Rural and Remote Health www.rrh.org.au
James Cook University ISSN 1445-6354

Original Research

Technostress and telemedicine in rural communities: insights from healthcare professionals in the Italian Dolomites

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PUBLISHED

4 November 2026 Volume 26 Issue 4

HISTORY

RECEIVED: 2 July 2025

REVISED: 20 July 2026

ACCEPTED: 23 September 2026

CITATION

Lezcano M, Pasini M, Landuzzi MG. Technostress and telemedicine in rural communities: insights from healthcare professionals in the Italian Dolomites. Rural and Remote Health 2026; 26: 10154. https://doi.org/10.22605/RRH10154

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Abstract

Introduction: In Italy, many facilities have started adopting telemedicine services since their regulation in 2020. Rural areas mainly benefit from telemedicine implementation due to their geographic features. We investigated the interests, attitudes, and perceptions of healthcare providers operating in the Italian Dolomites regarding the adoption of telemedicine. Furthermore, we explored the relationship between technostress and the intention to integrate telemedicine services during daily practices.
Methods: We developed a structured interview protocol based on existing literature and following the key principles of constructivist grounded theory to investigate five areas of interest in telemedicine. After the interview, participants completed the Italian version of the Technostress Creators Scale (TCS) to evaluate the current technostress experienced in work activities, and a TCS-adapted version to measure technostress values generated through telemedicine services.
Results: A content analysis of the interviews highlighted four main factors that can help communities more readily accept telemedicine services: the convenience of not having to travel, the ageing population, cost savings, and a sense of community. Regarding the scales, there were positive significant correlations between most of the subscales.
Discussion: Our findings confirm that telemedicine fosters perceived security and service quality in rural settings. Despite moderate technostress, professionals remain supportive, highlighting the role of perceived usefulness. Key barriers include low digital literacy and reduced social contact, underscoring the need for strong patient–provider relationships and targeted digital

training to ensure successful implementation.
Conclusion: Telemedicine offers vital support in improving healthcare access in remote areas. Overcoming barriers like low digital skills and poor connectivity requires infrastructure investment and training. Evaluating technostress alongside digital readiness is essential for future research.

Keywords

healthcare professionals, interviews, Italy, mixed methods, mountainous areas, remote areas, rural areas, telemedicine.

Introduction

The COVID-19 pandemic accelerated the digital transformation of health care, including the implementation of telemedicine services in routine care. As defined by WHO, telemedicine services encompass 'the delivery of health-care services where distance is a critical factor, by all health-care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment, and prevention of disease and injuries'[1]. Telemedicine service comprises:

- teleconsultation – medical visits with GPs[2], or specialized physicians[3] where the doctor and the patient interact at distance, with or without the help of an assistant
- telerehabilitation – delivery via telecommunication technologies of a specific therapy for a patient, for example remotely delivering cognitive rehabilitation therapies[4] or physical therapy[5]
- telemonitoring – recording and transmission of a patient's vital parameters (eg blood pressure) to a health professional to monitor specific conditions[6]
- tele-expertise – a remote counselling activity in which healthcare professionals can communicate and discuss the management of their patients[7] or ask for supervision and help during emergencies[8].

Telemedicine services can be accessed via smartphones, PCs, and tablets, or through specialized medical technologies such as high-tech smart glasses[9] and medical devices[10].

Telemedicine benefits in rural areas

One of the strongest assets of telemedicine services lies in their applications to rural and remote areas, far from public health services such as hospitals and health clinics. Implementations in such areas leads their inhabitants to a series of benefits such as lower transportation costs to healthcare facilities, shorter wait times for services use, reduced internal hospital workload, decreased job stress for healthcare professionals, reduction in hospitalizations, enhanced quality of life for patients, reduced physical and emotional stress on patients, greater satisfaction with the healthcare services provided, and empowerment of patients to advocate for their own care[11-16]. Furthermore, telemedicine services tend to reduce health-related costs for people living in rural areas[17], increase trust in local physicians and healthcare facilities[18], improve access to care for severely ill patients living in remote locations[19], and decrease pre-hospital transport and triage delays[20].

An implementation attempt was made during the e-Rés@MONT project between 2017 and 2018 in five different mountain huts located across Italy, France and Switzerland. The objective was to bring telemedicine services to remote mountainous areas, specifically at altitudes ranging from 1533 to 3500 m. A total of 702 teleconsultations were conducted, with an average duration of 32 minutes. The project managed 30 emergency cases, avoiding 18 ambulance trips and 12 helicopter rescues, saving €75,489 (A$121,731) for the Aosta hospital[21].

Technostress and healthcare systems

In recent decades, societal digital transformations have changed how people socialize, access information, and work. The benefits experienced from these innovations come with a potential psychological challenge known as technostress. In 1984, Craig Brod first developed the concept of technostress, defining it as 'a modern disease of adaptation caused by an inability to cope with the new computer technologies in a healthy manner'[22]. When applied to work environments where the use of information and communication technologies (ICTs) prevails over other working techniques, we can define technostress as 'the phenomenon of stress experienced by end users in organizations as a result of their use of ICTs'[23]. As a complex construct, technostress is characterized by multiple dimensions: techno-overload (ICTs' potential to compel users to work faster and longer or change work habits), techno-invasion (ICTs' ability to invade users' personal lives and make the boundaries between work and private contexts more blurred), techno-complexity (situations where ICTs' features and complexity make users feel inadequate concerning their skills), techno-uncertainty (continuous upgrades and changes in ICTs that disturb users and force them to learn new aspects constantly), and techno-insecurity (potential users' feeling of being threatened about losing their jobs, due to a replacement by automation or others who have a better ICT knowledge)[24].

Healthcare and hospital workplaces are now characterized by numerous stress-inducing factors. As shown in the study by Peter and colleagues (2020), stress often arises from a range of conditions across different health workers, such as work–life conflicts, lack of role clarity, unfair behaviour by colleagues, and higher demands to hide emotions. These stressors may lead to a reduction in job satisfaction and an increase in the intention to leave the workplace prematurely[25]. If the existing characteristics of workplaces contribute to the rise in stress among healthcare workers, ICTs and the associated technostress might amplify these stressors' effects for those who lack digital competencies[26]. Studies have already highlighted the nature of technostress in healthcare workplaces, identifying techno-overload and techno-insecurity as the main generators of technostress among professionals[27,28]. Overall, technostress tends to be positively correlated with burnout, sleep disturbances, and cardiovascular strain, and negatively associated with job satisfaction and work engagement[29,30]. The most common sources of technostress identified in the literature are technical problems (eg wi-fi connections, hardware, software), lack of technical support, insufficient adaptation to everyday clinical practice, and dependence on technology for specific tasks[27,29].

As shown, technostress plays a critical role in the quality of life of healthcare professionals. We think that addressing the dimensions of technostress is essential to the successful implementation of telemedicine, to ensure that digital transformation in health care does not come at the cost of increased psychological strain among medical professionals.

Research gap and the study's objectives

Although previous research has explored rural healthcare workers' needs and interest in telemedicine, as well as the technological stressors experienced by healthcare professionals in their daily practice, few studies have examined these topics together. As a result, limited evidence is available on how technostress influences the implementation and adoption of telemedicine in rural healthcare settings. To the best of our knowledge, empirical evidence on the integration of technostress with healthcare professionals' perceptions of telemedicine implementation remains limited. In the literature, a model that links technostress characteristics to telemedicine acceptance was developed but never tested[31]. Furthermore, previous studies have highlighted that, despite its benefits, telemedicine implementation attempts face numerous challenges in rural and isolated communities, such as technophobia[32], technological mistrust[33,34], and social and economic barriers that limit access to healthcare and digital services[35,36]. These factors may foster scepticism toward new technologies and hinder their adoption. Consequently, although telemedicine aims to reduce disparities in healthcare access between rural and urban populations[37], insufficient culturally tailored education and dissemination strategies widen the gap[38].

To address these gaps, this study adopts a mixed-methods approach that combines quantitative measures of technostress with qualitative interviews exploring healthcare professionals' experiences with telemedicine in rural mountainous areas of north-eastern Italy. By integrating these perspectives, the study seeks to identify the benefits, facilitators, and barriers to telemedicine adoption, and to examine the role of technostress in shaping healthcare professionals' attitudes toward its implementation. Ultimately, the findings aim to support the development of context-specific implementation strategies and evidence-informed policies for telemedicine services in geographically isolated communities. Given that nearly 35% of Italy's territory consists of mountainous regions[39], the findings from this case study can provide valuable insights applicable to broader national telemedicine strategies, helping refine policies and implementation models for other remote areas across Italy.

Accordingly, the study aims to answer the following research questions:

- What are the interests and benefits for rural healthcare workers in the adoption of telemedicine?
- What contextual factors facilitate the adoption of telemedical services by inhabitants of remote communities?
- What are the physical, social, and organizational barriers to the use of telemedicine?
- How do healthcare professionals perceive and experience technostress associated with current work activities and telemedicine implementation, and how are these stresses connected to service interest?

Methods

A mixed-methods approach comprising structured interviews and questionnaires has been adopted. The qualitative part of the study, composed of a series of structured interviews, aims to explore in depth the opinions and interests of healthcare workers, while the quantitative surveys aim to evaluate current practices and the potential impact of telemedicine on technostress levels. During data analysis, results from both parts were integrated, looking for emerging patterns across the different data collection methods.

Participants, environment characteristics, and procedure

In total, we collected data from 16 individuals (14 women and 2 men) with a mean age of 50 years (standard deviation 11.04). All participants were healthcare workers and worked in two municipalities in the mountainous Dolomite region of northern Italy. Participants divided themselves across various health professions: six pharmacists, five volunteers, two nurses, and one from each of the following professions: healthcare assistant, GP, and psychologist. All participants operated in rural areas with altitudes ranging from 1177 m to 1350 m above sea level. In 2023, the average population between the two municipalities was 1623 inhabitants. The average distance from the hospitals in the area for both municipalities is about 40 km. Participants were recruited by contact by either email or through the publicly available telephone numbers of their respective clinics. All the interviews were conducted between April and May 2024 and lasted 20 to 80 minutes. Data collection was conducted in person at participants' offices or clinics. For each participant, data collection followed the same procedure: we administered the structured interview on telemedicine interest, and then the technostress questionnaires.

Measurement instruments

The structured interview protocol was developed by referring to existing literature on the topic[40-42] and our research interests. During the interview, we followed the key principle of the constructivist grounded theory approach[43], aiming to elaborate on and integrate participants' opinions on the topic as we formulated new questions. We focused on the following areas:

- current knowledge of telemedicine services
- present use (and modalities) of telemedicine services
- individual willingness to use the service in daily professional activities
- expectations about patients' service usage and acceptance
- environmental advantages and limits regarding implementation and use of the service.

The interviews were conducted in Italian and were designed with current Italian regulations and telemedicine practices in mind.

Technostress was evaluated using the Italian version of the Technostress Creator Scale (TCS)[44]. The scale evaluates three of the five technostress dimensions: techno-overload, techno-invasion, and techno-complexity. The scale, composed of 11 items (four for techno-overload, three for techno-invasion, and four for techno-complexity), asked each participant to rate their agreement on a five-point Likert scale from 1 ('strongly disagree') to 5 ('strongly agree') on a series of statements. Given its good psychometric properties, the tool was integrated into our study. To measure the

expected technostress associated with the future use of new telemedicine services, we created an ad hoc adapted version of the TCS by changing the wording in each item to refer to telemedicine services. Our research group is evaluating this short and adapted scale version to ensure its reliability and validity in telemedicine services. Thus, the three original dimensions of the TCS measure the same constructs related to expectations for the future use of new telemedicine services. As in the original TCS, we asked each participant to rate their agreement with a series of statements on a five-point Likert scale from 1 ('strongly disagree') to 5 ('strongly agree').

Data analysis

All interviews were audio-recorded and transcribed verbatim between March and May 2024. No software was used to automate the transcription process. Based on the five research topics, we identified categories and subcategories for each question. To better summarize the results and ensure clarity, we exported each category and subcategory to Microsoft Excel. Here, we created frequency indexes for each category that emerged across the different interviews.

Because the technostress questionnaires were administered on paper, we entered the results into an Excel document to begin data analysis. Here, we calculated the mean value for each group of items, corresponding to the different dimensions of technostress, and for all items, corresponding to the overall technostress level. This was done for all participants. Then, we transported the data to Jamovi v2.4 (Jamovi Project; https://www.jamovi.org [https://www.jamovi.org]) for further data analysis. We decided to run a correlation analysis to assess associations between results across the different dimensions and overall levels of technostress for participants from the two versions of the questionnaires. Concurrently, to ensure the reliability of the results, McDonald's omega was adopted, with values of 0.80 or greater indicating good reliability[45].

Ethics approval

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and its subsequent amendments. The study protocol was reviewed and approved by the Ethics Committee of the University of Verona (approval code: 2024_12). All participants provided written informed consent prior to their inclusion in the study.

Results

Interviews

Current knowledge of telemedicine services

The first part of the interview focused on the current information and training in telemedicine. When asked about their first thought upon hearing the word *telemedicine*, most participants provided a definition of the practice and examples of its characteristics. In total, seven participants included characteristics related to distance; eight included characteristics related to advanced technology; four described telemedicine as a technique for monitoring patients' vital signs; and another four described the service, referring to its usefulness.

> *A system, one of monitoring also, of situations … especially in the mountains where territorial services are reduced. I was saying monitoring for people who are lonely, elderly, with problems, and who have difficulty in reaching doctors, hospitals, etc., etc., and then the possibility of making an initial diagnosis.* (AU34, female pharmacist, age 53 years)

When asked about receiving any type of training during their academic career, only one participant reported receiving training during university, while 13 participants reported receiving training after university studies. Two participants refused to answer this question.

> *In my very past education, no, I only heard about it in recent years at work.* (AU36, female nurse, age 48 years)

Asking participants to provide examples of the practice to understand their level of knowledge across the variety of services led around 13 participants to refer to remote reporting of vital parameters, particularly associated with telecardiology analysis, such as electrocardiogram (ECG), spirometry, and Holter cardiac and blood pressure monitoring. Only a few gave examples of telemonitoring (eg for diabetes), teleconsultation, and routine check-ups with GPs.

Present use (and modalities) of telemedicine services

We wanted to explore the experiences and expectations of professionals on the usage of telemedicine. At the time of the interview, 7 out of 16 participants actively used telemedicine services in their professional practices. All the interviewees mentioned telecardiology services when asked what services they implemented in their daily professional activities.

> *ECG, cardiac and blood pressure holter … currently these three … and for several years, about 5 or 6.* (AU29, female pharmacist, age 55 years)

We decided to investigate the potential for problems during work activities. From the answers, we could see that participants mostly complained about internet connection problems.

> *The only problem is related to slow connections.* (AU31, female pharmacist, age 46 years)

When discussing the availability of external support in the event of device or software malfunction, all participants emphasized the existence of an always-available support and assistance line for any technical problem.

> *They* [external support] *come for an electrocardiograph check every few months. Besides that, once we had a cable that didn't work, but they fixed it within a short while.* (AU36, female nurse, age 48 years)

In conclusion, when asked how their patients might have felt during the visit, health professionals highlighted that the 'familiar' environment and their confidence in the professionals made them feel more comfortable than during a hospital visit.

> *It is like a 'home' environment. In the sense that it is outside the hospital, and they see it as a good thing. Also, very convenient since it's at their doorstep.* (AU37, female pharmacist, age 30 years)

For participants who had never used telemedicine services, we developed a parallel version of the interview and investigated their perceptions of potential use, reflecting ideas shaped by knowledge, personal views on their jobs, and cultural factors. Before proceeding, we asked professionals to imagine what it would be like to use telemedicine and to refer to that imagining while answering. Of the nine participants who were not currently implementing the services in their professional practice, almost all identified telecardiology as their primary use. The main concerns in the actual implementation of the services were the instability of internet connectivity, fears of inadequate training in the use of specific devices, and uncertainty about connectivity with hospitals to send the data.

> *Would I feel comfortable? I might have some initial apprehension when you're not yet familiar with it, since it's not part of my academic studies.* (AU26, male pharmacist, age 37 years)

Compared with their colleagues who were already using the service, participants who had not yet experienced it expressed concern that some patients might not accept telemedicine due to mistrust of technology.

> *Being an elderly population, they are not very accustomed to the use of technology. For them, it would be easier to pick up the phone and call the doctor.* (AU34, female psychologist, age 53 years)

Across all participants, 10 interviewees reported having good to very good abilities in using technology services in their work, and six reported having only sufficient skills.

Individual willingness to use the service in daily professional activities

In this third section of the interview, we wanted to understand the advantages, risks, and functionality of implementing telemedicine services in mountainous rural areas. Participants identified ease of work management (eg during emergency calls, high-demand shifts, and global pandemics such as COVID-19), enhanced service quality, and economic and time savings as the main advantages that would encourage them to implement telemedicine practices in their daily activities.

> *In my professional life as a nurse, I would like these things to be more encouraged because the advantages of an isolated place like ours are that … sometimes you might have* [a patient with] *an arrhythmia, and while travelling from here to the hospital, the symptom disappear, and the issue could be missed, you know? As has happened other times.* (AU33, female nurse, age 37 years)

When asked about risks related to the practice, results show that professionals are mainly concerned with inadequate training in using the service and a 'loss of human contact' between them and their patients.

> *The risks? That we lose human contact, and we go more and more into isolation, no? Because in mountainous places like this, those who come to the pharmacy, those who go to the GP, also go to have a moment of dialogue, social contact.* (AU29, female pharmacist, age 55 years)

Participants identified other risks, including increased workload, privacy issues, difficulties in finding specialized staff, and the deregulation of the national health system.

> *If all pharmacies, as well as small medical centres, started offering telemedicine services, the national healthcare system might no longer need to provide these services directly. The system is already lacking, and instead of freeing up more spots, services that could be provided for free to those most in need might be removed. Unfortunately, it's very much about numbers and statistics. If people are directed to different places, instead of helping to ease the burden on the healthcare system, those at the top might say, 'There's no demand', and could remove the service.* (AU37, female pharmacist, age 30 years)

Contrary to the fear of being left behind by the national health systems, participants identified the reduction of waiting times for healthcare visits, reduction of visits to emergency departments and unnecessary hospitalization of patients, and significant support to rural and urban areas as the main advantages the national health system would get by supporting the implementation of telemedicine services in local/rural communities.

> *To reduce waiting and booking times for a visit. The time and, as said before, also the costs for the patient.* (AU29, female pharmacist, age 55 years)

Expectations about patients' service usage and acceptance

In this fourth section of the interview, we asked the interviewees about the impressions their patients might have of the service's use. We think that healthcare providers are the people who best know those they assist, and for this reason we wanted to investigate their expectations and reactions to the service usage. We wanted to know which factors might influence patients' acceptance and usage of telemedicine services in their areas. Participants highlighted the convenience of not having to travel, the age of the population, cost savings, a sense of community, and greater security as the five main factors that would make it easier for their communities to accept telemedicine services.

> *The fact of not having to travel and having everything here, because to go to the hospital, you must cover 40 km. And you need to find someone to take you.* (AU28, female volunteer, age 43 years)
> *A great time saver for people, and convenient, because if someone says, 'I need to go for an electrocardiogram, I have to drive over an hour', not to mention the cost, they might lose the motivation. Having it close to home is a completely different story.* (AU26, male pharmacist, age 37 years)

> [The patients] *are not alone at home, while the hospital is far away. There's this service, and I can connect if needed, and even those undergoing treatment can benefit.* (AU34, female psychologist, age 53 years)

Conversely, a lack of digital competencies, reduced social contact with physicians, and distrust of new technologies have been identified as the leading factors hindering the acceptance and use of these services.

Perhaps, not having the doctor right in front of them is something they'd need to get used to. The aspect of the relationship is missing … people are used to going to the doctor, even just because at the clinic they'll see this person, that person, and someone else. It's also a moment of social connection. (AU34, female psychologist, age 53 years)

Perhaps the limitations are for very elderly people who find themselves facing something new and innovative. (AU29, female pharmacist, age 55 years)

Environmental advantages and limits regarding implementation and use of the service

In the last part of the interview, we asked participants to reflect on the advantages the territory would gain from implementing telemedicine services, the practical limits and obstacles to its implementation, and what professionals would need to implement the service. Regarding the advantages telemedicine services might bring to the territory, participants identified the enhancement of the territory (eg attracting tourists and possible residents in the areas), countering depopulation, resilience during natural catastrophes (eg avalanches or landslides), and reduction of distances to urban centres as the main advantages the rural territory would get.

Depopulation? Well, of course, yes, in the sense that people don't stay because they imagine there are no services. If they have children, they'll have to go to the hospital for anything. (AU38, female volunteer, age 69 years)

When asked about the territory's limits in a practical sense, participants identified three main problems: poor replenishment of internet connection, electrical power, and a lack of space for the service.

To be fair, we've got fibre internet now, but we're still lacking. Especially because here, all it takes is a heavy snowfall, and everything goes down. Not to mention blocked roads, landslides, or avalanches. (AU29, female pharmacist, age 55 years)

Survey on technostress

Following the interviews, we asked each participant to complete two questionnaires: one to measure technostress levels in their current working practices (original questionnaire) and the second to assess expected technostress levels during telemedicine use (telemedicine questionnaire). For participants who had never used the service, we asked them to imagine how the practice could be, while for those already using the service in their professional practice, we asked them to think about different types of telemedicine services they could use in their practice while answering the survey. Table 1 presents the internal consistency coefficients for each technostress scale used in the study.

Overall, the scales' reliability exceeds 0.80, indicating good reliability of the assessment tools. Only the original techno-invasion scale (ω=0.62) does not meet the expected level of internal consistency, falling slightly short of the other coefficients. Given the number of participants and the exploratory nature of the study, we deemed it acceptable to proceed with further analysis. Table 2 shows the mean values of each variable from the original TCS and its adapted version.

From the results, overall technostress levels, as measured by both the original and telemedicine questionnaires, indicate moderate stress among all participants. Furthermore, a significant positive correlation emerged between the participants' mean values for original and telemedicine techno-invasion ($r(14)=0.51$, $p=0.044$), and for techno-complexity ($r(14)=0.58$, $p=0.019$). No statistically significant correlations were found between the different versions of the questionnaire, while accounting for techno-overload ($r(14)=–0.01$, $p=0.96$) and overall technostress levels ($r(14)=0.38$, $p=0.15$).

Taken together, the results shed light on the technological stress experienced by rural healthcare workers during their daily work activities, as well as the relationship between current and expected stress across different devices. Given the importance of such evaluations during implementation attempts and their insights for local administrators and policymakers, we asked that these results be cautiously interpreted. The limited sample size ($n=16$) and the exploratory nature of the study limit the generalizability of the results but serve as a first attempt to introduce technostress evaluations in new medical device adoptions, which future work should consider and replicate.

Table 1: Reliability coefficients of technostress short scales adopted in the study

Technostress dimension	Internal consistency (McDonald's ω)	
	Original	Telemedicine
Techno-overload	0.80	0.93
Techno-invasion	0.62	0.86
Techno-complexity	0.94	0.87

Table 2: Mean values of original and telemedicine technostress variables

Technostress dimension	Questionnaire mean (SD)	
	Original	Telemedicine
Techno-overload	2.32 (0.93)	2.52 (1.22)
Techno-invasion	2.46 (0.92)	2.15 (1.19)
Techno-complexity	2.39 (1.16)	2.23 (0.82)
Overall technostress	2.39 (0.82)	2.30 (0.85)

SD, standard deviation.

Emerging path between interviews and surveys

The integration and exploration of results across the investigations highlighted convergent themes regarding the implementation of telemedicine services in rural mountain regions.

High levels of techno-overload related to future use of telemedicine have been observed across the healthcare assistant (AU25, mean 4.25), and two pharmacists (AU26, mean 4.50; AU35, mean 4.50). In general, these participants were more likely to report struggles over a lack of personnel in the areas and difficulties in completing their daily routine. During their interviews, telemedicine was perceived as an additional task and a new potential burden on daily activities. While the healthcare assistant associated telemedicine with the current lack of time for existing occupational duties, the pharmacists linked the new

service to the fear of an increased workload, connected to inadequate financial compensation and the expansion of responsibilities.

The highest levels of techno-invasion associated with telemedicine were reported by the healthcare assistant (AU25, mean 3.67), the GP (AU32, mean 3.33), and two pharmacists, AU26 (mean 3.33) and AU35 (mean 5.00). Interview results suggest that this dimension is associated with concerns about patients misusing the service. Both the GP and the two pharmacists underlined the concerns about constant availability for their patients and the fear of blurring the line between private and work life.

Regarding the techno-complexity dimension, the GP (AU32) reported the highest score in both the original technostress scale (mean 3.75) and the telemedicine scale (mean 3.75). At the same time, while generally techno-complexity over telemedicine tended to remain below average level, the original scale identified moderate stress level in the healthcare assistant (AU25, mean 4.25), and two volunteers (AU38, mean 3.75; AU39, mean 3.50) and AU40 (mean 3.50). After review of their interview results, it emerged that participants with high techno-complexity levels were more likely to report infrastructural problems, such as limited connectivity, power supply, and coordination between primary and hospital services. Infrastructural deficiencies increased uncertainty about telemedicine's reliability, amplifying perceptions of technological complexity and reducing confidence in its routine clinical use.

The two nurses reported the lowest overall telemedicine technostress scores across participants (AU33, mean 1.44; AU36, mean 1.25). In general, their interviews underscored strong confidence in the use of technologies and extensive practical experience with telemedicine equipment. Participants described the routine use of electrocardiography systems without significant technical difficulties and identified telemedicine as an essential resource for isolated communities. Telemedicine was not perceived as an additional burden but rather as a bridge enabling rapid consultation with the nearest hospital, not only in emergencies.

To summarize, participants with high technostress primarily discussed staff shortages and time availability, unreliable technological infrastructure, fear of a reduction in face-to-face contact with patients, and concerns about the accuracy of results obtained through telemedicine. The service was often perceived as an external burden imposed by local and health administration, without proper organizational support. Conversely, participants with technostress levels below average were more likely to report that telemedicine would enhance their efficacy and efficiency in delivering care by reducing patients' travel time and improving decision-making processes. Rather than being a substitute to their capacities, telemedicine was seen as a tool that strengthened their abilities to deliver safe and appropriate care. For example, one of the volunteers (AU38) reported relatively high levels of technostress in current activities (mean 3.72), but substantially lower telemedicine-related stress (mean 1.83). The participant reported that telemedicine would have functioned as a 'psychological safety net', not only during emergency situations, but also by providing close specialist support in case of necessity, and reducing uncertainty during rescue operations.

In conclusion, despite differences and, at times, elevated technostress levels across categories, the interviews with all participants revealed consistent and positive support for the introduction and use of telemedicine. Such services were considered an essential strategy to overcome structural current barriers associated with geographical isolation from primary healthcare delivery centres. According to participants, the introduction would benefit public health infrastructures as well by reducing unnecessary travel to clinics or emergency departments and by reducing the waiting lists for medical examinations.

Discussion

This study aims to analyse the challenges and implications of telemedicine adoption in rural and remote areas, focusing on the barriers that healthcare professionals and patients face in these settings, while accounting for the technological stress experienced.

As shown by our results, participants highlighted the major benefits of telemedicine implementation, including cost savings from reduced transportation and time spent travelling, improved service quality, easier work management, and increased security for their professional activities and patients. Our findings are consistent with those reported in recent reviews[15] and underscore the importance of administrators and policymakers considering the specific needs of their local communities. They also highlight the value of supporting investigations such as the current one, which provide evidence to identify and address territory-specific needs and inform the planning of healthcare services. Furthermore, to improve the likelihood of interest in and use of telemedicine during implementation attempts, future studies should engage healthcare professionals before local populations. Engaging professionals from the outset enables the collection of feedback, opinions, and practical insights on the usability and adequacy of the systems they will ultimately use[46]. Beyond improving functionality, early participation contributes to professionals' sense of ownership and confidence in the technology, which in turn influences patients' acceptance and adherence. The relationship between healthcare providers and patients is dynamic and shaped by the tools that deliver care; as Tuckson and colleagues (2017) observed, healthcare professionals act as intermediaries between innovation and the community, and their endorsement is often decisive in the diffusion of new health technologies[47]. Conversely, the absence of professionals' engagement may result in services that remain underused or are perceived as externally imposed solutions.

During the interviews, the sense of security has been highlighted for both patients and professionals. For patients, security means developing a network of professionals who are more easily accessible in case of need while, for healthcare workers, security arises from the possibility of contacting other professionals in case of emergency, for a different opinion, or for support. Similar results were reported by Hege and Kari in 2010. In their study, the researchers report two case studies: one of an assisted individual and the other of a healthcare provider, narrating their experiences with telemedicine services in a rural setting. In both cases, the actual use of telemedicine was rare, but having the option to use the service was enough to make them feel safe about their conditions or jobs[48]. By combining these results with ours, it seems that the mere presence, rather than the use, of telemedicine services creates social networks with healthcare providers or other

colleagues, fostering perceptions of safety and security, and reducing feelings of loneliness and abandonment, among those living in remote areas. Concurrently, perceived safety should be combined with physical patient safety during care delivery. Digital environments generated by telemedicine create new challenges in different aspects of service provision, such as failures in communication and information exchange regarding drug prescription, administration, and treatment instructions[49-51], as well as vulnerabilities in the storage and sharing of confidential patient information[52]. Future studies and implementation attempts should consider these aspects by involving health workers in co-design efforts to build safe, equitable, person-centred telemedicine services tailored to the needs of target communities and aligned with their needs[53].

Participants identified the lack of digital competencies, mistrust of new technologies, and reduced social contact as the main deterrents to patients' telemedicine acceptance. Similar results are consistent with a series of interviews with GPs, in which participants highlighted the patient's lack of digital literacy as a major concern for telemedicine implementation[40]. Another analogy with our findings stems from the fear of reduced social contact between practitioners and patients, which is identified as one of the main risks of introducing telemedicine. Our participants identified this as one of the main issues in service use, highlighting the necessity of strong patient–professional pre-existing relationships to overcome the disclosure of negative effects. Future implementation attempts should consider telemedicine as a tool to improve accessibility to care, rather than a substitute for existing practices. Furthermore, future studies should propose, test, and evaluate participatory interventions with care providers and participants to enhance understanding of the benefits of adopting telemedicine services and foster mutual support. Concurrently, it is key to account for the needs of new technological workers. Telemedicine services, like any technological innovation, can create cognitive overload for both providers and users if they are introduced without sufficient support or training[46]. This requirement may exacerbate the pre-existing digital divide, particularly relevant in rural communities, where educational and economic limitations often correspond to lower digital literacy than in urban areas[40]. Reducing these disparities, while accounting for technostress levels and workers' digital competencies, requires targeted interventions to improve users' familiarity with technology, such as tailored training sessions, public demonstrations, and simplified, intuitive interfaces. Addressing the digital divide is not only a technical matter but also a social one: without deliberate inclusion strategies, telemedicine may inadvertently widen the accessibility gap it was designed to close.

Regarding technostress, our sample showed moderate levels not only in current ICT use but also in potential telemedicine use. This result aligns with the current trend in technostress levels among healthcare providers worldwide, demonstrating that healthcare professionals are keen to exhibit moderate levels of technostress during their work activities[26,28,54]. In particular, as shown by Kasemy and colleagues (2022), operating in rural areas is a risk factor for the development of high stress levels[54]. In our study, data collected via the technostress questionnaires revealed a positive association between the two components of technostress (techno-invasion and techno-complexity) as measured across the two scales. This finding suggests that individuals who already experience certain levels (low or high) of technostress in their work activities anticipate similar experiences with telemedicine tools. This result should be interpreted with the understanding that all participants supported introducing telemedicine services into their professional lives during the interviews. In this case, we can consider that the advantages and benefits of introducing telemedicine services into professional and community life mitigate such concerns, fostering interest, willingness to use, and support for their implementation. Our result is consistent with the existing literature, which has found that the perceived usefulness of ICTs is associated with the development of positive technostress and the intention to use new technologies[55,56]. Future research and implementation efforts should focus on developing and using valid research tools to identify the key psychosocial antecedents of telemedicine service acceptance prior to and during introduction in rural communities. Frameworks such as the Unified Theory of Acceptance and Use of Technology[57] and the technology acceptance model[58] offer well-grounded, flexible[59] theoretical models that can be easily adapted across technologies and contexts. The development of such evaluations should include technostress dimensions and their role in telemedicine acceptance and use over time. The inclusion of technological stressors would provide valuable insights into their role in shaping workers' interest in the proposed services, highlight current deficiencies in work activities, and inform the need for infrastructure changes and ad hoc digital literacy training.

Limitations

The study has several limitations. First, the sample size (n=16) is small, which negatively affects the generalizability of the results. Even though we reached saturation in the information gathered during the interviews, we believe a larger sample size might have benefited the study. Second, we couldn't reach all healthcare professionals operating in the area, which reduced the heterogeneity of our results. Finally, the adapted version of the TCS has not been validated and might lack consistent psychometric properties.

Conclusion

The current study explored healthcare providers' perspectives, attitudes, and challenges regarding the adoption of telemedicine services in rural mountainous areas. The results underscore the pivotal role of telemedicine in enhancing healthcare accessibility and have practical implications for policymakers and healthcare administrators. Investments in digital infrastructure and training programs are crucial to overcoming barriers such as poor connectivity and inadequate skills. Furthermore, fostering trust in technology among patients and providers will be critical to maximising the impact of these interventions. Future research should include evaluating the value of technostress and professionals' digital literacy when evaluating new medical technologies. In conclusion, addressing these challenges through comprehensive strategies, can make telemedicine become a cornerstone of equitable and efficient healthcare systems, especially in geographically isolated communities.

Funding

For Marco Lezcano and Maria Gabriella Landuzzi's contribution, this research has been carried out with the University of Verona, PhD program, and funded by Next Generation EU – PNRR ex D.M.

117/2023 and 118/2023. For Margherita Pasini's contribution, this research has been carried out within the PNRR research activities of the consortium iNEST (Interconnected North-East Innovation Ecosystem) funded by the European Union Next-GenerationEU (Piano Nazionale di Ripresa e Resilienza (PNRR) Missione 4 Componente 2, Investimento 1.5 D.D. 1058 23/06/2022, ECS_00000043 – Spoke1, RT1A, CUP I43C22000250006).

Conflicts of interest

The authors declare no conflicts of interest.

AI disclosure statement

During the writing and internal revision of the present manuscript, we used the Grammarly tool, provided by the University of Verona, to check for semantic, syntactic, and spelling errors. All authors take full responsibility for the content of the final article.

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