










Original article

Mobile application for addressing COVID-19 in Brazil's epicenter

Aplicativo móvel para o enfrentamento à COVID-19 no epicentro brasileiro

Aplicación móvil para abordar la COVID-19 en el epicentro de Brasil

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Abstract

Objective: To characterize the services provided by the mobile application Chatbot/Call Center implemented as a strategy to combat the COVID-19 pandemic in Manaus, Amazonas. **Method:** A quantitative, cross-sectional, retrospective study based on the following variables: age, gender, origin, geolocation, comorbidities, main questions, complaints of signs and symptoms, municipality, total number of accesses, and waiting time. **Results:** A total of 85,000 consultations were recorded, including 27,156 calls/conversations. Of these, 1,384 (5.1%) were resolved exclusively through automated service. Among the five most frequent user concerns, the most common complaints were fever, chest pain, and dyspnea, totaling 528 occurrences. **Conclusion:** The application proved to be an innovative health care technology, facilitating access to information and appropriate decision-making procedures for the assisted population. It helped reduce people's mobility, the spread of the disease, and the demand on health services.

Descriptors: Information Technology; COVID-19; Call Centers; Pandemics; Public Health Nursing

Resumo

instalado como estratégia de enfrentamento a pandemia da COVID-19 em Manaus, Amazonas. **Método:** estudo quantitativo, transversal, retrospectivo, constituído com as seguintes variáveis: idade, gênero, procedência, geolocalização, comorbidades, principais dúvidas, queixas de sinais e sintomas, município, total de acessos e tempo de espera. **Resultados:** foram contabilizados 85 mil atendimentos, 27.156 ligações/conversas, desse total 1.384 (5,1%) tiveram resolução apenas pelo atendimento automático. Entre as cinco questões mais frequentes dos usuários, a maior queixa foi a de febre, dor torácica e dispneia, com um total de 528 ocorrências. **Conclusão:** o aplicativo se mostrou uma tecnologia inovadora de cuidado à saúde, favorecendo o acesso à informação e procedimentos adequados de tomada de decisões da população atendida, evitando a mobilidade das pessoas, disseminação da doença e demandas dos serviços de saúde.

Descritores: Tecnologia da Informação; COVID-19; Call Centers; Pandemias; Enfermagem de Saúde Pública

Resumen

Objetivo: Caracterizar los servicios prestados por la aplicación móvil *Chatbot/Call Center* implementada como estrategia para enfrentar la pandemia de COVID-19 en Manaus, Amazonas.

Método: Estudio cuantitativo, transversal y retrospectivo, basado en las siguientes variables: edad, género, procedencia, geolocalización, comorbilidades, principales dudas, quejas de signos y síntomas, municipio, número total de accesos y tiempo de espera. **Resultados:** Se registraron un total de 85.000 consultas, incluyendo 27.156 llamadas/conversaciones. De estas, 1.384 (5,1%) fueron resueltas exclusivamente mediante atención automatizada. Entre las cinco preocupaciones más frecuentes de los usuarios, las quejas más comunes fueron fiebre, dolor torácico y disnea, con un total de 528 ocurrencias.

Descriptor: Tecnología de la Información; COVID-19; Centrales de Llamados; Pandemias; Enfermería en Salud Pública

Introduction

COVID-19, caused by a virus known as SARS-CoV-2, was declared a pandemic by the World Health Organization (WHO) on March 11, 2020, following significant reports of the disease due to its rapid spread across the globe. The first cases were recorded in the city of Wuhan, China, in December 2019.¹

In Brazil, the first confirmed cases of COVID-19 date back to February 2020. Three months later, the country ranked 4th among those most affected by the pandemic, both in terms of confirmed cases ($n = 241,080$) and deaths ($n = 16,188$).² Among the regions of the country, the North accounted for 22% of the total cases. In the State of Amazonas alone, in May 2020, there were 20,328 cases and 1,413 deaths, making it the 4th state with the highest number of cases and mortality, and one of the epicenters of the country.^{3,4}

Studies on the incidence of COVID-19 per thousand inhabitants, calculated based on projections from *Instituto Brasileiro de Geografia e Estatística* ("*IBGE*", Brazilian Institute of Geography and Statistics) for 2020, showed that among Brazilian capitals, Manaus, the capital of Amazonas, ranked 5th (762 cases) in April of that year, behind Fortaleza (1,007 cases), São Luís (899 cases), Recife (850 cases), and São Paulo (789 cases). Furthermore, the research highlighted the existence of poor healthcare and sanitation infrastructure, a shortage of Intensive Care Unit (ICU) beds, as well as pulmonary ventilators and healthcare professionals in most Brazilian states.³

In this context, with the rapid spread of the disease, measures such as early detection of positive cases, mask utilization, home isolation, and social distancing actions, as well as the pursuit of better therapeutic strategies, were adopted, since the

positive impacts of these measures were already known worldwide, contributing to a reduction in mortality curves.⁵⁻⁶ However, these measures were still insufficient, allowing the disease to cause a collapse in the public healthcare system due to overcrowded hospital beds, especially in intensive care units (ICUs). This was the case in Manaus, which experienced the worst pandemic scenario in the country at the time, exposing shocking scenes of death that gained visibility and repercussion across the globe.⁷

Faced with this pandemic and epidemic scenario, the need arose for the adoption of interactive and innovative strategies to confront this major public health issue - for example, the use of Information and Communication Technologies (ICTs). These technological resources have been identified as promising tools in the fight against COVID-19, such as telehealth and telemedicine, home care services, smart medicine, artificial intelligence (AI), mobile health applications, emails, and phone calls. Their aim is to improve access to information and speed up care delivery, while reducing the risks of contagion and disease spread, as well as lowering costs and demand for hospital services.⁶⁻⁹

Mobile applications, in particular, are software programs designed to operate on platforms such as smartphones, tablets, smartwatches, and even internet-connected televisions. They have proven to be powerful tools for health interventions, expanding access and improving the efficiency of services. Among the innovations associated with these apps, conversational agents, especially chatbots, stand out. These are a type of artificial intelligence (AI) that use Natural Language Processing (NLP) techniques to interact with users. These systems can be accessed via mobile devices and serve as facilitators of automated or semi-interactive communication, widely used to optimize healthcare services, from scheduling appointments and managing clinical data to providing personalized guidance.⁸⁻⁹

From this perspective, the *Universidade do Estado do Amazonas* ("UEA", State University of Amazonas), located in the northern region of Brazil, implemented a remote care service through a mobile Chatbot/Call Center application. The goal was to provide the local population with individualized, automated, and real-time information about COVID-19, especially regarding the recognition of symptoms,

prevention methods, and guidance on how to proceed in suspected cases. The initiative also aimed to reduce the demand for care at public healthcare units, which were already overwhelmed and facing collapse.

Given the need to produce and disseminate knowledge as a socially relevant contribution to healthcare practices in the fight against major endemic diseases, the following research question was proposed: *How were the Chatbot/Call Center services characterized from a strategic perspective in confronting the COVID-19 pandemic in Manaus, Amazonas?*

The study aimed to characterize the services provided by the mobile Chatbot/Call Center application implemented as a strategic response to the COVID-19 pandemic in Manaus, Amazonas.

Method

A quantitative, cross-sectional, and retrospective study was conducted at a public university located in a state within the Brazilian Amazon. The State of Amazonas, immersed in the vast greenery of the hot and humid Amazon Rainforest, is home to a population of just over four million inhabitants, spread across a territory of nearly 1,600,000 km², with a population density of 2.23 inhabitants/km², of which 52% reside in Manaus.¹⁰

The sample consisted of an analysis of the Chatbot/Call Center platform during the period from April 1 to July 30, 2020, which marked the highest incidence of COVID-19 cases in the state. Data were collected from the platform's hosting system, including the following variables: age, gender, place of origin, geolocation, comorbidities, main questions and concerns, reported signs and symptoms, municipality, total number of accesses, and waiting time for service. The following were excluded: calls that were not completed, incomplete data, and services with external or unrelated purposes.

For this study, a preliminary selection of data stored in the mobile technology was considered, totaling 85,000 consultations, all monitored and supervised by nurses, physicians, and dentists. After applying the inclusion and exclusion criteria, a final sample of 53,000 consultations was selected.

Data were collected using a form developed by the researchers, which included the sociodemographic characterization of the population. The form was made available electronically through the platform, without identifying participants, and included

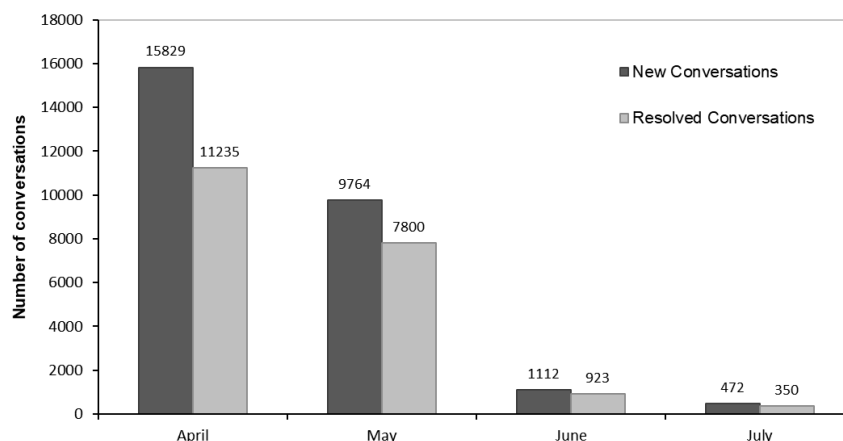
frequency, proportions, and median values for the variables. The analysis was supported by computational tools for data organization and processing, specifically the SASI Platform, a suite of software used in digital communication that systematizes reports based on analytical and descriptive statistical procedures.

The study adhered to ethical principles of confidentiality, privacy, and anonymity, in accordance with Resolution 466/2012 of the *Conselho Nacional de Saúde* (National Health Council). It was initiated following approval of the research proposal by the Research Ethics Committee of the *Universidade do Estado do Amazonas*, under approval number 4.148.014, dated July 10, 2020.

Results

Over the course of 122 days of service provided to the population through the Chatbot/Call Center, a total of 85,000 consultations were recorded, including 27,156 calls/conversations. Of this total, 1,384 (5.1%) were resolved entirely by the bot, meaning the call was opened and closed without the need for personalized assistance. Figure 1 illustrates the monthly number of users who initiated a conversation in the system and those who received a personalized response from the team. The majority of these consultations occurred in April, with a gradual decline in the following months.

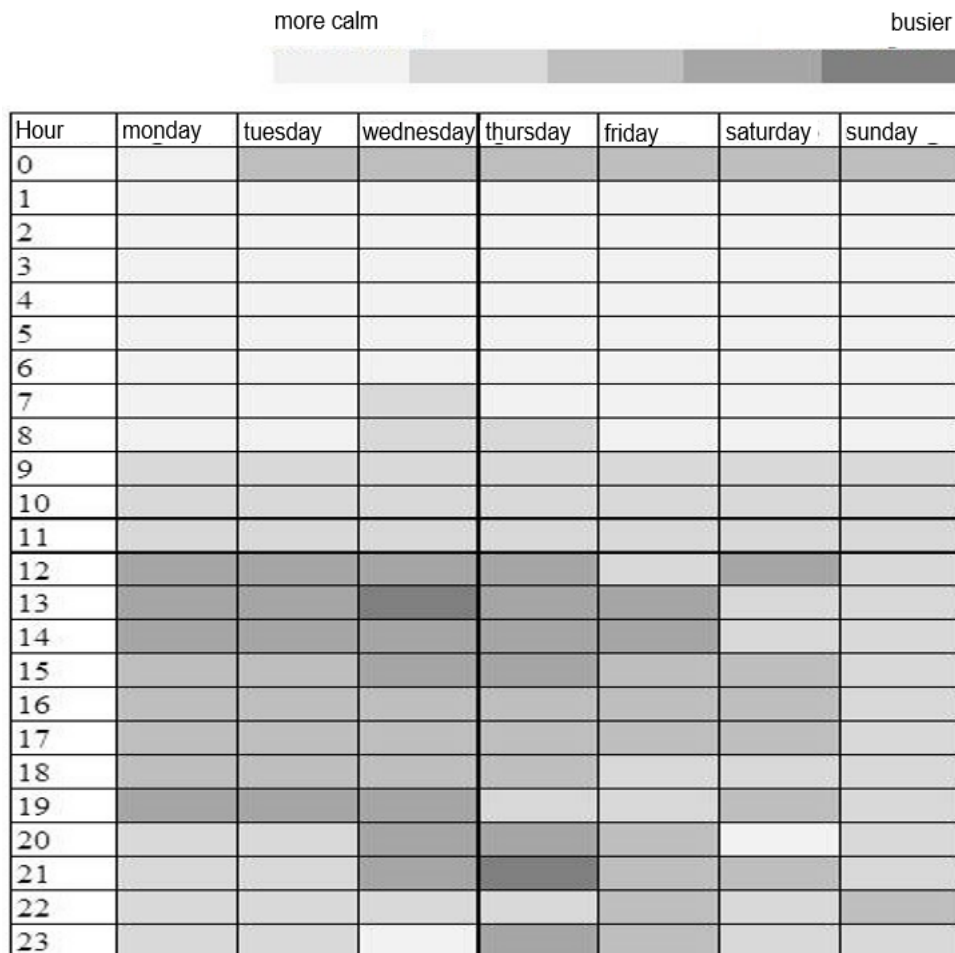
Figure 1- Monthly distribution of the number of calls/conversations conducted and the number of personalized services provided by the Chatbot/Call Center team. Manaus, Amazonas, Brazil, 2020



Comparing the pandemic's peak months (April–May) in the state of Amazonas, consultation volumes also peaked in that same period, exceeding those of the subsequent months. In relative terms, however, the share of conversations that were reopened remained stable across the four-month service period, averaging 24%.

The average first response time for users, following automated service, was 19 minutes and 24 seconds. The longest waiting time occurred in April (approximately 40 minutes), while the shortest was in July (approximately 4 minutes). After initiating contact with the system, 99.7% of users responded either to the automated or personalized service, while only 0.3% did not interact with the system. The highest demand for services occurred during daytime hours, with peak activity between 12:00 PM and 2:00 PM on all days of the week except Sunday. The maximum peak was recorded on Tuesdays around 9:00 PM (Figure 2).

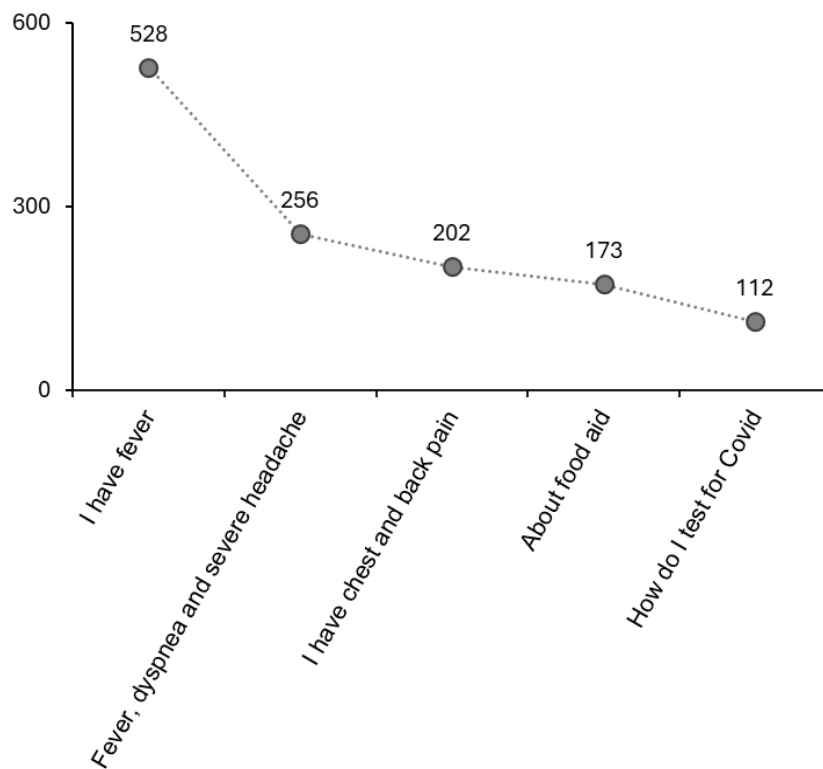
Figure 2 - Peak periods for personalized service via Chatbot/Call Center. Manaus, Amazonas, Brazil, 2020



Of the total number of users who accessed the service, 64% were female, primarily in the age groups of 30 to 40 years (26%) and 20 to 30 years (23%). 61% of users were referred to attending physicians and nurses, while 39% were directed to psychologists. Notably, 53.6% of all consultations occurred on the day the Call Center was launched. Although the Chatbot/Call Center service for COVID-19 response was mainly used by residents of Manaus, calls were also received from residents of other municipalities in the state of Amazonas, such as Tefé (0.08%), Rio Preto da Eva (0.03%), and Parintins (0.01%).

Among those who sought assistance through the Chatbot/Call Center, 270 individuals (1% of total consultations) identified themselves as belonging to the COVID-19 risk group, meaning they had at least one comorbidity (such as obesity, diabetes, hypertension, immunodeficiency, among others). Among the five most frequent questions asked by users during their initial interaction with the automated system, the most common complaint was elevated body temperature (fever), with 528 occurrences (Figure 3).

Figure 03 - Most frequent responses resolved through automated Chatbot/Call Center service. Manaus, Amazonas, Brazil, 2020



Among the most frequently asked questions by users to initiate a conversation and receive a response from the support team were: “When will I get tested for COVID-19?” (75%); “If I feel something, what should I do?” (8.33%); 4.17% for each of the following questions: There is a case of coronavirus in home isolation, how should the rest of the family proceed?; Who are the people that need to remain in social isolation?; Can someone without symptoms transmit the coronavirus?; How long can a person transmit COVID-19?

Discussion

The results showed that the Chatbot/Call Center service was widely used by the local population, demonstrating its ability to meet high demand interactively through a conversational approach between users and healthcare professionals. The guidance provided included essential health education content, such as preventive measures, social isolation protocols, directions to healthcare facilities, non-pharmacological care and interventions, as well as identification of signs and symptoms of the disease.

A study aimed at identifying the use of chatbots as strategic tools in response to public health challenges during the COVID-19 pandemic revealed the implementation of 61 applications across 30 countries worldwide. These services focused on risk assessment, information dissemination (and even misinformation), health surveillance, vaccine scheduling, and screening and follow-up of post-COVID-19 cases. It is also worth noting that the deployment of these services was carried out quickly and simply, as was the case with the Chatbot/Call Center analyzed in this study.¹¹⁻¹²

Some studies also observed that chatbots were designed for the general public, while others targeted specific audiences such as healthcare professionals, adolescents, and LGBT populations. African countries, for example, implemented the mHero platform to connect frontline healthcare workers with the Ministry of Health, enabling access to accurate and timely information.¹³⁻¹⁴

In the present study, female users were the ones who most frequently accessed the Chatbot/Call Center. However, this does not necessarily indicate that women were the most affected by the disease in Amazonas. The higher rate of access by women to healthcare services in Brazil is historically linked to their role in family caregiving, often

taking the initiative to seek medical assistance or health guidance for their children, partners, parents, and other relatives. Nonetheless, another study revealed that men and women have equal chances of contracting the virus, but men show significantly higher evidence of experiencing severe effects of the disease, with a fatality rate 2.5 times higher than that of women, regardless of age.¹⁵

Regarding the most frequently reported signs and symptoms by Chatbot users, fever, dyspnea, and chest pain were identified, highlighting the key symptoms that clinically differentiate COVID-19 from the common cold. According to the Ministry of Health, the most frequent clinical manifestations confirmed in the Unified Health System (SUS) are cases presenting cough, fever, sore throat, and dyspnea. As for the disease progression, most cases evolved toward recovery, while others were advised to undergo home treatment or were referred for hospitalization, and approximately 1.8% progressed to death.¹⁶⁻¹⁷

Regarding the most frequently reported signs and symptoms by Chatbot users, fever, dyspnea, and chest pain were identified, highlighting the key symptoms that clinically differentiate COVID-19 from the common cold. According to the Ministry of Health, the most frequent clinical manifestations confirmed in the "SUS" (Unified Health System) were cases presenting cough, fever, sore throat, and dyspnea. As for the progression of the disease, most cases evolved toward recovery, while others were advised to undergo home treatment or were referred for hospitalization, and approximately 1.8% progressed to death.¹⁶⁻¹⁷

The clinical information obtained through interactions with the Chatbot/Call Center was essential for screening severe cases and assessing the risk of COVID-19 complications. Based on Ministry of Health protocols and the list of available services in the local healthcare network, it was possible to direct information, optimize patient flow, and preserve hospital capacity. The initiative also contributed to social isolation measures, helping to prevent unnecessary travel. Other studies report similar strategies, such as referrals for consultations, telehealth sessions, and the availability of emergency contact numbers.¹¹⁻¹³

The results of the present study showed that Chatbot users, especially those presenting symptoms, were primarily seeking testing to confirm a diagnosis. During the most critical phase of the pandemic in the state of Amazonas and in Brazil, testing was restricted to severely ill hospitalized patients.¹⁷

Brazil emerged as one of the most affected countries by the disease, yet among those that conducted the fewest COVID-19 tests on its population. As a result, testing difficulties in healthcare units after the onset of symptoms led to increased demand for personalized assistance via the Chatbot, which allowed for a more detailed investigation of users' symptoms and their onset. Case confirmation during the pandemic remained a challenge nationwide, as tests were scarce for those in need. Moreover, approximately 80% of COVID-19 cases were asymptomatic, and were often underreported due to individuals undergoing testing without observing the necessary time interval between symptom onset and laboratory diagnosis, resulting in false negatives.¹⁸

Only 25% of access to the Chatbot/Call Center corresponded to responses related to guidance on healthcare units designated for treating individuals with symptoms of the disease, preventive measures, and information on how to act throughout the course of the illness. It is suggested that this is due to the actions of the *Plano de Contingência Nacional da COVID-19* (National COVID-19 Contingency Plan) of the Ministry of Health, which included containment, prevention, control, and case/contact monitoring measures carried out by health surveillance teams and were widely implemented across the country. Additionally, contingency information was extensively disseminated through social media platforms.¹⁹

Of the 62 municipalities in the State of Amazonas, service requests were received from only three, accounting for less than 0.1% of total consultations. Although the implementation of the Chatbot/Call Center within the *Subsistema de Atenção à Saúde do Estado* ("SASI", State Health Care Subsystem) aimed to enhance communication speed—and many rural areas do have access to mobile internet—a large portion of communities are located along riverbanks, which poses a significant barrier to accessing the application.²⁰

It is worth noting that in Brazil and other countries, the use of digital tools in the fight against and control of COVID-19 was experienced in a positive and effective

manner, as evidenced in the present study. For example, the online chat available on the website <https://coronavirus.saude.gov.br>, provided by the Ministry of Health, along with the telephone number 136 for nationwide public assistance, were both created to facilitate communication between patients and healthcare services.²¹

Similarly, India, the United States, Croatia, and Spain developed and implemented technological tools such as Chatbots and Call Centers to help users clarify doubts about COVID-19 and assess infection risk based on reported symptoms. In addition, these countries adopted telemedicine and telepsychiatry resources to enable real-time communication, support decision-making for professionals and users, provide prevention and care guides, geolocate active cases, and refer patients to specialized services.²²⁻²³

The fight against COVID-19 strengthened the global use of digital tools, giving rise to new possibilities for interaction between healthcare services, professionals, and patients, thereby enabling remote access to care and health assistance. It is important to highlight the collective effort involving students and faculty from dentistry, medicine, and especially nursing programs—the team that conceived and organized the Chatbot/Call Center initiative.

In this context, the service, integrated with local interventions by the *Fundação de Vigilância em Saúde do Amazonas* (Amazonas State Health Surveillance Foundation) and offered free of charge to the population, carried out over 27,000 consultations, establishing itself as an initiative of high technological, social, and academic relevance. Its role was fundamental in supporting the population during the pandemic, serving as a strategic tool for health education, early identification of COVID-19 symptoms, and dissemination of information about the availability of other healthcare services, in-person care locations, diagnostic testing, specialized treatment, and emotional and psychological Support, therefore strengthening the healthcare network and expanding the response capacity in the face of the public health emergency.

A key limitation of this study is that the sample analyzed was restricted to the population of Amazonas, which may limit the generalizability of the results to other contexts. Additionally, the service period was relatively short, making it impossible to evaluate other aspects such as follow-up consultations and referrals made.

Conclusion

The characteristics of the services provided through the mobile application known as Chatbot/Call Center during the COVID-19 pandemic in Amazonas proved to be an important technological tool for supporting public health. It promoted agility in care delivery, helped reduce demand on hospital services, and contributed to social isolation efforts, thereby limiting the spread of the virus.

It is worth highlighting the collaboration between the service and academic institutions, whose combined efforts were essential in addressing the population's health needs, expanding access to care, and reinforcing the implementation of the initiatives in "SUS". In this sense, the Chatbot service is recommended as a rapid and scalable solution, offering cost-effective access to health information and the ability to influence behavior and support decision-making in large-scale emergency situations such as the COVID-19 pandemic.

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