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Development and evaluation of a medical teleconsultation application for the Brazilian Army

Desarrollo y evaluación de una aplicación de teleconsulta médica para el Ejército Brasileño

Abstract: The Brazilian Army is present throughout the country, and some units are located in remote areas where there is a shortage of medical subspecialists for clinical management. The advent of telemedicine makes it possible to meet this demand. In this paper, we describe the development, prototyping, and evaluation of an application for conducting medical teleconsultations in the Brazilian Army, with the aim of reducing the number of referrals to civilian health organizations. The application, called EBSAU, was evaluated in two aspects: usability and quality. Tests were conducted with 60 patients and three specialist physicians (Pediatrics, Internal Medicine, and General Surgery). The usability assessment indicated that both patients and physicians responded positively to the proposed application (SUS score: 82/100). The qualitative evaluation showed a high degree of satisfaction in both groups, indicating a positive impact. Tests with EBSAU demonstrated that its implementation in the force would reduce referral costs and help meet the demand for medical care.

Keywords: medical teleconsultations, Brazilian Army, application, military sciences, health.

Resumen: El Ejército Brasileño tiene una alcance nacional, y algunas de sus unidades están ubicadas en lugares remotos, donde hay escasez de subespecialidades médicas para la asistencia clínica. La telemedicina puede satisfacer esta demanda. En este trabajo describimos el desarrollo, prototipado y evaluación de una aplicación para teleconsultas médicas para el Ejército Brasileño, con el objetivo de reducir el número de derivaciones a organizaciones civiles de salud. La aplicación denominada EBSAU se evaluó en dos aspectos: funcionalidad y calidad. Las pruebas se realizaron con 60 pacientes y tres médicos especialistas (pediatría, clínica médica y cirugía general). La evaluación de funcionalidad identificó que los pacientes y los médicos tuvieron una buena aceptación de la aplicación propuesta (puntuación SUS 82/100 puntos). La evaluación cualitativa mostró un alto nivel de satisfacción en ambos grupos, lo cual indicó un impacto positivo. Las pruebas con la EBSAU demostraron que su implementación en la fuerza puede reducir los costos de las derivaciones y ayudar la demanda de atención.

Palabras clave: teleconsultas médicas, Ejército Brasileño, aplicación, ciencias militares, salud.

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1 INTRODUCTION

The Brazilian Army is present in the most diverse corners of the country, some of which of difficult access. These units face a limited management of pathologies due to scarce specialized human resources (Arantes de Moraes; Franchi; Rocha, 2024).

The advent and growing use of telemedicine have reduced distances and improved access to specialists in these remote locations via digital tools (Vidal, 2020). Telemedicine has emerged as a powerful resource in health care, remotely supporting, for example, patients and general practitioners by videoconferences. These cases showed its positive impact by reducing mortality rates and the severity of disease sequela, increasing patients' adherence to treatment, and improving the overall quality of health services, while reducing their costs (Melo, 2019).

Countries such as the United States of America, Germany, France, and Italy already use telemedicine as a means to meet the military and civilian demand for health support. The U.S. Army experimentally uses vital signs telemetry (heart rate, blood pressure, and electrocardiogram tracing) to monitor soldiers on the front. Real-time monitoring provides individualized care and rationalizes the evacuation resources in health support (Melo, 2019).

The Brazilian Army's health system has gaps in its provision of telecare services, particularly in access to medical subspecialties. The development of a teleconsultation application is a promising strategy to fill these gaps by enabling remote specialized medical care and offering equitable access to health. This functionality becomes especially relevant in military units in geographically remote or hard-to-reach regions, which face a restricted availability of specialized professionals. In addition to increasing the problem-solving capacity of the system, this technology also securely stores clinical data on an integrated basis, favoring the continuity of care and efficiency in the management of health information.

This study designed, developed, prototyped, and evaluated a platform for teleconsultations, considering the specificities of the Brazilian Army's health system, to address the lack of medical subspecialties in the military health system effective staff, especially in remote locations, since this absence generates a high number of referrals to civilian health organizations or autonomous professionals (Melo, 2019). The proposed application consists of scheduling and consultation modules, support for videoconferences, and post-consultation support for professionals' feedback. This study evaluated two aspects of its prototype: usability and quality. It was tested with 60 patients and three physicians of pediatrics, internal medicine, and general surgery fields. Its usability assessment found that patients and physicians accepted the proposed application well (82/100 points). The qualitative evaluation showed great satisfaction from both groups, indicating the positive impact of its prototype.

2 LITERATURE REVIEW

Several articles mention the use of telemedicine in the armed forces as a strategic resource and cost reduction in health. However, the current literature has no description of teleconsultation applications used by the Brazilian armed forces and no record exist of the institution formally adopting any such application.

To survey the state of the art in the use of telemedicine in the armed forces, this research carried out an integrative literature review for the terms "*Forças Armadas*," "*Teleconsulta*," and "*Aplicativos*" on PubMed, SciELO, and Google Scholar, which required accessing the Health Sciences Descriptors database to locate the subject via the keywords above.

A total of 56 articles were retrieved. The titles and abstracts of the chosen articles were read, and the following inclusion and exclusion criteria were considered:

- Exclusion criteria: articles that neither addressed telemedicine nor related the use of digital care technologies in Armed Forces medicine.
- Inclusion criteria: articles that described the use of telemedicine as an alternative to care or digital technologies that enabled remote care in Armed Forces.

With these filters, only seven of the 56 articles were chosen for evaluation. Their most relevant aspects are discussed sequentially below.

In 2017, the Brazilian Navy, in partnership with Universidade Federal Fluminense, created a video collaboration telepresence system for medical teleconsultations with holography. The system has a virtual health consultation via telepresence and holography, promoting specialized care in remote locations (especially in the Amazon) that have precarious health care (Fonseca; Fernandes; Carrano, 2019).

Reis, Carvalho, and Santos (2020) have described the use of telemedicine resources in the evaluation and follow-up of patients with neurosurgical pathologies. Its applicability reduced costs for the Army Health Service, morbidity, and limitations due to geographical distances and time.

Mohammadi *et al.* (2020) systematically reviewed studies on telemedicine in armed forces across the globe. They point out that the USA has the most telemedicine projects in progress, the positive effects of which on the provision of health care to military forces refers to cost reduction. That review indicates the need to adapt and implement a system to safely enable the Brazilian Army using this modality of care.

Schallhorn, Richmond, and Schallhorn (2020) addressed the United States Navy using remote medical consultations for military operations that lack *in loco* subspecialist. They proposed to show the use of teleconsultations with medical subspecialties via appointments and in an on-call format with its own secure system, also allowing for exams and medical prescriptions to be requested through a single platform.

Similar to the previously mentioned project, the evaluation of an ophthalmological teleconsultation application in Gensheimer *et al.* (2020) described its use by besieged US troops in Afghanistan. Results indicated approval and good satisfaction with this type of service in combat zones as it can provide prescriptions and medical requests within its specialty. This is the first article to show the ease of use of an application for scheduling ophthalmological appointments and in which the concern with the data collected resembles the aspects in the Brazilian Data Protection Law.

Likewise, Schafrank *et al.* (2021) mentioned the importance of dermatological teleconsultations in military operational environments as a critical factor due to its lower cost and greater efficiency than in-person consultations in field hospitals. Despite describing dermatological teleconsultations as a facilitating resource for diagnosis and treatment, the study lacked a proprietary application that could schedule appointments.

The last chosen article, Segobia *et al.* (2019) described a video collaboration by a telemedicine application called Video For Health that enabled, during the COVID-19 pandemic, virtual meetings between patients, family members, and the health care team of the the Brazilian Army São Paulo Area Military Hospital. This study showed a safe application that had been developed for the care, integration, reception, and information of family members about hospitalized patients' condition. The application could schedule virtual visits but no medical consultations or support for prescriptions or exam requests.

Table 1 summarizes the evaluated studies and highlights some comparison criteria. The proposed application had to feature the topics in the first column of the table. Moreover, it was important to evaluate whether the chosen articles had included these topics and how they addressed them.

Table 1 — Comparison of functionalities between the retrieved articles

	Fonseca, Fernandes, and Carrano (2019)	**Reis, Carvalho, and Santos (2020)**	**Mohammadi *et al.* (2020)**	**Schallhorn, Richmond, and Schallhorn (2020)**	**Gensheimer *et al.* (2020)**	**Schafrank *et al.* (2021)**	**Segobia *et al.* (2019)**
Armed forces worldwide	N	Y	Y	Y	Y	Y	Y
Brazilian Army	N	Y	N	N	N	N	Y
Application	N	N	N	N	Y	N	Y
All medical specialties	Y	N	N	Y	N	N	N
Appointment scheduling	N	Y	N	N	N	Y	N
Video teleconsultations	Y	Y	Y	Y	Y	Y	N
Prescriptions or exam requests	N	Y	N	Y	Y	Y	N
Safety	Y	N	N	Y	Y	Y	Y

Y: yes; N: No.

Source: Prepared by the authors (2024).

In addition to the integrative review above, we investigated the applications on the market and how they featured the characteristics of Table 1. Although we have found several teleconsultation applications in the private market (Doc24: https://www.doc24.com.br/; Telemedicina Einstein: https://www.telemedicina.einstein.br/; AppHealth: https://www.apphealth.com.br/; Conexa Saúde: https://www.conexasaude.com.br/, etc.) that provide telemedicine services in which it is possible to schedule medical appointments of any specialty and enjoy a secure service with electronic medical records and other functionalities appropriate to the Brazilian Data Protection Law, the literature shows a gap regarding the use of medical teleconsultation application by Brazilian armed forces.

3 METHODOLOGY

A medical teleconsultation application for the Brazilian Army was developed, prototyped, and evaluated in this methodological and quantitative study in three stages: (1) prototype development (design and implementation); (2) quantitative usability evaluation (via a system usability scale [SUS] questionnaire); and (3) satisfaction assessment (by a questionnaire based on the "consolidated criteria for reporting qualitative research").

Note that, given its sensitive and private nature, we neither used official information nor had access to the Brazilian Army database to create our application. Thus, the data in our project simulated the main required elements to validate this information in the application.

3.1 Application development

Requirements and necessary functionalities were surveyed as a preliminary step to develop the application and validated to connect ideas. As a basic requirement, it was established that the functionalities and types of data and codes in the Brazilian Army be adopted so the prototype would fit the current system. Once again, real data, metadata, and procedures were not used due to their confidentiality.

The system should include a mobile application with a version for physicians and another for patients.

The following features should be available in the patients' version:

- login with username and password (simulating data that would have been registered in the Army database since routines of new registrations will not be covered);
- access to functionality that allows the registration of underage users in the main users' login;
- access to information on specialties for selection;
- access to dates and places available for scheduling appointments;
- a mechanism for completing the appointment and a confirmation message;

- access to a functionality to view the scheduled appointments and a cancellation option, if relevant;
- on the day of the session, an authentication should grant users access to a virtual office;
- consultations should take place by videoconference with activated camera and audio.

The following features should be available in the physicians' version:

- login with username and password (simulating the data that would have been registered in the Army database);
- access to a functionality to view appointments;
- on the day of the session, physicians' authentication should grant them access to their scheduled appointments of the day and to their virtual office;
- consultations should take place by videoconference with activated camera and audio.
- the virtual office interface would have a text area so physicians could record the information from the consultation, which must be stored in a database for later references;
- after the teleconsultation session is over, physicians should be able to classify care as delivered or not;
- a registration area to make available the list of previous consultations and the described information.

In addition to the requirements of mobile applications directly used by patients and physicians, the system should also include local information and transmit sensitive data in encrypted form.

The proposed system should also provide for a back-end structure, i.e., a set of elements on a remote server that contains a database to retain information, such as user registration, session metadata, scheduling, etc., the structure of which should be aligned to contain information inherent to military systems, such as the Prec-CP (beneficiary registration number), military ID, and SIAPE registration (civil servant registration number). The system would also have to contain the available specialties and identify the military units that would be available for consultation.

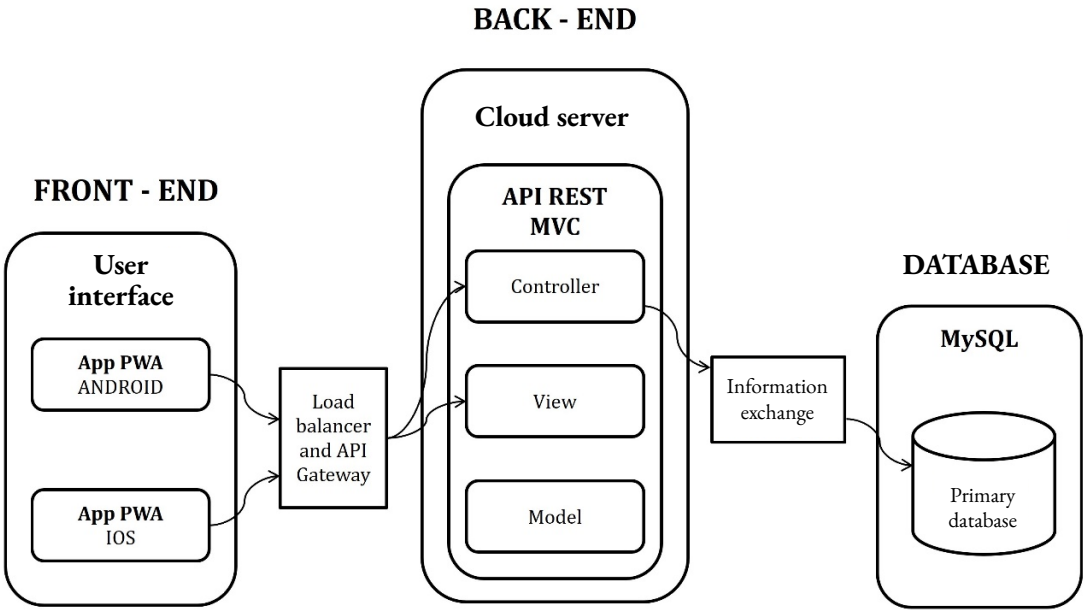
If the system is transferred and incorporated by the Brazilian Army, the back-end elements executed on the server, the communication infrastructure, database, and its functionalities should be easy to adapt. Also, it would be ideal for the mechanism of access to functionalities to be easily transported and adapted to other systems. Thus, the use of technology representational state transfer on a hypertext transfer protocol would be recommended in this case since the necessary infrastructure is widely used and the call of functions is independent of programming language (Purewal, 2014). With these non-functional requirements, the functions of the proposed system could be adapted with some practicality to fit the standards and systems in operation of the Brazilian Army.

The mobile application was named EBSAU, a reference to the intended integration of the Brazilian Army's health system.

3.2 Application architecture

Figure 1 shows the structure of the elements that make up the system: a front-end, mobile applications, and a back-end hosted on a server, which in turn is supported by a database. The infrastructure also includes a load balancer, enabling scalability. The drive flow is also shown at a high level of abstraction. Every interaction is initiated in the front-end via the user application interface (patients' and physicians' versions), triggering the back-end required on the server via a representational state transfer application programming interface. If necessary, the back-end services can search or enter information into the database. During teleconsultations, direct communication also occurs between patients' and physicians' application instances.

Figure 1 – System structure and flow



Source: Prepared by the authors (2024).

A progressive web application was used in the development and prototyping strategy (Silva; Tiosso, 2020). In it, the features of modern browsers are used to make users' experience more intuitive by technologies adopted in web development, such as cascading style sheets, hypertext markup language, and JavaScript (Purewal, 2014), in conjunction with browser application programming interfaces (Costa Stutzel et al., 2019). Thus, it is possible to run the application on Android devices and easily port it to the iOS platform (the operating system at Apple, exclusively developed for its devices. "OS" is an acronym for operating system and the letter "I" follows the Apple tradition that has become a symbol to represent their products, such as Iphone, Ipad, etc.).

The front-end applications were developed using JavaScript, hypertext markup language, and cascading style sheets. The prototype of the user interface was initially developed for Android devices (Teza *et al*., 2015).

The back-end services were developed considering a representational state transfer application programming interface (Silva, 2019), thus enabling communication between the front-end application, business rules, and a single-engine database.

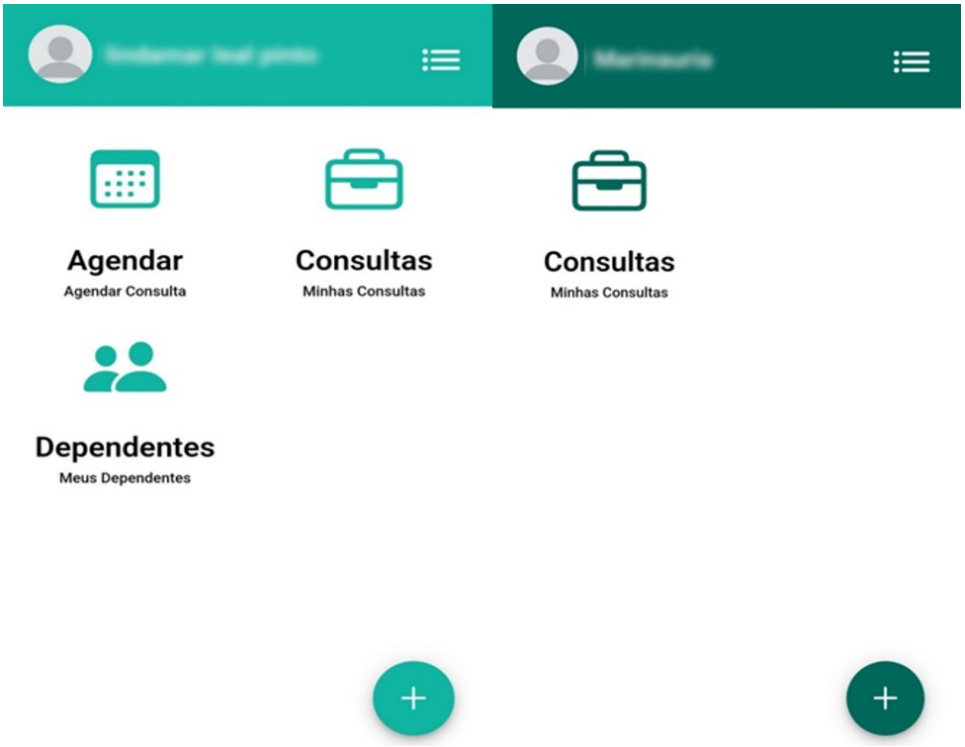
The structure of the database tables was based on the available information on the health systems and current procedures of the Brazilian Army and the structures necessary for the functionalities of the proposed application.

3.3 Operation Tests

After development and refinement, operation tests of the mobile application prototype and back-end integration were carried out.

The operations of the proposed application were tested first, simulating possible interactions in teleconsultations. Flaws were found during testing, and a new version of the prototype was developed to adjust aspects such as the color of the interface layout in users' and physicians' versions and the functions on their respective home pages (Figure 2).

Figure 2 – Patients' Home Screen and the Physicians' Home Screen

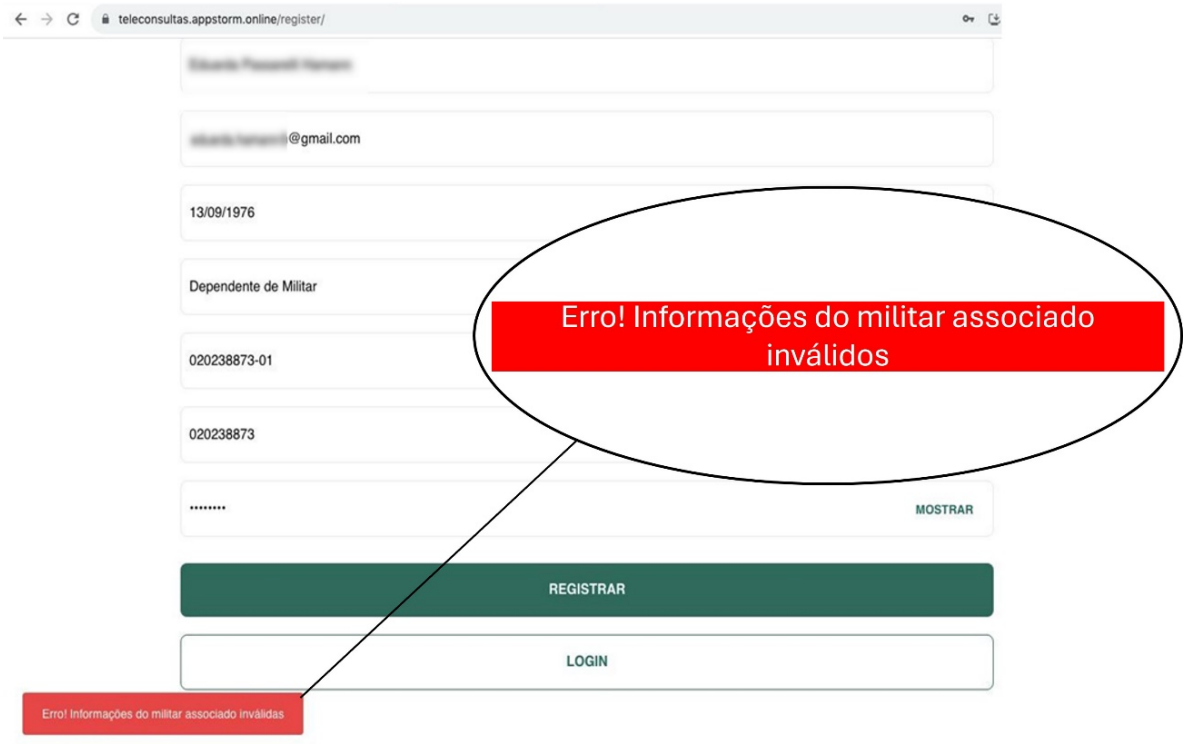


Source: Prepared by the authors (2024).

Some flaws in the application were detected in testing. A failure was found that deemed Prec-cp numbers invalid when dependents tried to register themselves in the application (Figure 3). The solution included introducing directions in the application that

advised users about the error and what they should do to be able to register ("Military user not yet registered: first register the main user and then register the dependent"). The premise of the system was that the military user would register before their dependents so that they could have access to the system. Moreover, minor dependents could only register via the account of the military user.

Figure 3 – Initial Error Message



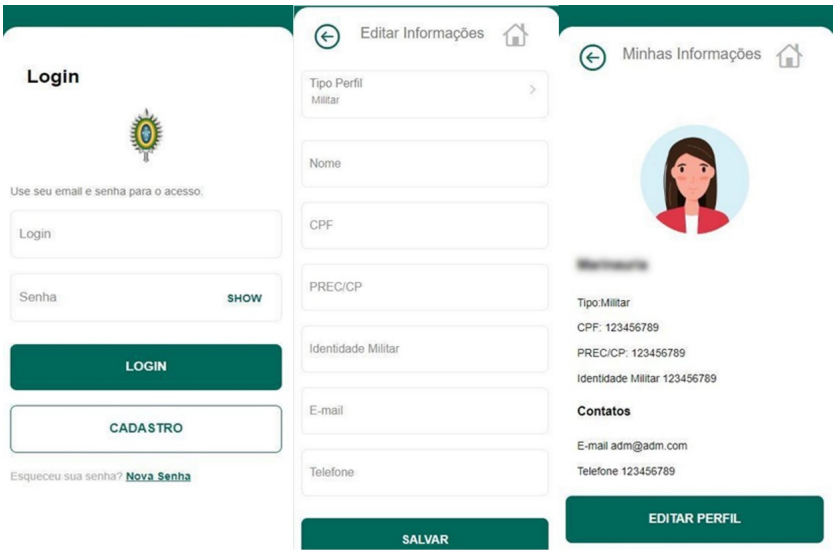
Source: Prepared by the authors (2024).

Once these problems were overcome, the video image tests during the interactions were error-free; the only questions reported were over the use of telecall icons, such as the microphone and camera.

3.4 Evaluated prototype

After testing, an operational prototype of the application was obtained. When activated, it then enables users to log in with an email and password (Figure 4). Patients and physicians are directed to a screen in which they can register by filling in their personal information (Figure 4) (note that we obtained no access to the Brazilian Army database). After saving the information, the application directs users to a screen to view the information in their profile (Figure 4).

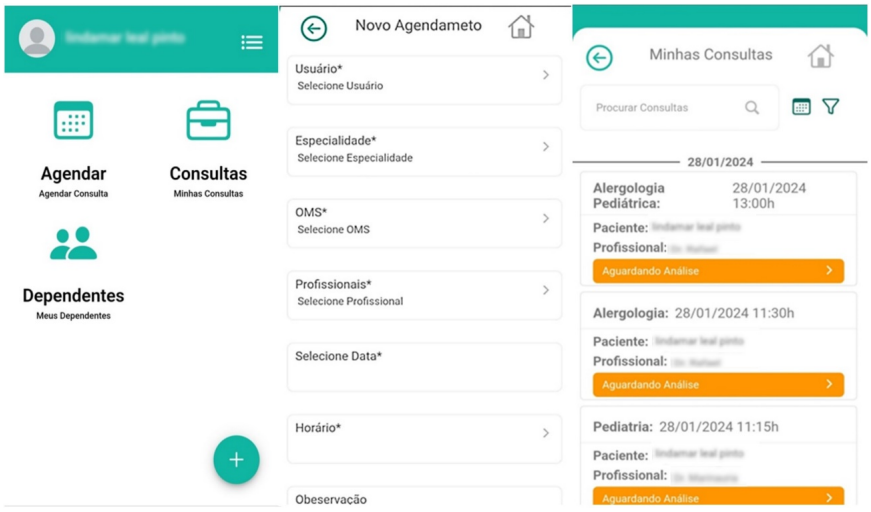
Figure 4 – User registration; Registration information; Completed user registration



Source: Prepared by the authors (2024).

After registering, patients are directed to the home screen with the options: "Schedule," "Appointments," and "Dependents" (Figure 5). When patients activate the "Schedule" option, the corresponding panel is activated and a new appointment can be made by users (military staff or their dependents), the desired care specialty, the clinic of the Military Health Organization in which this consultation will take place, and the available care professional, dates, and times (Figure 5). When the appointment is finished, patients are directed to the "My Appointments" panel, in which they can view all the appointments scheduled in that login (Figure 5).

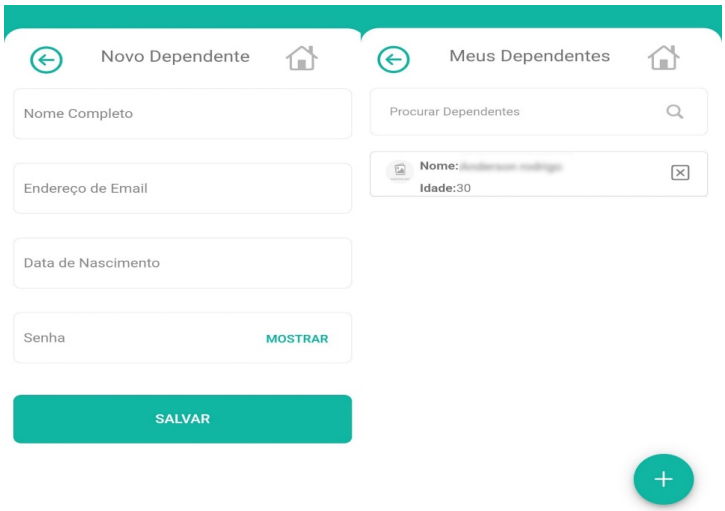
Figure 5 - Home screen: main functions; Appointment Scheduling



Source: Prepared by the authors (2024).

On the initial screen, patients still have the option to click on "Dependents," which activates a corresponding panel so they can register their dependents and view them (Figure 6).

Figure 6 - Registration of Dependents; Registered Dependent

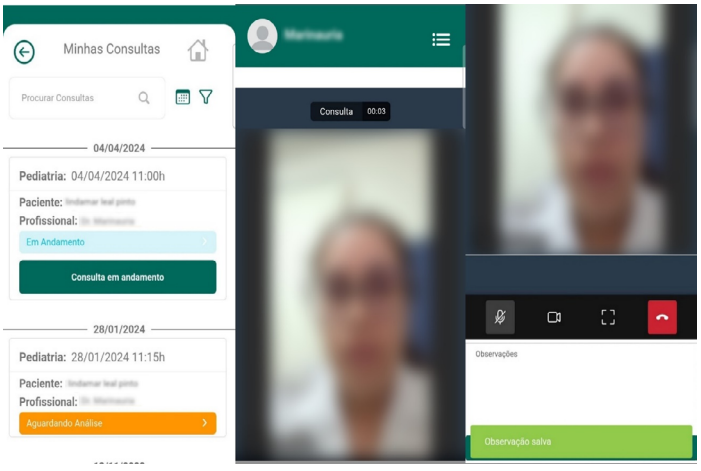


Source: Prepared by the authors (2024).

Then, patients can immediately view their appointments on the "My Appointments" panel.

On the day of the scheduled appointment, both physicians and patients must activate the application, register in it, and access its "Consultations" panel. In this panel, "Consultation in progress" is available, which directs users to the service room (Figure 7). The service room is "open" 15 minutes before the scheduled appointment time and is closed by pressing the red icon "End call," which is available at the bottom of the screen. In the physicians' interface, it is possible to record the service in the text box available below the call screen (Figure 7).

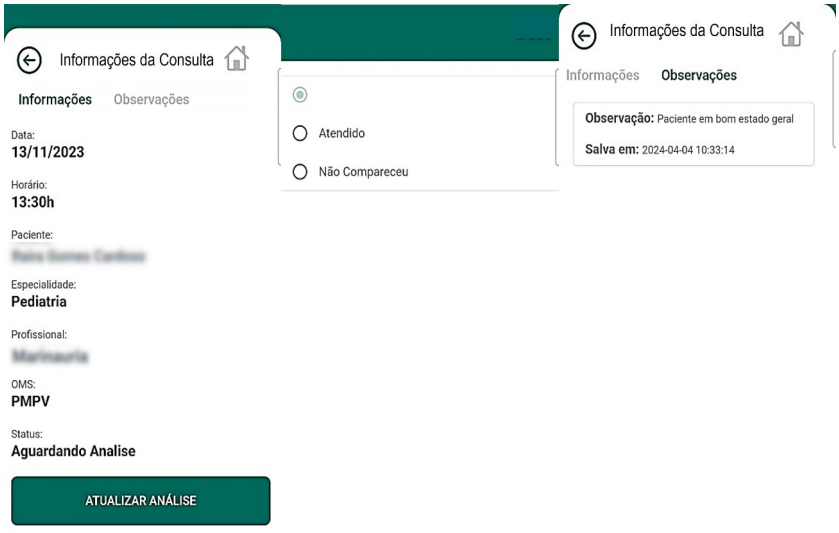
Figure 7 - My Consultations; Service Room; Ending the call



Source: Prepared by the authors (2024).

In the physicians' interface, when the call ends, they are redirected to the "My Consultations" panel, in which the service will be in the status "Awaiting Analysis" (Figure 8). It is possible to update the status of the appointment by the "Update Analysis" icon, and physicians can classify it as "Serviced" or "Did not show up" (Figure 8). Moreover, it is possible to view their notes in the "Observations" field (Figure 8).

Figure 8 – Consultation Information; Consultation Status Update; Consultation Observations



Source: Prepared by the authors (2024).

3.5 Evaluation

Before defining the design of the evaluation of the proposed application, it was necessary to determine the most appropriate techniques for the project since the system is used in a distributed way, with consultations involving physicians and patients operating in their respective versions of the application.

Usability is a widely used approach to evaluate software application as it measures the ease with which users engage with the interface. Usability evaluation aims to determine the consistency of the proposed application in practice. Use ease can indicate patients' and physicians' adherence and continuity (Cavalcanti *et al*., 2021). This approach is also adopted in evaluations of health-related software as it aims to avoid causing discomfort to users due to software use (Cavalcanti *et al.*, 2021).

To choose the technique to evaluate the usability of the developed system, a systematic review of the literature was carried out to find a method that uses questionnaires to facilitate application in user tests. The review was carried out on PubMed, Scielo, and VHL in January 2023 using the terms "(clinic OR health) AND (usability) AND (application)."

SUS was the most mentioned technique in the chosen studies (about 54.5%) (Jorge *et al.*, 2020; Mota; Turrini, 2022).

In addition to being the most mentioned, SUS is the best scale to be implemented due to its brevity (10 items), intelligibility, and presence in several health software. It aims to subjectively evaluate usability-related aspects by a five-point Likert scale. The final score is calculated thus: for its odd-numbered items (1, 3, 5, 7, and 9), 1 is subtracted from users' score, whereas for its even-numbered items (2, 4, 6, 8, and 10), a marked score of 5 is subtracted. Then, all values from the 10 questions are summed and the obtained value is multiplied by 2.5. The result comprises the final score, which can range from 0 to 100. Scores with at least 90 points represent that the usability expectation stands above users' expectation, whereas those from 80 to 90 points, excellent usability; from 70 to 80 points, good usability but with space for improvement; from 60 and 70 points, marginal usability, subject to analysis and improvement; and below 60 points, no acceptable degree of usability. Thus, SUS was selected as an important part of the evaluation of the proposed application.

In addition to usability, it is important to measure the level of user satisfaction with the new application via qualitative methods. Thus, patients' satisfaction can indicate adherence to the proposed application and, according to results, its establishment will result in a useful tool for the target public (Freitas *et al*., 2023). This research aimed to evaluate whether the software met physicians' and patients' demands and whether the operation met users' expectations.

The review of satisfaction assessment methods was carried out on PubMed, Scielo, and VHL in January 2023 "(clinic OR health) AND (qualitative) AND (application)."

Of the discussed tools, the chosen studies mostly mentioned the "consolidated criteria for reporting qualitative research" (Tong; Sainsbury's; Craig, 2007): a 32-item checklist that guides the transparency and quality of conducting and reporting qualitative studies. Thus, the questionnaire to qualitatively assess satisfaction followed criteria that were inspired by these guidelines, especially regarding the structuring of open questions, the understanding of participants' experience, and the guarantee of methodological rigor in the collection of qualitative data. The proposed questionnaire consisted of 15 questions prepared by the authors of this study.

Thus, the proposed application was evaluated for two dimensions: usability and quality/satisfaction.

4 EVALUATION DESIGN

The snowball method was used to contact participants (Vinuto, 2014), in which some professionals the researcher knew formed the original set and each could forward this research to patients in their personal or professional relationships, expanding the sample via WhatsApp groups.

The application was tested with three volunteer physicians (who were specialized in pediatrics, internal medicine, and general surgery) and 60 patients. Interactions were

carried out online as physicians sat in a care room and patients, at their home or in an appropriate place.

For the usability and qualitative evaluations, questionnaires were used after the end of the medical consultations, the links of which were available in the information tab of the proposed application in addition to informed consent forms. As discussed, functionality evaluation followed a SUS questionnaire and user satisfaction survey, 15-question questionnaire designed by the authors of this study.

5 RESULTS

The evaluation lasted 30 days (from October to November 2023) and included 60 interactions between physicians and patients. Data analysis excluded three interactions due to a lack of answers to the survey questionnaires. Thus, 19 interactions involved internal medicine; 18, general surgery; and 20, pediatrics.

To evaluate the proposed platform, physicians and patients used the prototype in interactions that explored its functionalities, evaluating its interface, usability, and utility.

Patients' participation consisted of a medical teleconsultation simulation in the evaluated specialties via the proposed application.

Invitations to participate in testing occurred via WhatsApp groups, in which patients and physicians received information about the research project and an invitation to read and agree to participate in this research via an informed consent form.

Then, this study directed patients and physicians to a link from which they could install the application, register in it, choose their login, and schedule an appointment with a specialty at the available times and dates.

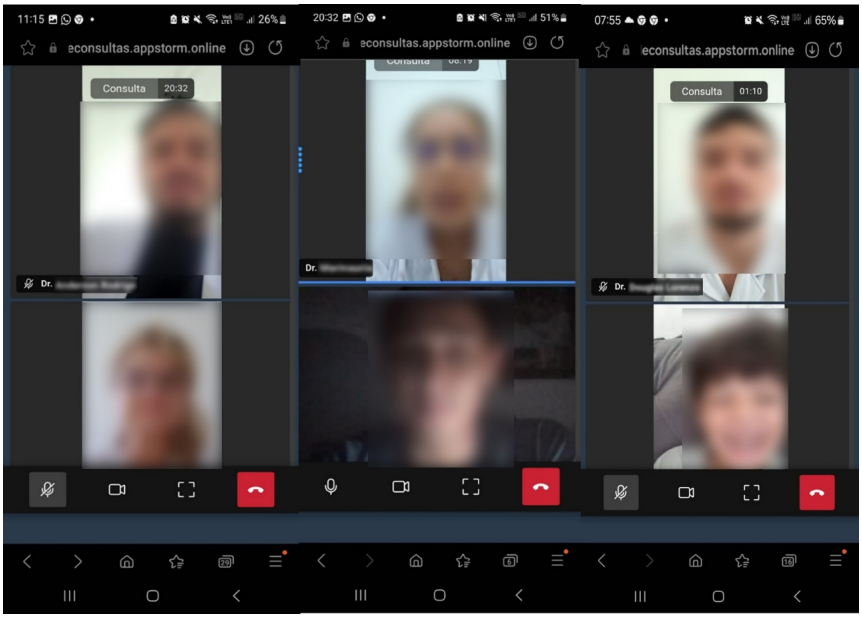
On the scheduled day and time, participants should re-enter the application, provide their identification and password, and start a video call to test the operation of a teleconsultation.

Logging into the application directs users to the main menu panel so they could select the "Consultations" option. Clicking on this option would show a new panel with the scheduled consultations and a green option named "Appointment in progress." Pressing this option would direct users to the consultation room, after which users could press the red "End Call" button and be directed to the consultation tab with a new option "Waiting for Analysis." Figure 9 shows some examples the sessions.

An application function in the physicians' interface would record the pertinent information to the service in "Observations" during the video call. Testing showed no failures in this field. After saving the information in this field, clicking on the session and the

"Observations" option would enable physicians to access their notes whenever necessary for following interactions (Figure 10).

Figure 9 – Physician/User Interaction: Medical Clinic; Physician/User Interaction: Pediatrics; Physician/User Interaction: General surgery



Source: Prepared by the authors (2024).

Figure 10 — Medical record field

Source: Prepared by the authors (2024).

Once the simulated medical teleconsultations ended, a link would direct participants to electronic usability and qualitative evaluation questionnaires.

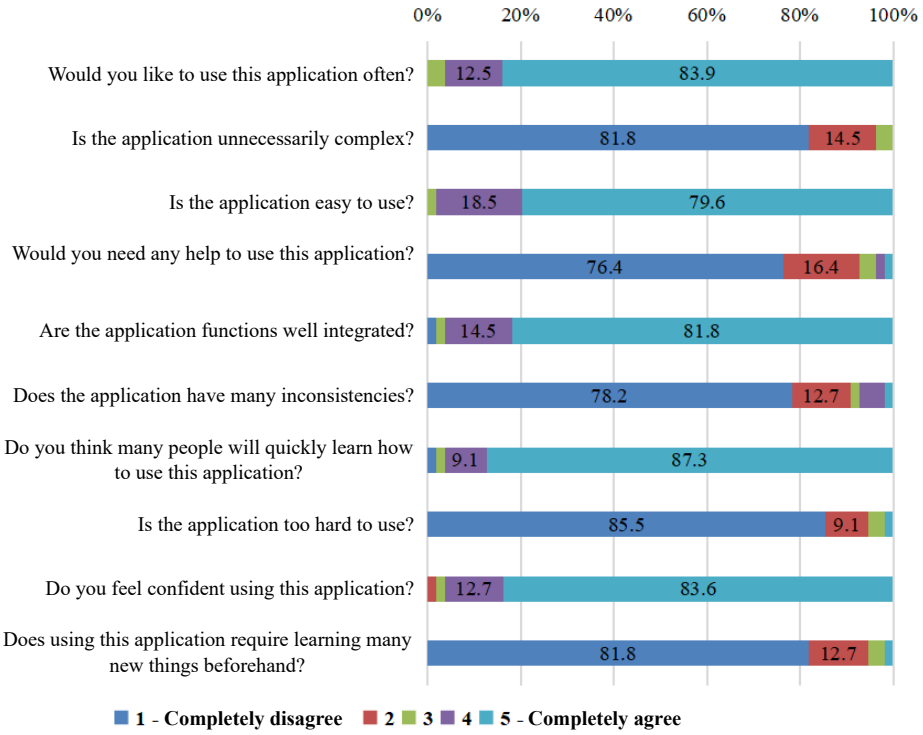
Statistical techniques analyzed the results of the questionnaires to evaluate their accuracy and significance, if relevant, which this study shows graphically to facilitate result interpretation.

5.1 Usability Evaluation

Graph 1 shows patients' answers to the 10 questions on usability according to SUS. Most offered positive responses despite some respondents' negative answers.

According to the percentage analysis in Graph 1, the tested application meets the desired usability characteristics such as ease of use (as per the percentages of the first five questions of the questionnaire: 83.9%; 81.8%; 76.6%; 76.4%, and 81.8%) and consistency (as per the percentages of the remaining questions of the questionnaire: 78.2%; 87.3%; 85.5%; 83.6%, and 81.8%).

Graph 1 – Patients' responses to the SUS questionnaire in the EBSAU tests



Source: Prepared by the authors (2024).

After consolidating the percentages of each answer, we analyzed and summed question scores according to SUS, finding an 82-point score, which indicates that the patients in the test considered the proposed application as having excellent usability.

The analysis of physicians' answers to SUS used the same questions as those applied to patients. We obtained answers from three questionnaires in this category, all of which showed 100% agreement regarding the usability criteria of the 10 SUS questions. Thus, physicians' answers totaled a 100-point score, indicating that the usability of the proposed application exceeded this group's expectations.

5.2 Satisfaction assessment

This study surveyed satisfaction by a semi-structured online questionnaire. The authors of this research developed this questionnaire (Figure 11), sending it to participants at the end of their teleconsultations via a link in the "Information" section of the application to measure their overall satisfaction with the prototype and whether they would recommend it to other people.

Figure 11 — Satisfaction questionnaire

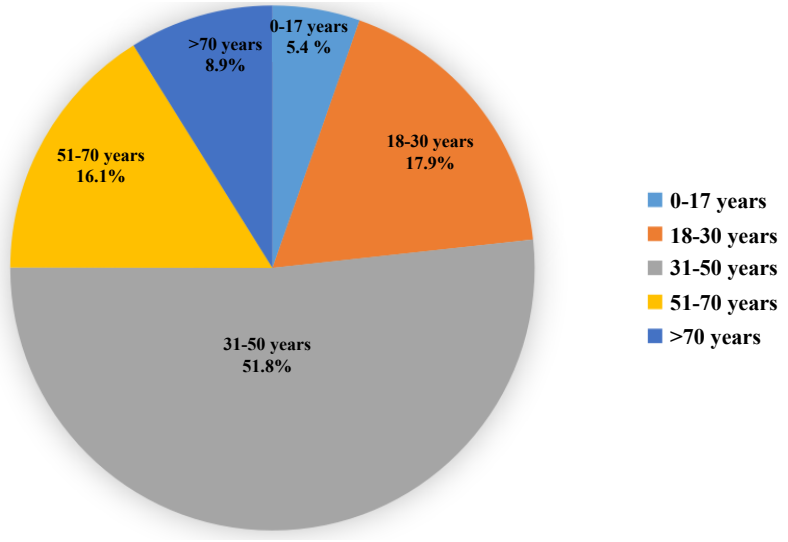
1- What is your age?
( )0-17 ( )18-30 ( )31-50 ( )51-70 ( )>70
2- What is your highest obtained education level?
( )Primary education ( )Secondary education ( )Tertiary education
( )Graduate degree ( )Master's or PhD degree
3- Are you a physician?
( )Yes ( )No
4- Are you military staff or a dependent?
( )Yes ( )No
5- Is this your first time using a health teleconsultation service?
( )Yes ( )No
6- If you have used a health teleconsultation service before,
in what occasion?
( )In a consultation via my healthcare plan ( )In the private office of a medical specialty
( )In the emergency room of a hospital ( )Other ( )Never used it
7- What is your degree of satisfaction with the proposed health teleconsultation service?
( )1 ( )2 ( )3 ( )4 ( )5 ( )6 ( )7 ( )8 ( )9 ( )10
8- What is your degree of satisfaction with the proposed application?
( )1 ( )2 ( )3 ( )4 ( )5 ( )6 ( )7 ( )8 ( )9 ( )10
9- Did the teleconsultation begin at the scheduled time?
( )1 ( )2 ( )3 ( )4 ( )5 ( )6 ( )7 ( )8 ( )9 ( )10
10- Would you use this teleconsultation application again?
( )Yes ( )No
11- Would you use this teleconsultation application again?
( )Yes ( )No ( )Maybe
12- Considering your experience with this health teleconsultation application, would you recommend it to your friends and Family?
( )Yes ( )No ( )Maybe
13- Do you acknowledge health teleconsultation applications as an alternative to face-to-face consultations in areas that face difficulties accessing scarce medical subspecialties?
( )Yes ( )No ( )Maybe
14- Would you recommend the implementation of this health teleconsultation application in the Brazilian Army?
( )Yes ( )No ( )Maybe
15- In which Brazilian macroregion do you reside?
( )North ( )Northeast ( )South ( )Southeast ( )Midwest

Source: Prepared by the authors (2024).

The users' satisfaction questionnaire proposed 15 questions on their demographic characteristics and experience using the application.

Most patients were adults aged from 31 to 50 years (51.8% of the answered questionnaires), followed by those aged from 18 to 30 years (17.9%) (Graph 2).

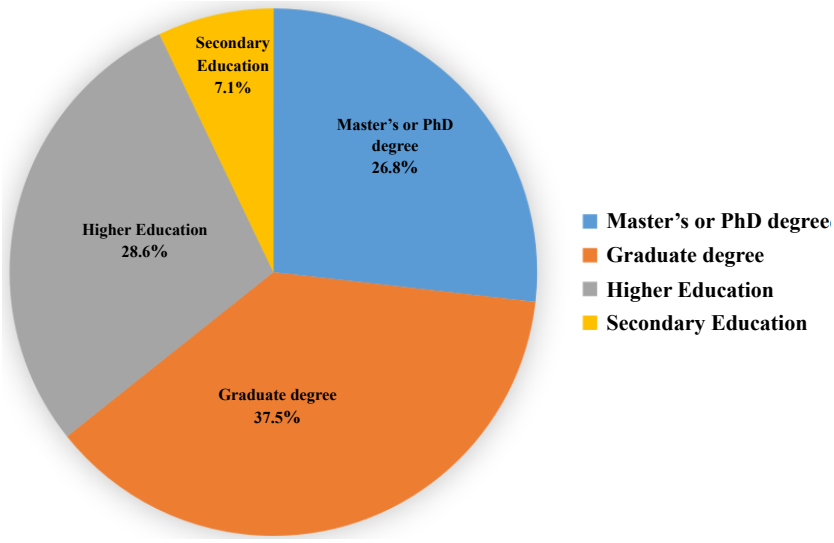
Graph 2 – Age group



Source: Prepared by the authors (2024).

The analyzed answers show that 37.5% of interviewees had a graduate degree and that 28.6% of them had higher education (Graph 3).

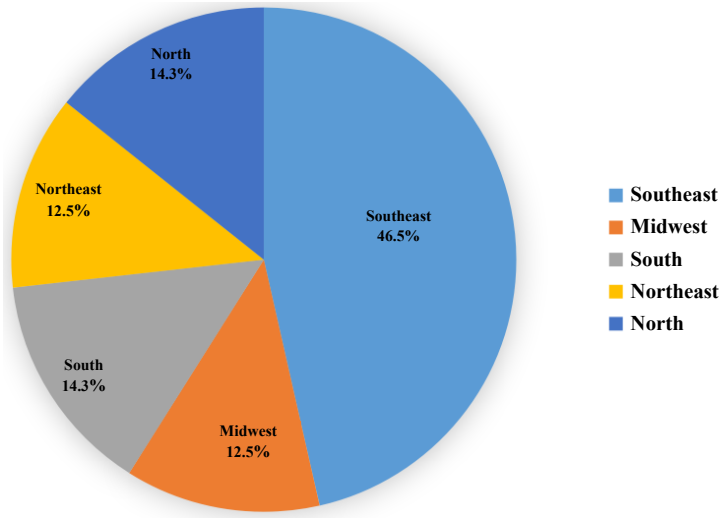
Graph 3 - Level of education



Source: Prepared by the authors (2024).

This research also asked in which Brazilian macroregion participants resided. As expected, most answers referred to its Southeast (46.4%). However, we found that a good portion of patients resided in other regions, such as the Brazilian South and North (both:14.3%) and its Midwest and Northeast (both: 12.5%) (Graph 4).

Graph 4 – In which region of the country do you live?



Source: Prepared by the authors (2024).

Graph 5 shows the questions and answers about the dynamics of the use of the proposed prototype.

As expected, asking whether they were military personnel or dependents resulted in 96.4% of positive answers as only 3.6% of participants stood outside this category (two volunteer civilian physicians who had knowledge of military practice).

This research also asked patients if that was their first time using medical teleconsultation services (60% positive answers). Considering that the Brazilian Army scarcely disseminates and uses this type of service modality, results remained within expectations.

This study asked whether the medical consultations began as scheduled, to which 100% of patients answered affirmatively.

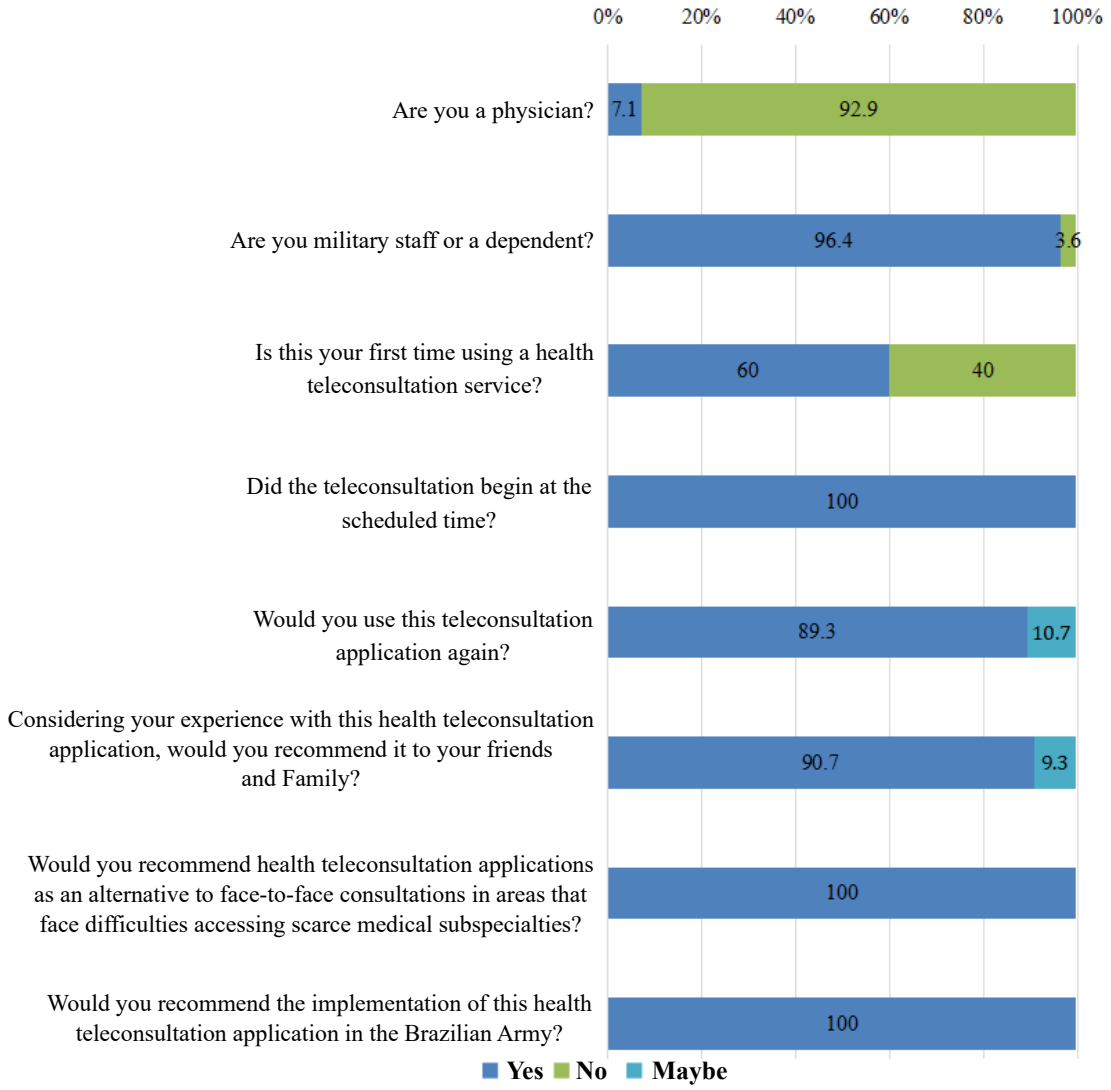
When asked if they would use the proposed teleconsultation application other times, 89.3% and 10.7% of patients offered positive and uncertain answers, respectively. We received no negative responses, indicating a strong degree of acceptance of the studied approach.

This study found that 90.7% of patients would recommend the proposed teleconsultation application to other people and that 9.3% of them indicated their uncertainty. We received no negative responses, indicating a strong degree of acceptance of the studied characteristic.

We also evaluated whether patients would recommend the application as an alternative to in-person consultations in places of difficult access and scarce medical subspecialties. We only obtained positive answers to this question.

Finally, this study asked whether patients would recommend the implementation of this medical teleconsultation application in the Brazilian Army, finding unanimous positive answers.

Graph 5 – Responses to the satisfaction questionnaire applied to patients in the EBSAU application test

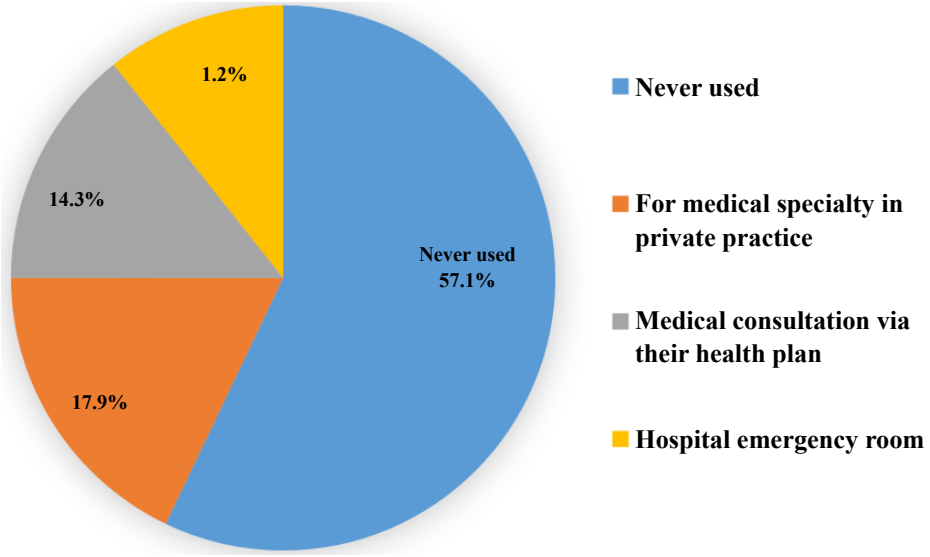


Source: Prepared by the authors (2024).

This study evaluated the context (unlike that of the proposed application) in which previous medical teleconsultations services had occurred. Of those who had used this type of care, 17.9% did so for a medical specialty in a private practice; 14.3%, in a medical consultation via their health plan; and 10.7%, in a hospital emergency room (Graph 6).

Finally, all responding patients indicated that they would recommend the application as an alternative to in-person consultations in hard-to-reach places and its implementation as a medical teleconsultation application in the Brazilian Army.

Graph 6 – If you have used the medical teleconsultation service, tell us when it was used



Source: Prepared by the authors (2024).

Graph 7 shows the answers to the questions on satisfaction with the application and users' experience.

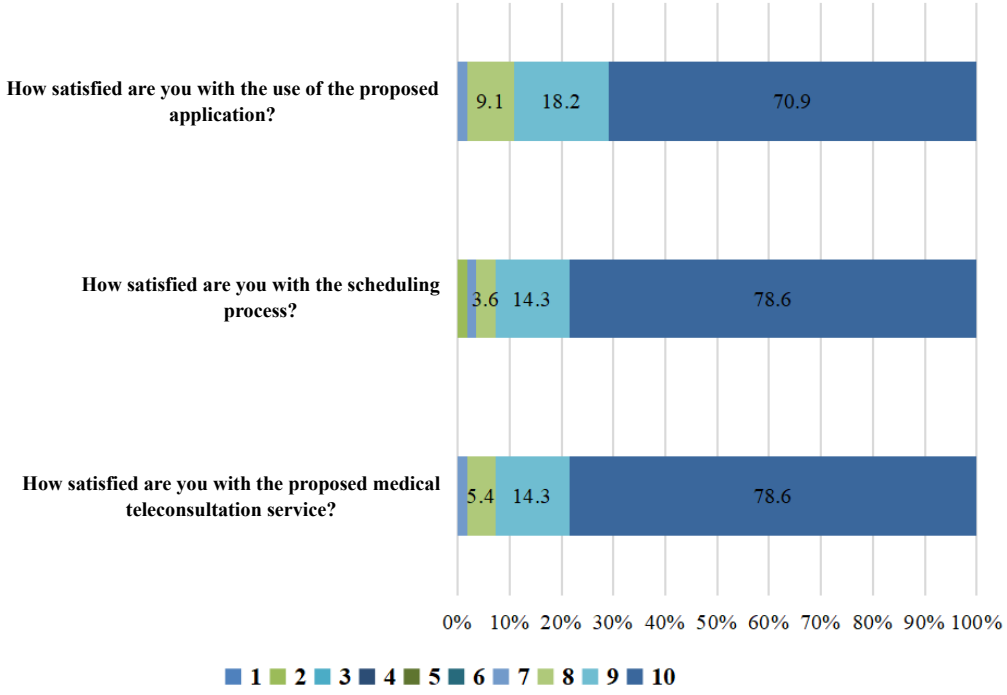
Respondents' degree of satisfaction with scheduling showed the following distribution: 78.6% scored it as 10, 14.3%, as 9; 3.6%, as 8; 1.8%, as 7; and 1.8%, as 2. Most users scored from eight to 10, indicating positive evaluations. However, a patient (1.8%) scored it as 2. This may stem from the initial inconsistencies in the system that were corrected during testing.

This study asked participants' degree of satisfaction with the proposed application: 70.9% scored it as 10, 18.2%, as 9; 9.1%, as 8; 1.8%, as 7; and 1.8%, as 2, evincing a greatly satisfactory pattern.

Users also rated their degree of satisfaction with the proposed medical teleconsultation service: 78.6% scored it as 10; 14.3%, as 9; 5.4%, as 8; and 1.7%, as 7 (the lowest score), indicating a strong acceptance for the system.

The satisfaction questionnaire the three physicians answered contained the same 15 questions as that for patients. All physicians were aged from 31 to 50 years; had a graduate degree; lived in the Brazilian Southeast; had previously performed teleconsultations; answered that the teleconsultation session started at the scheduled time; that they would use the application again; that they would recommend it to their friends and family; and reported total satisfaction with the prototype, scheduling, the use of the application. Moreover, 66.6% of them worked outside the military and 33.3% answered that they had used teleconsultations via healthcare plans; 33.3%, in a hospital emergency room; and 33.3%, in private practice.

Graph 7 – Degree of satisfaction with the application and its services



Source: Prepared by the authors (2024).

Due to the small number of subjects in the physicians' satisfaction survey, result interpretation requires care.

6 DISCUSSION

Users' acceptance of the usability of the proposed prototype based on SUS totaled 82 points, which indicates their perceived ease of use, i.e., users understood how to operate the application prototype without major difficulties. However, this study ignored issues such as age and technological skills, which could have affected the acceptance and management of the application, leading to lower scores on the SUS questionnaire. We obtained similar results to those in with Mota and Turrini (2022), who also used SUS (82.7 points) to investigate their mobile application toward monitoring patients with peripherally inserted central catheters, reinforcing the idea that users accept the inclusion of new technologies in health care even if they require a great learning curve and the acquisition of new skills.

Physicians rated usability above our expectations (100 points), perhaps due to their limited number in this research. It would be interesting to enlarge this sample to better evaluate the proposed items.

We observed that, in the satisfaction assessment, unlike what we imagined, the Brazilian Southeast failed to harbor most tests despite its greater dissemination of information.

It comprised 46.4% of the sample, whereas the engagement in the other regions of the country showed a similar distribution: 14.3% of participants lived in the Brazilian South and North regions and 12.5% of participants in its Midwest and Northeast. We found the snowball method (which we adopted to attract volunteers for this evaluation) satisfactory. The participation in the tests in the Brazilian North (which faces a smaller supply of medical specialties from the Brazilian Army), indicates that, if implemented, the proposed application may improve the quality of local military health. Moreover, its high acceptability across regions may represent the lack of in-person care in subspecialties and the difficulty to obtain immediate care and resolutions. Teleservices can provide the necessary resources to solve the high demand for consultations, expand the range of medical services, and rationalize military financial resources by avoiding the creation of new infrastructure and the displacement of professionals or patients.

Another relevant point of this study concerns the age group of participants in the tests. We observed a predominance of those aged from 31 to 50 years (51.8%), which fits the prevalence of graduate (37.5%) and higher education degrees (28.6%), indicating that the group is sufficiently educated to adequately evaluate the application.

This study reached its targeted audience since 96.4% of interviewees were military personnel or military dependents. The other 3.6% comprised physicians with no link with the Brazilian Army who agreed to participate in this study.

Regarding the aspects directly linked to the use of teleconsultation applications, this study formulated a pertinent question about the use of medical teleconsultation applications since 60% of its sample used this type of service for the first time. In view of this percentage, it would be very useful and productive to implement access to this modality of care. The 40% of those who had used telemedical care showed a predominance of its use in private medical offices (17.9%), followed by health insurance (14.3%) and emergency services (10.7%), indicating a suitable population to evaluate the proposed application in view of their previous experiences.

Regarding the proposed system and the evaluated prototype, we found that, regarding participants' degree of satisfaction with the medical teleconsultations, 78.6% of users scored them as 10 and that the lowest score equaled seven (1.8%). We also found an excellent result for the degree of satisfaction with the use of the application since 70.9% assigned a score of 10 and that the lowest score for this question equaled seven (1.8%), showing how using this application positively impacted the military in the tests. We found a good degree of satisfaction and scheduling since 78.6% of users scored it as 10. However, we observed that 1.8% scored it as two, which may stem from the initial inconsistencies in the system that were corrected as the tests progressed.

Thus, when we analyzed whether users would use the application again, we found 89.3% of positive responses and no negative responses. Moreover, 90.7% of users claimed they would recommend the application to their friends and family. As with the previous question, we found no negative answers. Note that the high acceptance of the proposed application shows users took interest in the platform and would recommend it as they understand its importance as a means of service. Thus, the great importance of this theme stems from users' unanimous

answers that they would recommend the proposed application as an alternative to in-person consultations in places with scarce medical subspecialties and that the Brazilian Army should implement it as a medical teleconsultation application.

However, despite the great evidence regarding the benefit of a teleconsultation application for the Brazilian Army, note that internet access—despite having exponentially improved in recent years after the Connected Amazon Project (2022)—remains precarious in remote areas of the Brazilian North and in some areas in its inner Northeast, which can impact the scope and effectiveness of the proposed service.

Another issue concerns the institutional resistance to implementing this new tool in everyday use. Currently, the Brazilian Army has no telemedicine center, and teleconsultations in health units are an uncommon practice.

The creation of a specialized center and the prospect of training a new modality of temporary military personnel focused on teleservice, especially scarce subspecialties in the force, can achieve surprisingly reduce financial costs and optimize the recruitment of specialized personnel.

Moreover, the effectiveness of the system requires training in this new modality for healthcare providers working in military health units. Note that professionals with expertise in telemedicine and digital health must manage this training.

7 CONCLUSION

Telemedicine configures an innovative resource that is currently available for health care, it offers remote support for patients and general practitioners via videoconferences. It can positively impact health, reducing mortality rates due to patients' greater adherence to treatment stemming from ease of communication and decreasing monetary costs (Melo, 2019).

Despite several teleconsultation applications on the market, there are no mentions on the literature on the official use of such application by the Brazilian armed forces.

Thus, this study proposed an application for medical teleconsultations for the Brazilian Army. The application was prototyped and evaluated considering the specificities of the armed forces health system in supplying the scarce specialties that generate a high number of referrals to civil organizations or autonomous professionals (especially in remote locations).

The tests showed that this digital tool facilitates access for the military to medical specialties via teleconsultations, enabling a timely management of conditions that affect populations in remote places since distance represents a critical factor in health service provision. The application tests (which this study carried out for a month) included 60 users from across Brazil. We first thought that the Brazilian Southeast (in which information is better disseminated) would comprise the most participants; the result analysis disproved this since its distribution was equivalent to that of other Brazilian regions in the studied sample.

The Brazilian Southeast comprised 46.4% of the sample. We also found good engagement from other regions of the country: 14.3% of participants lived in the Brazilian South and North regions and 12.5% of participants in its Midwest and Northeast. In more remote regions, such as the Brazilian North (which has a scarcer supply of medical specialties), test engagement could indicate that implementing the proposed application would increase the effectiveness of teleservice, improving the quality of local military health.

We found a great potential in this technology due to its excellent degree of satisfaction and high usability indices (due to its 82-point score in users' usability and 100-point one in physicians' usability) and degree of satisfaction, evinced by positive responses in the qualitative evaluation.

The next version of the proposed application should include the requirements the evaluated prototype lacked, for example, incorporating a digital prescription functionality and a digital certificate validation. The Regional Council of Medicine of the State of Rio de Janeiro platform issues the current digital prescriptions in other health systems.

Interest from the Brazilian Army could implement the developed technology as a complementary tool to their current health systems.

Incorporating teleconsultations into the options of the Brazilian Army's health system is important to reduce costs from referrals and offer the military access to various specialties, even in remote regions. This would configure a technological leap and an advance in the traditional health system, decentralizing resources and quickly meeting demands.

Future studies may evaluate the clinical effectiveness of our application in improving health outcomes and its integration into the Brazilian Army's corporate systems.

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