to see you again. The last time we spoke, we discussed how you were feeling. I'm glad you reached out to me again today"

(CA3)

"Just to check, is it around 2:39 p.m., Saturday where you are?"

(CA8)

Additionally, one CA (CA8) requested information on the individual's approximate age, and another (CA7) requested confirmation that the user was above 18 years old. None of the CAs asked for other personal demographic information such as gender, education levels or socioeconomic status, or past medical history, including information related to the current complaint. Furthermore, CA2 asked for information on the user's support network, such as type of relationship, and closeness to the user, while CA6 offered extensive options to personalize the continuation of activities after initial trials:

"When would you like to stretch? And how often? What about weekends?"

(CA6)

Finally, CA8 personalized the privacy settings by offering users to set an access PIN:

"Also, you can set a PIN from the settings so that only you can see our chats" (CA8)

3.2.3. Appropriateness of conversational agent responses

To ascertain the capacity of CAs to understand free text statements made by the standardized user, we assessed the alignment of the CA response to the user question or claim. In general, CAs were able to respond appropriately to queries or statements, and recall previous conversations:

"Are you able to talk about what triggered these feelings? It's important that you wait till you feel strong enough to face your thoughts"

(CA8)

"You told me: My goal is to play a pick-up sport"

(CA9)

Other times the CA signposted a change of topic:

"If I can shift the conversation for a moment, I'd really like to get to know more about some of the people in your life"

(CA2)

At other moments, the CA response consisted of generic statements, not specifically related to the flow of the conversation but not inappropriate either:

"I'm really glad to hear that, [user name]"

(CA7)

"Super cool! I'm happy to hear it!"

(CA9)

Although infrequent, there were instances when the CAs were unable to understand the user's statement. CAs reacted in two different ways, they either asked for clarification:

"Oops! I couldn't compute that message. Could you try again?"

(CA1)

"I can't figure out what to call it, though. Could you give me one or two words for its title?"

(CA8)

Or they generated a response that was not aligned with the user's previous statement (misaligned statement is highlighted with bold fonts):

CA: "Finally, what's a third thing you're grateful for today?"
User: "Nothing"
CA: "**Explain more about why you feel grateful for this**"

(CA2)

User: "I will never find a new job. I'm so useless"
CA: "**Starting a new job is always scary. It's like the first day of school. I see**"

(CA5)

CA: "Choose one thing from your list that you can do today"
User: "I don't have a list"
CA: "**Bravo, [user name]!**"

(CA8)

In one instance, the CA inappropriately responded to a statement reflecting a considerable degree of distress:

User: "I just feel like dying now"
CA: "**I see. How about becoming a neuroscientist and digging deeper?**"

(CA9)

3.2.4. Conveying empathy

Seven CAs expressed compassion when the user reported hardships, sadness, or distress or offered encouragement for completed tasks or mood improvement. These empathic comments reflected an understanding of the user's feelings:

"I imagine this is a very difficult time for you and I'm sorry to hear that you're feeling so down"

(CA7)

Or an acknowledgement of special circumstances that may hinder the user's ability to complete a task:

"It's OK if you've been busy with other things"

(CA2)

CAs also offered support in case of distress, as a trusted, judgement-free companion:

"It's quite recent, then. This must be a really stressful time for you. I'd like to help"

(CA8)

Table 3
Psychotherapeutic modalities and activities offered by the CAs.

	CA2	CA3	CA4	CA5	CA6	CA7	CA8	CA9
Therapy modalities	CBT + others	CBT + others	CBT	CBT + others	BA	CBT + others	CBT + others	CBT + others
Activities offered by the CAs								
Patient education	Dep + CBT	Dep + CBT	–	–	–	CBT	CBT	Dep + CBT
Behavioural activation	Yes	Yes	–	–	Yes	Yes	–	Yes
Cognitive restructuring	Yes	Yes	–	Yes	–	Yes	Yes	Yes
Problem-solving	–	–	–	–	–	–	Yes	Yes
Relaxation	Yes	Yes	–	Yes	–	–	Yes	Yes
Mood diary	–	Yes	Yes	Yes	–	Yes	Yes	Yes
Goal setting	Yes	Yes	–	–	–	–	Yes	Yes
Others								
Gratitude	Yes	–	–	–	–	–	Yes	Yes
Acceptance	–	–	–	–	–	–	–	Yes
Positivity	Yes	–	–	–	–	–	–	
Journaling	–	–	–	–	–	Yes	–	–
Fitness	–	–	–	–	–	–	Yes	–
Games	Yes	–	–	–	–	–	–	–
Forums	Yes	Yes	–	–	–	Yes	–	–
Suicide risk management	–	–	–	Yes	Yes	Yes	Yes	Yes

CA: conversational agent; CBT: cognitive behavioural therapy; Dep: depression.

"Thanks for trusting me with this. I know it can be intimidating to talk about this, but I'm here to support you, judgment-free"

(CA9)

Or simply just being there when the suffering is substantial:

"I really wish I could give you a hug right now"

(CA1)

"Sadness can make the smallest tasks seem like an unclimbable mountain but I want you to know: I'm here to help you and we can get through this together"

(CA7)

CAs also used empathy to encourage the user after completing a task or expressing satisfaction that the user's mood is improving:

"You should be proud. Fighting back against negative thinking takes time, but the work you've put in here has laid a really strong foundation for taking control over your mind"

(CA2)

"Yay! I'm so happy it worked. I'm glad we found something that could tackle your sadness. You took a small but important step to take care of yourself, John. That is good. I'm proud of you!"

(CA3)

Or simply to express a desire that circumstances improve for the user:

"you know everyone feels hopeless sometimes: (I hope your day gets better."

(CA5)

3.2.5. *Guiding users to engage or complete mood-boosting activities*

Conversational agents guided users through the completion of activities. These activities were based on behavioural activation (BA) in one (11%) CA, or CBT in seven (78%) CAs, alone (1/7, 14%), or associated with other psychotherapies (positive psychology, acceptance and

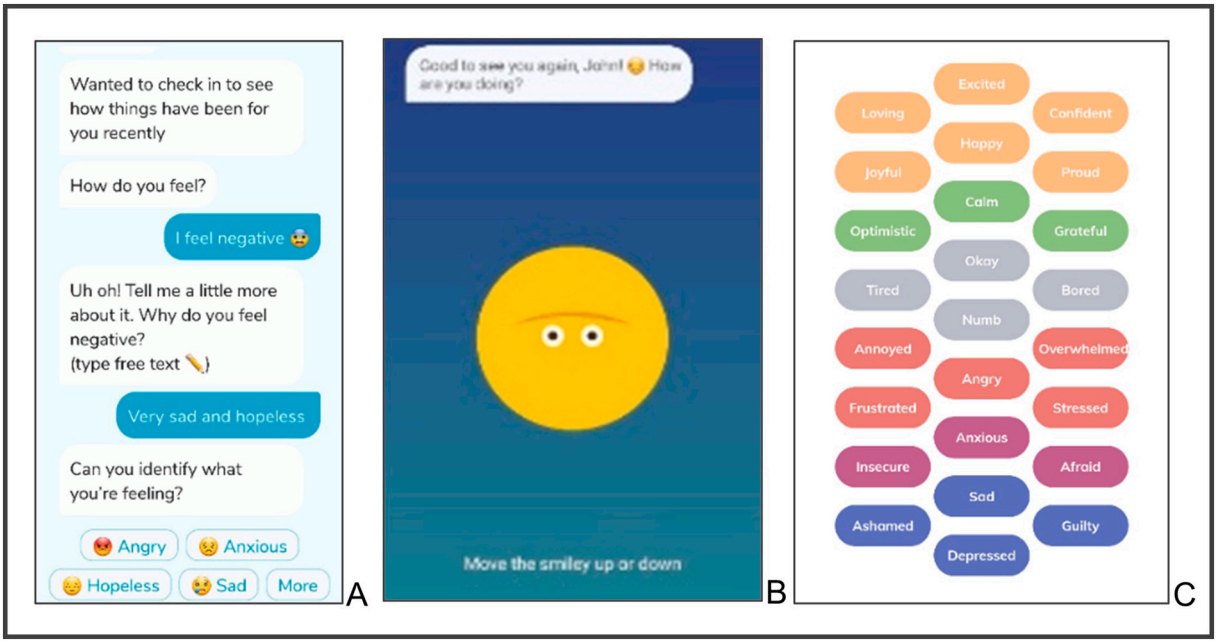

Fig. 1. Mood monitoring using emojis or other visual aids.

commitment therapy (ACT), dialectical behavioural therapy (DBT)) and mindfulness (6/7, 86%). Table 3 summarises the psychotherapeutic approaches used by CAs and the type of exercises they offered.

The CAs offered a variety of activities, guiding users in all steps:

"Good morning, [user name]! Many of the negative thoughts we have are statements based on little evidence or fact. When we prove to ourselves how untrue these statements are, the negative thoughts immediately lose their strength. Here you'll identify a few negative thoughts you have and use evidence to prove them wrong. Ready to begin?"

(CA2)

"Take a moment to think about something you want to do in the next few days. It might seem difficult, but remember — even small things to look forward to can help"

(CA3)

"Try to find a place that is free of distractions to help you relax as much as possible. You can use headphones to help you to focus on the practice. Then let me know when you're ready"

(CA9)

CAs used encouraging words when users successfully completed different phases of the activity:

"That's it for our first CBT! Understanding your thoughts is an important first step"

(CA5)

"Well done! Think about your examples. What's the main thing that's holding you back from taking better care?"

(CA6)

3.2.6. Mood monitoring

Seven (78%) CAs assessed users' mood by directly enquiring about current mood (7/7, 100%) or including a screening questionnaire (4/7, 43%). Most often, CAs used predetermined options, in the form of words or emojis to gauge users' mood, allowing for single response selection (Fig. 1):

"How are you feeling right now?"

(CA3)

"First, I'd like to understand how you're feeling. I'll do this by administering the PHQ9 test"

(CA5)

A: CA5 provided emoji and text options to log mood; B: CA8 offered an interactive emoji for the user to express mood; and C: CA9 included a selection of words grouped by colours representing the different moods

All CAs used the PHQ-9 to screen for depression, while CA8 and CA9 also assessed anxiety using GAD-7. The screening questionnaires were presented on a separate screen, except for CA4 which administered the PHQ-9 embedded in the conversational screen.

3.2.7. Suicide risk management conversations

Four CAs (44%) responded to a user at risk of suicide, by following a well-defined protocol. First, CAs confirmed the user was in crisis by directly asking about self-harm or suicidal thoughts:

"Something in your message sounded like you might be in crisis. Are you considering harming yourself or something else?"

(CA1)

"My crisis systems have been triggered. This is because I've recognized "kill myself" as an emergency. Is this the case? Are you in crisis?"

(CA7)

"Are you having thoughts of ending your life? I'm sorry if I misunderstood you, but I thought it would be better to ask"

(CA8)

"Are you having thoughts about ending your life? I know this is direct, but I thought it would be better to ask than to avoid a possible issue."

(CA9)

If the individual confirmed having suicidal thoughts, the CA offered one or more crisis helpline numbers in the next step. At least one of the phone numbers allowed a direct dialling option through the app. CA1 offered US-only emergency and crisis helpline phone numbers, while the other three CAs included access to global directories while offering direct dialling for one or two locations, generally the US, plus Europe or the UK. In addition, one CA encouraged the user to call the crisis helpline and provide an update after the call, although it did not actively seek confirmation:

"Take care, friend. Do make that call. Let me know when you have"

(CA8)

In general, a crisis protocol was triggered by an unambiguous statement of an intention to die or self-harm, using direct comments about "dying", "killing myself", or "not living" accompanied by the verb "want" or "have to":

"I don't want to live anymore"

"I want to die"

"I want kill myself"

In contrast, if similar statements about "dying" or "not living" were expressed using the phrasal verb "feel like", or users expressed deep sadness and hopelessness, the crisis protocol was not activated, nor were further enquiries made to elucidate the motives of these statements. Instead, CAs responded using unspecific, sometimes empathic statements acknowledging the user suffering, or suggesting evidence-based exercises to reframe negative thoughts, practise gratitude, or engage in mindfulness:

User: "I just feel like dying now"
CA: "Hey remember I wanted to talk about gratitude yesterday?"

(CA7)

User: "I feel very sad and hopeless"
CA: "It sounds like you are feeling somewhat sad and down. Is that true?"

(CA7)

User: "I just feel like dying now"
CA: "Embracing the whole universe of your emotions and accepting them is what makes you more human"

(CA9)

User: "I'm feeling extremely depressed

User: "*I'm feeling extremely depressed*😭"

CA: "*Understood. I'm here to support you through exploring that more*" (CA9)

"

CA: "Understood. I'm here to support you through exploring that more"

(CA9)

In contrast, CA8 appeared to follow up the conversation with statements more aligned with user feelings, even if it did not detect suicidal tendencies immediately:

User: "I am feeling very sad and quite hopeless"
CA: "Talking about it will help. I'm here to listen. I understand you are feeling sad and depressed. It is okay to be here for now, it will get better. Tell me everything"

(CA8)

However, a later iteration of CA8 became responsive to a broader range of comments to activate the crisis protocol, for example:
"I feel like dying"
"I just feel like dying now"
"I am feeling hopeless and feel like life is not worth"
"I am feeling very sad and quite hopeless"

3.2.8. Other CA features

One CA (1/9, 11%) primary function was to assist users in navigating its functionalities:

"Can you post on the welcome thread and help someone new feel welcome?"

(CA1)

Two CAs (2/9, 22%) included information on the current COVID-19 pandemic and the potential distress caused by social distancing, offering suggestions that could help users overcome it, or by sharing a "personal" story:

"Social distancing or self-isolation can disrupt your everyday life. Our activities have adapted to help you maintain physical and mental health"

(CA6)

(About visiting a friend to deliver toilet paper) "And having a nice chat together – at a distance of six feet, of course – was the highlight of my day"

(CA7)

Three CAs (33%) requested users to provide feedback on their functions, and one CA (11%) invited users to contribute usage data for a research project.

3.3. Conversational agent personality

The CAs personality was readily perceived through their interactions with the user. Following Tudor Car et al. (2020) (Tudor Car et al., 2020), all CAs displayed a "coach-like" personality, characterized by being encouraging, nurturing, and motivating (Tudor Car et al., 2020):

"If there's still work to be done to finish your goal, carry yourself forward with the confidence you feel thinking about what's worked so far. Nice work!"

(CA2)

"You mentioned that you were feeling useless and you felt really bad when your boss fired you and you do not have a job. There's usually a thought in our mind that influences how we feel. What was that thought for you?"

(CA8)

The tone of the conversation was informal in seven of the CAs, and was characterized by the use of emojis, exclamations, and colloquial expressions:

"Yay! I'm so happy it worked. I'm glad we found something that could tackle your sadness"

(CA3)

"I didn't quite catch that"

(CA6)

"wanna see if any of these same distortions are in this current thought?"

(CA7)

However, two CAs used formal vocabulary:

"Pay attention to all of your senses and to the emotions you feel during the experience"

(CA2)

"Thank you so much for, at least, entrusting me with a line of communication"

(CA4)

4. Discussion

The content analysis of dialogues between nine CAs and standardized users indicated that CAs were able to engage in empathic conversations, guide users through simple psychotherapeutic exercises, and could potentially support mental health care for people with depression. However, users should be cautious not to rely on CAs when reporting suicidal thoughts or behaviour. To our knowledge, this is the first analysis of CA-user dialogues.

CAs managed suicide risk by activating a predefined protocol that directed users to contact emergency services or crisis helplines. The protocol was deployed only after the user reported suicidal thoughts using explicit language, expressed by the verbs "want" or "have to", conveying a connotation of immediately acting on a thought. In contrast, expressions using the phrasal verb "feel like" suggesting a desire that may not translate into action in the short term, generated a non-specific response that could appear insensitive, and deepen the sense of hopelessness and being misunderstood in some users. Suicidal thoughts and behaviour carry an increased risk of severe harm and death, and users at risk of suicide should not be managed exclusively by a CA. However, CAs could be deployed to triage users at risk by identifying expressions of concern such as "extreme sadness", "feel like dying", "hopeless", "life is too hard", and "would be better dead". At the same time, CAs may allow users to voice their distress and be "heard" while offering non-judgemental, empathic support and encouraging users to contact their support network, a health professional, or a crisis helpline for further assistance.

Most CAs offered activities adapted from CBT or other psychotherapies, and relaxation or meditation techniques, including mindfulness. They guided individuals through the activity using predefined, sequential, interactive questions, more closely aligned with face-to-face interactions than other types of mental health apps. Although current evidence is limited, RCTs examining the use of CAs to deliver CBT and other psychotherapies, have reported improvement in participants' mood (Fitzpatrick et al., 2017; Fulmer et al., 2018; Ly et al., 2017), making them a feasible alternative to face-to-face therapy, particularly for people unable to access treatment (Tran et al., 2019). However, long-term adherence to digital psychotherapy remains challenging. The conversational, interactive nature of CAs may facilitate bonding with the

user and support higher engagement and long-term adherence to the intervention. Previous studies have endorsed CAs' responsiveness, friendliness, and empathy (Abd-Alrazaq et al., 2021; Milne-Ives et al., 2020), a feature that may prompt some individuals to select a CA to disclose sensitive information (Abd-Alrazaq et al., 2021). Furthermore, data from several randomized trials showed attrition rates of around 10% (Fitzpatrick et al., 2017; Fulmer et al., 2018; Ly et al., 2017) in CA-based interventions, which is substantially lower than participant dropouts of over 20% reported for other depression apps (Torous et al., 2020).

The included CAs exhibited diverse levels of "intelligence", but all incorporated pre-determined, rule-based responses to suggest activities, request information, and address users' suicidal thoughts. Selective use of pre-determined responses may prevent erroneous interpretation of user input and minimize the risk of an uncontrolled and potentially unsafe evolution of the algorithm (Char et al., 2018). Understanding human communication is very complex and depends not only on the selected words, but the context, tone, and other linguistic nuances that are unable to be extrapolated to a computer algorithm. This is particularly important when individuals refer to highly stigmatizing conditions such as mental health disorders and suicide. At the same time, the performance of an AI algorithm depends, not only on the data used to train the system, but the algorithms themselves, which may evolve in unforeseen ways if not carefully designed, deepening biases, or in healthcare settings providing wrong, and potentially harmful diagnostic or treatment advice (Char et al., 2018; Matheny et al., 2020; McGreevey et al., 2020). Special care should be exercised to use data that accurately represent the target population when designing AI-based algorithms to ensure safe, unbiased deployment of the CA.

Displays of empathy, by either sympathizing with users' distress, offering non-judgemental support or acknowledging their successes were common in all assessed CAs. Successful face-to-face psychotherapy requires that the client and the psychotherapist develop a strong, close connection based on empathy, regard for the other, and authenticity (Nienhuis et al., 2018). Several meta-analyses (Elliott et al., 2011; Nienhuis et al., 2018) have confirmed the importance of therapist's empathy in the successful development of a therapeutic alliance, which in turn is required to determine treatment success. The inclusion of empathic statements during user-CA conversations may explain the lower attrition rates seen in CA-based interventions, although further research is required to assess the impact of empathy in the adherence and effectiveness of CA-based interventions.

Most CAs communicated using colloquial language, often supported by emojis or other visual tools that emulated an informal, friendly conversation, eliciting a sense of closeness with the user (Abd-Alrazaq et al., 2021). Assessment of the conversation flow and readability is essential to develop engaging and accessible interventions able to reach users of varied educational levels. Particular attention should be placed on avoiding the use of medical or academic jargon, that may cause a break in communication (Silverman et al., 2013), leading to decreased engagement.

Occasionally, conversational agent responses were not aligned with the user's previous statements, suggesting the conversation followed a tightly scripted flow, with limited response options. The development of rule-based CAs offers several advantages for healthcare settings, primarily the complete control of the content of conversations. However, conversation scripts including limited options may lead to inadequate responses or repeated requests for clarification, and user frustration, discouraging long-term engagement (Abd-Alrazaq et al., 2021).

To preserve users' anonymity, CAs limited the request for personal information. As such, personalization was restricted to technical features like notifications, frequency and timing of check-ins, interface layout, and levels of privacy. A recent systematic review on the personalization of healthcare CAs reported that most CAs personalized their interactions with users, but implementation was not theory-based, and its impact was not fully investigated (Kocaballi et al., 2019). Individuals with mental health disorders, including depression, often find it difficult to express distress for fear of being a burden to their support network or due to stigma, and they may prefer to report sensitive topics using a digital interface (Burkill et al., 2016; Kummervold et al., 2002; Lotfipour et al., 2013). CAs offering anonymous yet personalized (Abd-Alrazaq et al., 2021) conversations may be particularly well placed to support individuals who would be otherwise unwilling to seek help.

4.1. Strengths and limitations

This study has several strengths. Firstly, the use of qualitative content analysis allowed for an in-depth analysis of the conversation flow, which may be helpful to developers when designing CAs. Secondly, the use of standardized user personas with a similar diagnosis but different demographic characteristics facilitated the comparison of responses, while evaluating the degree of personalization included by the CAs. Thirdly, the search strategy was conducted in a proprietary app database allowing for worldwide retrieval of apps without the geographical limitations of country-specific app stores.

There are several limitations to this study. Firstly, the CAs were retrieved from previous systematic app assessments using a search strategy aimed at the mental health condition rather than the type of app and may have missed relevant CAs. Secondly, the interactions with the CAs were recorded during each systematic assessment, thus CAs retrieved only in one study (suicide prevention or self-guided CBT) were not reassessed to determine their response to other interventions. Thirdly, the conversations were conducted by the researchers using standardized personas, which may limit the variety of topics discussed, while some statements may not fully reflect those of individuals with depression. Further studies evaluating the dialogs between people with depression and CAs are needed to identify the potential impact of CAs in depression management.

5. Conclusion

Conversational agents may support the management of depression, and other mental health disorders, by offering frequent, anonymous, personalized interactions to individuals unable or unwilling to contact a healthcare provider. CAs were able to engage in empathic conversations and guide users through simple psychotherapeutic exercises. However, CAs currently available in commercial app stores do not appear suited to provide comprehensive suicide risk assessment and management. Further research is needed to improve CAs for individuals at risk of suicide and to evaluate the long-term effectiveness of CA-led interventions for mental health.

CRediT authorship contribution statement

Dr. Martinengo had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: LM, EL, JC.

Acquisition, analysis, or interpretation of data: LM

Drafting of the manuscript: LM

Critical revision of the manuscript for important intellectual content: All authors.

Statistical analysis: LM.

Obtained funding: JC.

Administrative, technical, or material support: LM

Supervision: EL, JC.

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Declaration of competing interest

The authors declare no conflict of interests.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2022.09.028.

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