Chatbot for social needs screening and resource sharing with vulnerable families: Iterative design and evaluation study

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Abstract

Background: Health outcomes are significantly influenced by unmet social needs. Although screening for unmet social needs has become common in healthcare settings, there is often poor linkage to resources after needs are identified. The structural barriers (e.g., staffing, time, space) to helping address social needs could be overcome by a technology-based solution.

Objective: This study presents the design and evaluation of a chatbot, DAPHNE©, that screens for social needs and links patients to resources.

Methods: This study used a two-step approach: (1) iterative design with interdisciplinary stakeholder groups and (2) feasibility and usability assessment. Virtual sessions were held with an interdisciplinary group of stakeholders (n=10) using thematic and content analysis to inform the chatbot's design and development. Evaluation included an online survey, focus group interviews, and scenario-based usability testing with community health workers (family advocates) (n=4) and social workers (n=9).

Results: The stakeholders emphasized the importance of provider-technology collaboration, inclusive conversational design, and user education. Users found the chatbot's capabilities met expectations and the chatbot was easy to use (System Usability Scale score=72). The stakeholders raised concerns about accuracy of suggested resources, electronic health record integration, and trust with a chatbot.

Conclusions: Chatbots can provide personalized feedback platforms for families to identify and meet social needs. Our study highlights the importance of user-centered iterative design and development of chatbots for social needs. Future research should examine efficacy, cost-effectiveness, and scalability of chatbot interventions to address social needs.

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Chatbot for social needs screening and resource sharing with vulnerable families: Iterative design and evaluation study

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Abstract

Background: Health outcomes are significantly influenced by unmet social needs. Although screening for social needs has become common in healthcare settings, there is often poor linkage to resources after needs are identified. The structural barriers (e.g., staffing, time, space) to helping address social needs could be overcome by a technology-based solution. This study presents the design and evaluation of a chatbot, DAPHNE©, that screens for social needs and links patients and families to resources.
Methods: This research used a three-stage study approach: (Study 1) end-user survey to understand unmet needs and perception towards chatbots, (Study 2) iterative design with interdisciplinary stakeholder groups and (Study 3) feasibility and usability assessment. The study 1 was conducted online with low-income US resident households (n=201). Following that, virtual sessions were held with an interdisciplinary group of stakeholders (n=10) using thematic and content analysis to inform the chatbot's design and development. Finally, the assessment on feasibility and usability was completed via a mix of online survey and focus group interviews following scenario-based usability testing with community health workers (family advocates) (n=4) and social workers (n=9). We reported descriptive statistics and Chi Square test for household survey. Content analysis and thematic analysis were used to analyze qualitative data. Usability score was descriptively reported.
Results: Among the survey participants, employed and younger individuals reported a higher likelihood of using a chatbot to address social needs, in contrast to the oldest age group. Towards designing the chatbot, the stakeholders emphasized the importance of provider-technology collaboration, inclusive conversational design, and user education. The participants found the chatbot's capabilities met expectations and the chatbot was easy to use (System Usability Scale score=72/100). However, there were common concerns about accuracy of suggested resources, electronic health record integration, and trust with a chatbot.
Conclusions: Chatbots can provide personalized feedback for families to identify and meet social needs. Our study highlights the importance of user-centered iterative design and development of chatbots for social needs. Future research should examine efficacy, cost-effectiveness, and scalability of chatbot interventions to address social needs.

Keywords: social determinants of health, social needs, chatbot, conversational agent, primary care, digital health, iterative design, implementation, evaluation, usability, feasibility

Introduction

Social needs (e.g., food insecurity, housing insecurity, transportation challenges, economic instability) are strongly associated with poor health outcomes[1], perpetuating health inequities[2,3] and informing social determinants of health. Children are especially at risk when families face unmet social needs [4,5] Driven by recent recommendations, there has been rapid uptake of social needs screening.[2,6] Although screening can be relatively straightforward, linkage to resources to address social needs is a major challenge.[7,8]

Typically, clinicians provide families, who identified with a social need, a resource sheet. Families are then responsible for follow-up. Most clinics do not have social workers or other staff to help families access services and to help overcome barriers, such as language or cultural differences, financial constraints, transportation issues, limited internet access, or lack of awareness about available resources. Thus, families are often left to navigate complex social services independently, which can result in significant difficulties in obtaining much-needed assistance and support.[9] This passive provision of information is rarely effective. It is imperative to develop scalable strategies that screen for social needs and effectively link to services.

Digital health technology (DHT) could improve both screening and resource referral to assist vulnerable populations.[10] Currently, Electronic Health Records (EHRs) help facilitate screening and patient portals help with bidirectional communication.[2] However, this does not eliminate the need to maintain lists of resources and the need to link individuals to matching resources. Semi-autonomous intelligent and conversational DHTs, such as chatbots (conversational agents or dialogue systems), can help to address these gaps. By employing machine learning algorithms and natural language processing, chatbots can deliver personalized feedback and health recommendations to a wide range of users via interactive, user-friendly interfaces that are designed to maintain human conversation.[11,12] The capacity of the technology to reach and assist a large number of users simultaneously offers a cost-effective and efficient method for delivering personalized health services.[13,14] Chatbots have been used for healthcare communications, including health information seeking, health screening and support, and to improve adherence to recommended care.[15–20] A previous study [21] described a chatbot to screen adults with low and high health literacy for social needs in emergency departments. Authors reported that chatbot is performed comparable to traditional screening, and there is greater interest from lower literacy participants for a chatbot. At broader scale, chatbots show promise to facilitate social needs screening and provide personalized resources to families outside of the traditional clinic setting via speech or text, and could improve access,[22,23] and further contribute to increased understandability and personalization while addressing social needs.[21,24]

The DAPHNE© (Dialog-based Assistant Platform for Healthcare and Needs Ecosystem) chatbot project has been initiated to address unmet social needs via conversational interface for low-income or resource-limited families, who often have trouble with a complex web of social challenges that include food insecurity, inadequate housing, and financial difficulties.[25] These vulnerable groups typically experience lower incomes, higher rates of unemployment, and diminished access to quality healthcare services. In the Nationwide Children's Hospital (NCH) primary care clinics, approximately 10% of families are identified to have at least one social need,[4] reaching above 16% with food insecurity (based on current data from our ambulatory patient population). This emerging need for social support has been the main motivation of our study. In this paper, we report our findings from the iterative design, prototype development and evaluation of the chatbot, DAPHNE, for social needs screening and resource referral. In this stage of development, we focus on food

insecurity, the most frequently endorsed unmet social need which has significant impact on healthcare costs [26,27]

DAPHNE chatbot

DAPHNE is a web-app available via a computer or iOS/ Android based mobile devices over a web browser. Figure 1 presents the initial wireframe concept. The DAPHNE conversational interface prototype was designed using Adobe XD, Expo and JavaScript with a secure text-to-speech and speech-to-text service for voice interaction using Amazon Web Services (AWS). Conversational flow was designed to be rule-based. We opted for a rule-based design over language model-based or hybrid model at this stage to ensure greater transparency, predictability, and control in system responses, which is crucial for accurately identifying needs and retrieving specified resources.

Figure 1: Initial wireframes and mock-ups

The architecture, including data storage, conversational intelligence, information search and referral services, uses AWS and Microsoft Azure backend services. DAPHNE leverages Application Programming Interfaces (API) provided by community resource platforms to access resource databases. These platforms, such as FindHelp.org, 211.org and Cap4Kids.org provide information about community resources categorized by geographic region. DAPHNE's architecture is designed to be integrated with EHR, enabling the communication of social needs screening results to healthcare providers (HCP) such as social workers, community health workers, and care teams. Its functionalities are listed in Table 1. In the scope of this study, the resource database of DAPHNE was locally created for testing purposes, without leveraging real-time API connection to the community resource platforms. Also, the prototype was limited to screen one social need to reduce complexity during the testing.

Table 1. DAPHNE chatbot functionalities

Functionality	**Description**
Profile page	Users create their account and setup profile details including, name, ZIP code, family type/size and income level. The information is to

	be used for resource finding queries.
Avatar	Users can create an avatar to personalize their chatbot experience For the prototype, we used Apple's Memoji to create an avatar that dynamically reflects emotions.[28]
Language selection	Users can select their preferred language. The prototype included the following languages: Somali, Nepali and Spanish
Audio narration	Users can use text-to-speech and speech-to-text feature to enable audio entry and engagement and listen the responses
Multimodal input	Users can use voice input (using speech to input), assistive buttons pre-populated responses to select, text entry with free text form to interact with the chatbot
Social needs screening	DAPHNE uses the following standardized questions [4] to guide screening process: Food: Within the past 6 months, you worried that your food would run out before you had money to buy more. Housing: Do you think you are at risk of becoming homeless? Transportation: In the past 12 months, has lack of transportation kept you from medical appointments or from getting medications? Utility: In the past year, has the utility company shut off your service for not paying your bills?
Interactive resource sharing	DAPHNE can search the resource databases and present matching resources based on user response and ask follow-up questions.
Check-in and reminder notifications	DAPHNE can send notifications. Scheduled check-in: it can collect information if the resource shared was useful or not. Reminder: it can set and send reminders if the user would like to engage in another time. (See Figure 1 for reminder notification example)

Figure 2 outlines the chatbot ecosystem framework. Within the scope of this study, we are focusing on iterative design and evaluation of engagement using conversational interface (Figure 2.A). In the next phases, DAPHNE will have backend cloud services and API connection to access to online resource databases (Figure 2.B), provider dashboard to track engagement, control content (Figure 2.C), and integrate to medical records to report back SDH monitoring (Figure 2.D).

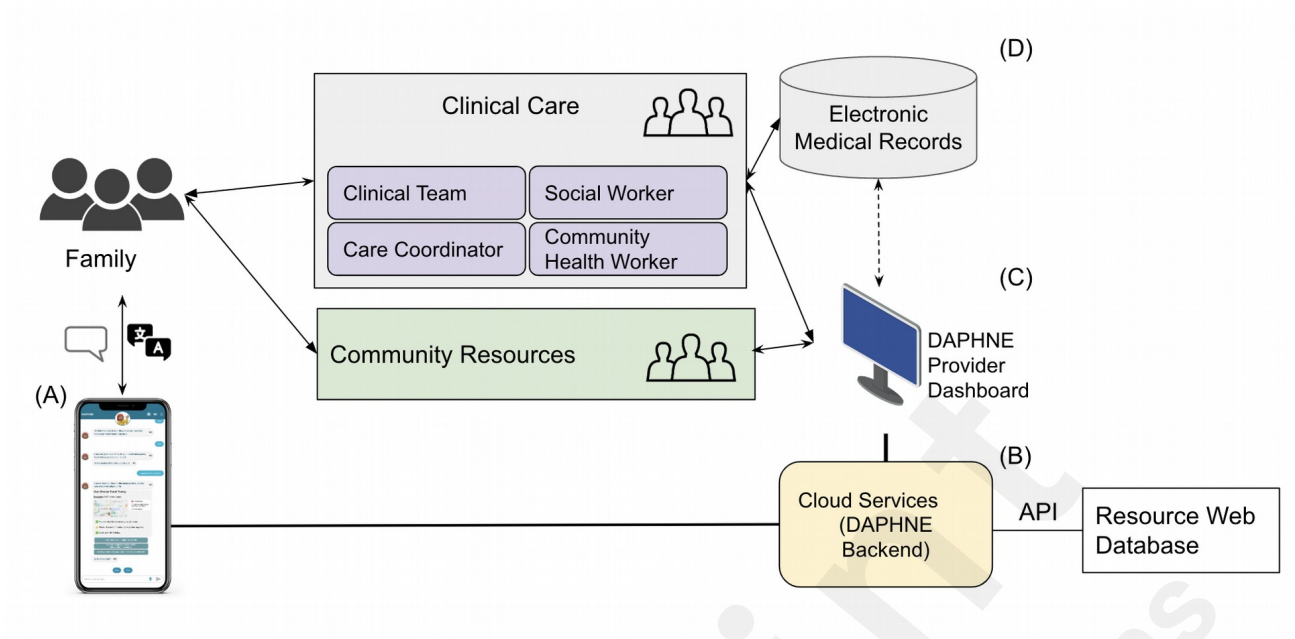


Figure 2. Conceptual framework of the chatbot ecosystem

Method

Study design and participants

The research was reported as three-stage study: (1) understanding family needs and perception towards chatbots, (2) designing the chatbot and (3) evaluating its feasibility and usability. We used a stepwise user-centered iterative and participatory development and improvement processes to ensure the proposed technology meets needs and expectations. Figure 3 presents the design, development and evaluation stages.

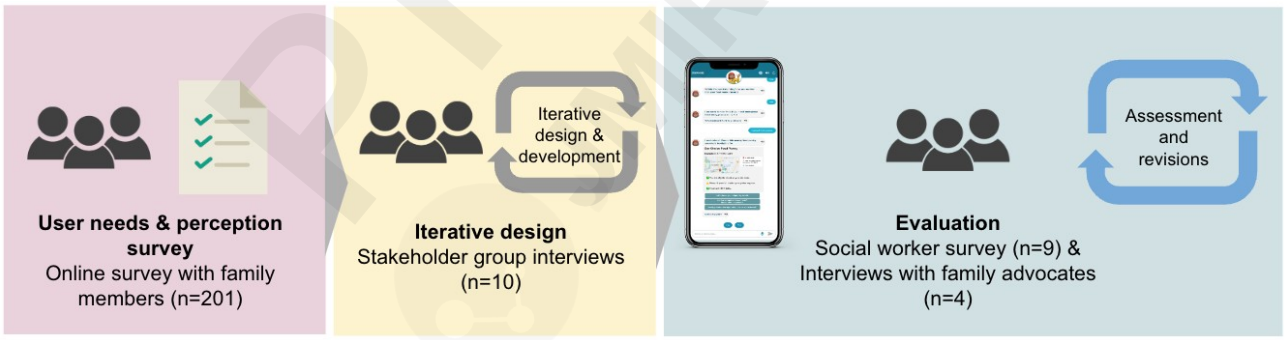


Figure 3. Study process diagram

Study 1 aims to understand families' ability to meet social needs, access essential resources, and perceptions towards using chatbots to find resources. We conducted a cross-sectional online survey. A total of 201 adults in United States households participated. Participants were living together with spouses, children and significant others, and self-reported an annual household income of $29,999 or less as of August 2023. The participants were recruited through an online platform designed for academic and market research, Prolific (https://www.prolific.com/). We followed a convenience sampling approach, inviting available participants via the survey tool. Survey details are available in Supplementary Materials.

Study 2 focuses on iterative design which includes the stages of ideation, prototyping, and refinement.[29,30] We held virtual sessions with an interdisciplinary group of stakeholders. The sessions focused on answering the following research questions to understand design preferences and needs: *"What are the pain points in current practices of social need screening and resource sharing?", "Why should we use or not use technology to facilitate this process?", "How can we design and use a chatbot to connect with families in primary care settings in order to address social needs effectively?"* For the iterative design session, an interdisciplinary stakeholder group (n=10) was formed internally at the Nationwide Children's Hospital, including epidemiologist (n=1), primary care physician (n=1) and nurse (n=1), director of clinical social work services (n=1), community health worker (n=1), public health scientist (n=1), industry partner leadership (n=1), community partner leadership (n=1), family advocate (n=1) and information system expert (n=1). Stakeholder group members were recruited within the NCH network (including primary care clinics) in September 2022.

Study 3 is mixed methods evaluation of the prototype. Our evaluation methodology was informed by a feasibility framework,[31] technology acceptance model [32] and a usability scale- Usability Metric for User Experience - Lite (UMUX-Lite) [33]. We conducted scenario-based usability testing via a focus group interview with community health workers (who are also family advocates as part of the community), and via online survey with social workers to examine the usability and feasibility of DAPHNE (semi-functional prototype) for families and communities. During these sessions, participants interacted with the chatbot to simulate the process of accessing and evaluating social resources (See supplementary materials for the scenario and questions). They used the chatbot to enter responses, navigate resource information, and provide feedback on its functionality qualitatively and quantitatively (via UMUX-Lite). Community health workers (n=4) and social workers (n=9) were recruited within the hospital network via email or phone (January- February 2023). Participation was voluntary for all participants. This study received ethical board approval (Nationwide Children's Hospital Institutional Review Board #00003766).

Data collection

In study 1, After participants signed consent, they completed a survey about their experiences. The survey captured their experiences and perceptions regarding the accessibility of social needs resources. Questions included items on awareness of and ability to access community support programs, methods used to obtain resources, and openness to using technological tools like chatbots for resource assistance. Responses were collected anonymously and the entire data collection process was structured to ensure the security and confidentiality of the participants. In study 2, iterative design sessions consisted of interactive interviews with open discussion guided by the research questions and moderated by a researcher. Wireframes were used to communicate initial design and revised designs of the chatbot (see Figure 1). In total, three 1-hour sessions of stakeholder interviews were held between September-December 2022. The research team continuously communicated with the stakeholder group via email to share iterative improvements in the prototype. Throughout the sessions and conversations, stakeholder feedback was captured as conversation notes and observational notes. In study 3, social workers completed a 20-minutes online scenario based study to use the chatbot prototype and provide feedback (See supplementary materials for scenario and survey details). They responded via an online survey tool (REDCap). Community health workers were invited to a single-session focus group interview at the hospital (~1 hour). The study team introduced the chatbot, shared examples, functionalities and a scenario-based demonstration. Usability questions and questions about dialogue and conversational design, voice interaction, perceived opportunities and barriers were verbally discussed, which followed a similar to online survey protocol. Data was collected via field notes.

Data analysis

Study 1 analysis included descriptive statistics to summarize demographic information and responses to survey questions. We compared observed distributions of income, age and employment status with responses to ability to meet social needs, knowledge about community resources and perception of chatbot use. Then, we conducted Chi-square analysis to assess association and independence of categories. In study 2, we conducted content analysis to inform the chatbot development process.[34] Stakeholder feedback was systematically analyzed by a single researcher to identify emerging themes, patterns, and insights, which were instrumental in understanding stakeholders' needs and expectations. Given the nature of semi-structured interviews and scenario-based surveys, study 3 data was analyzed using thematic analysis to synthesize the qualitative data and to understand the meanings and experiences reported in response to open ended questions and captured during the interviews.[35] The process began with two researchers independently conducting initial coding of the data. This coding was primarily inductive, allowing themes to emerge from the data, although a preliminary framework based on existing literature was also considered to guide the analysis. Regular discussions were held to review codes and themes, ensuring consistency and comprehensiveness. Data saturation was assessed to determine when no new themes were emerging, indicating sufficient depth of inquiry. Discrepancies between researchers were resolved through consensus; if consensus could not be reached, a third researcher was consulted to make a final decision, ensuring objectivity and reliability. In addition, we reported the total score of UMUX-lite, with an expected usability score of 60 or above.[33,36] The thematic analysis and usability results were triangulated to provide a robust understanding of both user satisfaction and deeper user experiences.

Results

Study 1. Family needs and perceptions

We surveyed 201 low-income households, each with at least one unmet social need, to understand their willingness to use a chatbot for resource assistance. As shown in table 2, demographics data showed an equal gender split (49.8% each and 0.5% unreported). Age distribution skewed towards the 21-40 range (60.4%), and the most reported income levels were $20,000-$29,999 (41.8%) followed by less than $10,000 (23.4%). Employment status varied, as 24.4 % of participants are full-time employed and 21.9% of them were not in paid work. Regarding unmet social needs, 33.3% of the participants found it moderately hard to meet. The majority were aware and have-used community resources (52.7%). A significant portion of participants primarily used the internet for discovering community resources (66.1%), and 60.2% were open to using a chatbot for resource finding.

Table 2. Demographics of online survey participants

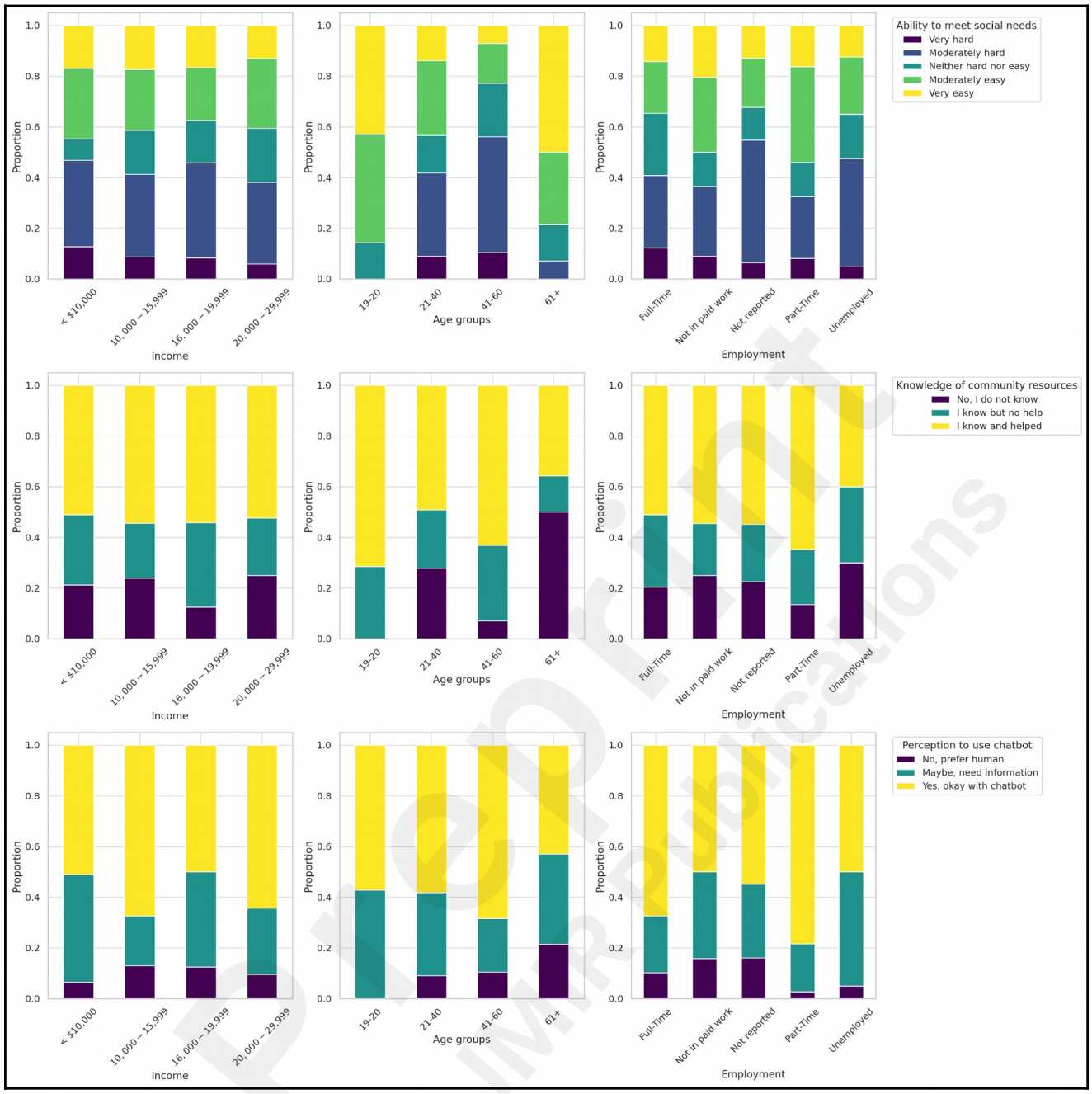
Income Range	(N)	(%)
Less than $10,000	47	23.38
$10,000 - $15,999	46	22.89
$16,000 - $19,999	24	11.94
$20,000 - $29,999	84	41.79
Gender		
Female	100	49.75
Male	100	49.75

Not reported	1	0.5
Race		
White	146	72.6
Black	24	11.9
Asian	14	7
Other	9	4.5
More than one	8	4.0
Age		
19-20	7	3.5
21- 40	122	60.4
41-60	57	28.2
61+	14	6.9
Not reported	1	1.0
Employment Status		
Full-Time	49	24.38
Part-Time	37	18.41
Unemployed (and job seeking)	40	19.9
Not in paid work (e.g., homemaker, retired, or disabled)	44	21.89
Not reported	31	15.42
Ability Meeting Social Needs		
Response	N	%
Very hard	17	8.46
Moderately hard	67	33.33
Neither hard nor easy	34	16.92
Moderately easy	52	25.87
Very easy	31	15.42
Knowledge about Community Resources		
No, I do not know about these programs	45	22.39
Yes, but could not get help	50	24.88
Yes, and they helped	106	52.74
Methods of Finding Community Resources		
Internet (websites, email)	133	66.17
In person (like at community centers, food banks, etc.)	93	46.27

Phone calls	61	20.90
Mobile apps	27	13.43
Other	20	9.95
Perception about using chatbot		
No, I would rather talk to a person	20	9.95
Maybe, I need to know more about how it works	60	29.85
Yes, I would be okay with using a chatbot	121	60.20

Figure 4 outlines proportional distribution of the responses. Lower income groups report a lower ability to meet social needs, with similar trends observed among mid-age groups and those who are unemployed. There is an increase in meeting social needs among slightly higher income earners, younger age groups, and individuals who are fully employed. Knowledge of community resources was lower among the unemployed, and the oldest age group, those over 61, exhibit a lower level of community resources awareness and utilization of community programs. In terms of chatbot usage, while there is a general receptiveness across all income levels, employed and younger individuals, particularly those between 21-40, demonstrate a higher tendency to use chatbot technology. In contrast, the oldest age group demonstrates a greater preference for human interaction over using chatbots.

Figure 4. Stacked bar graphs showing the proportional distribution of the survey responses for social needs and perception towards chatbot by income, age group and employment status



Chi-square analysis resulted with no strong evidence of dependency between income (x^2= 7.93, df = 6, p = 0.243), age (x^2= 6.47, df = 6, p = 0.372), and ability to meet social needs (x^2 = 6.18, df = 8, p = 0.627) with the perception of using a chatbot. However, there is a statistically significant association between knowledge about community resources and chatbot perception (x^2 = 12.91, df = 4, p = 0.012). In addition, the relationship between employment and chatbot perception is marginally close to being significant (x^2 = 15.48, df = 8, p = 0.051).

Study 2. Iterative design

The themes were grouped under three research questions. Table 3 outlines the questions and themes for each question. Themes included common pain points, technology opportunities and challenges, and technology considerations, including inclusivity, personalization, and information about accessing resources. Based on stakeholder feedback, we improved our chatbot design (Figure 5). We updated the prototype to include chatbot language options, modified language (e.g., “What makes it hard to get food?”), and resource education options (i.e., eligibility criteria, documentation

requirements, and referral guidance). These components are initiated and under development.

Table 3. Themes from stakeholder group sessions

Questions	Themes
"What are the pain points in current practices of social need screening and resource sharing?"	● **Inadequate or inconsistent screening tools:** The tools used for social need screening may not be comprehensive enough for addressing all social needs associated with SDH, resulting in incomplete assessments. Additionally, there might be inconsistency in the use of these tools across different settings, leading to variations in the identification and understanding of social needs. ● **Limited provider training and awareness:** Healthcare providers and other professionals involved in social need screening may lack sufficient training and awareness about how to implement and screen, and also address the needs. This can lead to lower quality of service as well as adversely affecting quality of life. ● **Fragmented systems and lack of integration:** Social need screening and resource sharing efforts are often fragmented across different divisions, departments, and organizations. This can lead to poor communication and collaboration, creating barriers to the effective identification and provision of resources. ● **Insufficient resources and capacity:** There may be a lack of adequate resources and capacity to address identified social needs based on the location and resources of institutions (rural vs urban health institution), resulting in unmet needs or long waiting periods for support. This can exacerbate existing disparities and negatively impact health outcomes. ● **Stigma and privacy concerns:** Patients and families may be reluctant to disclose their sensitive information as well as their social needs due to concerns about stigma or privacy. This can prevent accurate identification of needs and hinder access to appropriate resources. ● **Cultural and linguistic barriers:** Cultural and linguistic differences may negatively impact communication among providers and patients/ families, leading to misunderstandings and underestimation of social needs. This can result in the inadequate provision of resources and support.
"Why should we use or not use technology to facilitate this process?"	**Opportunities** ● **Improved efficiency:** Technology can streamline the screening and resource sharing process, reducing the time and effort required by both providers and patients/families. Automated systems and digital platforms can facilitate data collection, storage, and retrieval, making it easier to identify and address social needs at scale especially within low resource settings. ● **Standardization and consistency**: Digital tools can help ensure that social need screening is conducted in a standardized and consistent manner across different settings, reducing variations in the identification and understanding of social needs. ● **Personalization and customization:** Technology can enable more personalized and customized approaches to social need screening and resource sharing, tailoring interventions to the specific needs and preferences of patients and families (which can be beneficial considering cultural appropriateness, language options). **Challenges** ● **Digital divide:** The use of technology may exacerbate existing disparities in access to digital tools, particularly among vulnerable populations. This can result in the further marginalization of those who may be most in need of support yet do not have access to the necessary technology. ● **Privacy and security concerns:** Storing and sharing sensitive data and private information electronically can raise privacy and security concerns for individuals and institutions. It might be particularly concerning if appropriate safeguards are not in place to protect the information by the technology providers. ● **Implementation challenges:** Introducing a new approach with technology into social need screening and resource sharing processes may involve significant financial and human resource investments to initiate, as well as creating barriers or burdens related to staff training, infrastructure, and technological compatibility.
"*How can we*	● **Leveraging Provider and technology collaboration,** which means that chatbot and healthcare

design and use a chatbot to connect with families in primary care settings in order to address social needs effectively?"	providers (e.g. primary care team) and community centers can work together to serve families better and more effectively. ● Suggested use case 1: Chatbot as a triage follow-up tool that healthcare providers and community centers can "prescribe" to follow up after their visit, to ensure patient and family needs are met, and resources are useful (or not). So that chatbot can inform providers timely to intervene in case of unmet needs, as well as help to identify invalid or non-eligible resources, and update their resource list and database accordingly. ● Suggested use case 2: Chatbot as a pre-screening tool to inform providers and community centers about what needs to be communicated with families, and getting ready for detailed conversation about the resources and how to access them. The chatbot can ease the process of support and patient engagement so that providers can serve more families timely and spare more time to engage as well as for identifying and addressing urgent needs during their conversations. ● Conversational design could be guided to be more **inclusive and personal** ● Current screening instruments are not individually relatable or personal, and chatbot can be guided toward more conversational personalized screening, which can eventually inform current screening tools. Reframing dialogues towards positive attitude and social norms are some of the methods discussed. ● Cultural appropriateness and language barriers could be addressed by chatbot providing language options (e.g. Ohio has a high rate of Nepali and Somali refugees with limited English proficiency and requires interpreter services) and culturally guided and appropriate conversations and dialogue flow, accounting in cultural norms and connotation (e.g. In some cultures "free resource" still may mean you have to pay back due to cultural expectations or practices). ● Chatbots can help **educate families** about accessing resources (beyond sharing the resource, guiding for self-referral, how to check eligibility, how to navigate online resources…). This may eventually reduce dependency on low risk or quickly accessible resources by families and patients, reserving time and resources of health institutions and community centers to be spent with patients and families having urgent needs or complex needs.

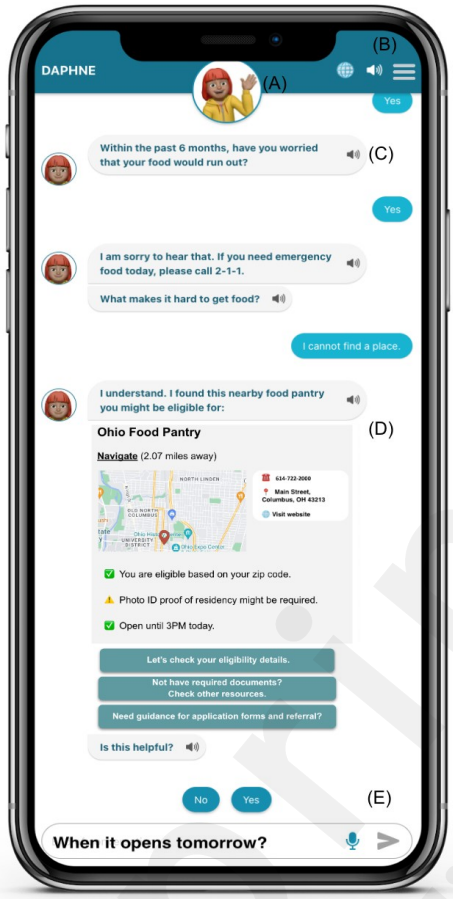


Figure 5: Revised semi-functional prototype (web app). (A) Customizable avatar, (B) Profile and setting menu, language selection and enable/disable audio narration (text-to-speech), (C) repeating audio narration for preferred messages, (D) interactive resource screen with navigation and communication details and follow-up questions suggested by stakeholders (E) assistive buttons for quick response, or text entry or speech-to-text for voice interaction.

Study 3. Prototype Evaluation

We collected feedback from 13 participants including community health workers (n=4) and social workers n=9) within the NCH network (Table 4). Community health workers had less than 5 years of professional experience (n=3, 75%). They had limited experience with chatbots and conversational agents. They are supporting families through the Connecting Families 4 Success program at NCH which provides resource linkages to families with identified social needs.

The majority of social workers ranged from 1 to 10 years of experience in their current profession (n=6, 67%). Most had prior exposure to chatbots (n=8, 89%). Social workers reported that they serve an average of 165 patients or families monthly. The social workers responded to the usability questions (UMUX) using a 7-point Likert scale, agreeing that the chatbot's capabilities met expectations to address social needs (Average score= 5.4) and its ease of use (Average score=5.6). Collectively, they agreed on the usability of chatbot, achieving an average of 72 system usability scale (SUS) score (calculated using Lewis et al.'s [37] regression equation)

Table 4: Social worker demographics

	Social worker (n=9)	Community health worker (n=4)

Have you ever used chatbots before for any purpose?	**n**	**%**	**n**	**%**
Yes, multiple times	8	88.8	1	25.0
No, never	1	11.1	3	75.0
Age group				
18-24	1	11.1	2	50.0
25-34	3	33.3	1	25.0
35-44	2	22.2	1	25.0
45-54	3	33.3	0	0.0
Experience				
Less than 1 year	1	11.1	2	50.0
1-5 years	3	33.3	1	25.0
5-10 years	3	33.3	1	25.0
10-20 years	1	11.1	0	0.0
More than 20 years	1	11.1	0	0.0

We analyzed responses from community health workers and social workers together and grouped under overarching 4 themes identified as: user experience (how users perceive the chatbot, interact with it and perception about its functionality and satisfaction), feature preferences (user preferences for additional features in the chatbot), resource concerns (the challenges related to the accuracy, relevance, and timeliness of the resources provided by the chatbot), perceived disadvantages and challenges (limitations and potential obstacles associated with using the chatbot) (Table 5). The themes were informed by the interview and survey questions, focusing on user experience (meeting expectations, ease of use), chatbot dialogue, audio interaction, perceived advantages and disadvantages, and integration to clinical workflow. As outlined in Table 5, our thematic analysis suggests that the use of a chatbot is perceived to be useful for patients, caregivers and providers, and can help with social needs and resource sharing. More specifically, social workers and community health workers appreciated its clear interface but noted the need for detailed options on eligibility and documentation. Opinions on audio narration were mixed, with some valuing it for accessibility and others preferring text for privacy. The need for multilingual support and careful consideration of privacy with EHR integration was also emphasized. Users were concerned about the accuracy and currency of resource information, doubtful of technology's current capability to update its content without human verification. Major drawbacks included the chatbot's inability to interpret nonverbal cues and complex situations, limited access to necessary technology for some users, and concerns about data privacy and trust.

Table 5: Themes from interviews and online survey with social workers and community health workers

Themes	**Explanations**	**Quotes**
User Experience	● Conversational interface was found to be simple and understandable. It is noted as “easy to use” as it enables turn based conversation via natural language through text messaging like interface with the option of voice interaction.	“[Dialogues] were clear and easy to understand” Participant #5 "Dialogue is overall

	● The simplicity of the dialogue was appreciated, although some suggested adding more options and details about resources, such as, expanding options for eligibility details, required documents and forms. Even though these components were included during the iterative design process, they were not functionally adapted in the prototype during the testing.	acceptable. I'd be interested in hearing what 'other' options it may generate for people who have food instability due to other reasons." Participant #8
Feature preference	● There was mixed feedback on whether audio narration would be preferable. Some participants thought it would be helpful, especially for those who face language barriers, have difficulty reading or writing, or physical impairment. However, others believe that families may prefer text or typing in certain cases, such as public places. ● Several participants mentioned the importance of offering multiple language options to engage with a diverse population and non-English speakers. Current service limitations and inability to follow-up due to language barriers necessitates such alternative support on communicating social needs. ● Opinions on integrating chatbot data with EHRs were mixed. Some participants supported integration for better decision-making and follow-up, while others were concerned about privacy, consent, and the potential for surveillance or stigmatization	“...voice to text can be sometimes challenging, as with Siri at times and this is more so common for individuals whose first language is not English.” Participant #4 “I think [chatbot] could [help if integrated to EHR] for basic medical records, but families might try to use this to ask medical questions thinking a doctor might respond.” Participant #3
Resource concerns	● Participants expressed concerns about the accuracy of resources and how to ensure up-to-date resource information. The concerns were also about identifying relevant resources to specific age groups or situations, which may not be available in a single database or web resource. In the current practice, support teams (e.g., community centers, social work) need to reach out and check availability of resources (e.g. food pantry) and eligibility to ensure the resource provider is operational before referring to a patient and family. ● Participants emphasize that any technology need to ensure resources are up to date, and with given mechanisms, they were skeptic that it is achievable with technology capabilities (given the necessity of calling and communicating with the service providers to ensure resource list is up-to-date)	"[resources] might not always be accurate if all the places are not regularly updated in the system." Participant #9 "It will also be useful to have more details about the pantry such as open hours of operation." Participant #6
Perceived Disadvantages and Challenges	● Some participants expressed concerns about the chatbot's major communication limitation, which is its inability to assess nonverbal cues, understand nuanced situations, and therefore, may not be able to articulate social need details to guide for appropriate resources. ● Limited access to technology, broadband or Wi-Fi, or mobile devices could pose challenges for some families. ● It is noted that some families or patients might be uncomfortable sharing personal information with a chatbot or might not trust the information provided by a chatbot.	“One disadvantage might be the chatbot not being able to assess nonverbal cues, or other concerns the family might have that can't be typed into a box.” Participant #5 “[Chatbot] can't share nuanced situations. Can it understand the intersection of different needs?...organizations that have food and housing resources if you are looking for orgs specifically with both” Participant #4

Discussion

Principal findings

We reported a three-stage study with a multi-stakeholder group, focusing on the development and evaluation of a social needs screening chatbot for families. Engaging stakeholders, including low-income households, healthcare providers and family advocates, throughout the needs assessment, design and development process helped identify specific needs, preferences, perceptions towards using chatbots and potential barriers to adoption. Our study highlights the importance of multi-layered and user-centered iterative design and development of chatbots for social needs. Furthermore, it was a promising step forward to develop a chatbot collectively with partners and to serve families effectively via conversational systems. [38,39] It also contributes to the literature, [19,21] by providing further evidence on diverse stakeholder perceptions of chatbot use in social need screening and resource sharing.

Our first study highlights that the awareness of community resources is traditionally less among lower income and unemployed groups, as well as among older households. However, the majority of participants, irrespective of demographics, use the internet to identify community resources. Even though this is promising, further investigation is needed on how to leverage current communication technologies to close the gap in digital inclusion, improving awareness of resources and access. [40,41] Furthermore, a broad acceptance of chatbot technology across all income levels is observed, as younger individuals, notably those aged 21-40, lead the charge in embracing this digital interaction. This suggests a generational pivot towards utilizing chatbots similarly to prior observations with acceptance of new technologies.[42] The knowledge of individuals with social needs and employment status is further associated with their perception about chatbots.

Our second study highlights potential implementation areas and improvements for the chatbot to be more engaging and effective. In the current healthcare ecosystem, chatbots may serve a dual function as follow-up tools and triage systems, as recommended by healthcare providers and community centers subsequent to family visits, ensuring the effective utilization of resources and to meet social needs. In line with that, chatbot data can be used for timely feedback to healthcare systems about unmet needs as well as to facilitate the updating of resource repositories and databases (e.g., user feedback on non-operational food pantries). When deployed as pre-screening instruments, chatbots can enable providers and community centers to be adequately prepared for comprehensive discussions about resource availability and access, thereby streamlining support procedures. Conversational design can be strategically geared towards providing more inclusive and personalized needs-assessment.[43–45] By enhancing the relational capacities of a chatbot [46]—including positive attitudes and social norms (e.g., “Others have found assistance through this local agency.”), and implementing behavioral nudges (e.g., “Completing this screening will require just a few minutes.”) within the conversational design, its engagement abilities can be bolstered. In addition, a chatbot can address cultural compatibility and linguistic barriers by providing multilingual options and culturally-sensitive dialogues.[47] In the context of current practices to adequately address social needs,[48] chatbots can act as supportive adjuncts, supplementing and enhancing these efforts. Furthermore, chatbots can play an educational role in assisting families in understanding and accessing resources, steering them through self-referral processes, eligibility assessments, and online resource navigation. As a next step, chatbots can be instrumental in augmenting health literacy,[49] as they have been well-received in addressing social needs among populations with low literacy levels.[24].

Building on top of stakeholder feedback, we implemented improvements in our chatbot prototype. In the study 3, our descriptive analysis showed a diverse range of participants in terms of age, experience, and department affiliation, providing a rich perspective on the chatbot's applicability with various contexts. Participants have generally rated the chatbot's capabilities and ease of use as average to high. The results of our study indicate that the chatbot designed for addressing social needs is generally well-received, with most users finding it easy to use and having a positive user experience overall. This overlaps with current trajectory with chatbot use in healthcare, as their capability increases as well as usefulness.[50,51]

Emerging opportunities and barriers

Audio narration emerged as a theme with mixed opinions. While some users believed it could benefit those facing language barriers or with difficulty reading, others felt that text-based communication would be more appropriate in publicly available spaces, which was also noted previously as a common concern on using voice interaction in health information exchange.[52]

Resource accuracy and availability were identified as concerns by participants, emphasizing the importance of regularly updating resource information and ensuring that resources are relevant to specific age groups or profiles. In order to ensure the sustainability and maintenance of resources, and accuracy of the DAPHNE’s responses, automatic updates of the chatbot resource listings by syncing with APIs provided by established community resource platforms may ensure the real-time accuracy. Additionally, a user feedback mechanism is in place (resource being helpful or not) via chatbot interface, allowing users to report any discrepancies or changes required in the resource information directly through the chatbot interface. Such a human-in-the-loop feedback mechanism is crucial for continuous improvement and helps maintain a high level of trust and reliability in the resources provided.[53,54]

Integration with EHRs received mixed feedback, with some users supporting the idea for better decision-making and follow-up. Such implementation is principally viable to support decision making with a feedback mechanism.[55] Others expressed concerns about privacy and potential stigmatization, which may lead to labeling and internalized negative stereotypes that may reduce disclosing social needs.[56] Therefore, EHR integration and adoption requires detailed investigation to reduce barriers and inequality in medical documentation.[56,57] For privacy, data transmitted to EHRs should be via HIPAA compliant services and encrypted, and a governance body should be established for regular oversight.[58,59] Additionally, where possible, data anonymization could be implemented to protect patient identity. To address stigma, training healthcare providers on handling sensitive information respectfully and confidentially is needed, which is crucial for integrating social determinants of health into patient care without bias.[60]

Participants raised several disadvantages and challenges related to the chatbot's ability to assess nonverbal cues and accurately screen needs, limited access to technology, and trust issues when sharing personal information with a non-human source. In that regard, using a single modality communication medium (no visual exchange) might limit chatbot ability to process nonverbal cues. Multimodal approaches with chatbots may overcome this limitation in the future.[61] Chatbot’s dependency on technology platforms (computer, Wi-Fi, or smart mobile devices) and data plans may limit access. Even though there are existing programs to support broadband access to low-income families (e.g., Affordable Connectivity Program by FCC),[62] in the long term, this underscores the importance of strategic consideration of the digital divide and accessibility challenges when designing and implementing chatbots for social needs. In earlier studies, IVR systems and chatbot over text messaging have been viable alternatives, which might be adapted for social needs screening and resource sharing, especially in rural areas.[63] The lack of trust between chatbot and families

might negatively influence the use. Some participants expressed concerns about sharing personal information with a non-human actor or not trusting the information provided by the chatbot. Literature has mixed evidence towards trust between humans and chatbot,[64] and further research can inform the trust built between families and chatbot.

Expanding with broader social needs

The potential scalability of the DAPHNE chatbot extends beyond its current application in food insecurity. At its current state, its design accommodates the integration of additional social needs by incorporating a flexible, rule-based conversational architecture that can be customized with minimal technical adjustments. For example, the chatbot could be adapted to screen for housing instability or transportation difficulties by updating the dialogue scripts and linking to different resource databases. Moreover, the back-end infrastructure, built on cloud services, supports scalability to handle increased user traffic and data volume as the system expands.

Improving technical capabilities

Even though current chatbot conversational flow was designed as rule-based, transformer-based large language models and AI-enabled conversational agents are alternative approaches to delegate a variety of tasks.[65,66] These intelligent chatbots include a large range of functionalities that set them apart from their predecessors, such as: i) engaging in discussions across multiple topics, ii) managing multi-turn conversations, iii) retaining information from previous conversations, iv) operating in both task-based and non-task-based modes, and most importantly, and v) collaborating effectively with users. In particular, being able to work together with users, listening to their instructions and understanding their preferences through naturally occurring conversations open up a wealth of opportunities for both healthcare providers and families with social needs. Although there are major concerns related to privacy, reliability and accuracy,[67] we can expect the development of hybrid solutions with increased conversational competence of the chatbots while being constrained by the strict specifications of a rule-based system. In addition, current guidelines and practices for developing skills to engage in sensitive conversation, like food insecurity, can be informative for AI enabled chatbot development.[68,69] For instance, AHA's guidelines suggesting cultural competency, motivational interviewing, active listening and empathic inquiry would be valuable input for conversational design and development. [70]

Future research

It is essential to evaluate the long-term effectiveness, scale-up capability to increase access resources, and impact of chatbots for addressing social needs through rigorous and comprehensive evaluation methodologies.[71,72] Our study provides preliminary evidence on the iterative design and evaluation of the chatbot for addressing social needs (focusing on food insecurity screening and resource sharing with text and voice interaction). However, future research should investigate the impact of chatbot interventions on users' health outcomes, quality of life, and access to resources, as well as the cost-effectiveness and scalability of such interventions. While chatbots can play a valuable role in addressing social needs, they are unlikely to replace human service providers entirely. Instead, chatbots can be considered complementary tools that support and enhance existing services by providing timely, personalized, and accessible information and resources. Future research should explore the potential synergies and integration opportunities between chatbots and other digital health interventions, such as telemedicine, mobile health apps, and online support groups, to maximize the overall impact on users' health and well-being.

Limitations

There are several limitations that should be acknowledged while interpreting the study results. First,

our participants in study 2 and 3 consist of stakeholders representing providers more than patients and caregivers, which may potentially skew the feedback towards professional perspectives. Providers may have perspectives or biased interests that differ from those of patients and caregivers, potentially leading to an overemphasis on the functionality and clinical utility of the chatbot. This skew could limit the generalizability of our findings to broader end-user experiences and might overlook key usability challenges faced by less technologically proficient users. Moreover, the diversity and size of our participant sample may not fully represent the broader population, which could limit the generalizability of our findings. Second, our research was conducted in a controlled setting with a single scenario and did not involve any real-world testing and observations. As such, the practical implications of our study remain limited to self-reported and perceived usability, feasibility and implementation with a limited user experience. Further research in real-world scenarios is required to evaluate the effectiveness and feasibility of chatbot in addressing social needs. Third, our research focused primarily on qualitative data, thus lacking quantitative information to assess the chatbot performance with a longitudinal observation. Even though we collected preliminary data from households towards their social needs and perception to use chatbot, the effort was limited in terms of demographic diversity and feedback (without chatbot engagement), and it may be subject to self-report bias. Future studies will aim to collect quantitative measures with real world chatbot use, such as user logs, response accuracy and user satisfaction rates, to provide a more comprehensive evaluation of the chatbot in addressing social needs.

Conclusion

The study reported iterative design and evaluation of a chatbot for social needs screening and resource identification, designed to scale screening and resource sharing for low-resource communities and disadvantaged neighborhoods. Further, it may augment health centers services, delegating low risk tasks (such as resource finding and sharing) to chatbot to scale the services provided. The DAPHNE chatbot has garnered largely favorable responses, providing initial evidence for its practicality and viability. Crucial factors in designing chatbots for social needs involve fostering user confidence, ensuring the precision of resources, and tackling accessibility obstacles. Future studies should investigate the efficacy, cost-efficiency, and expandability of chatbot initiatives, the opportunities provided by conversational AI technologies, as well as possible collaborations with other established digital health interventions.

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Conflict of Interest

ES serves on the editorial board of JMIR Publications.

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Supplementary Files

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