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Angeliki Chandrinou, Konstantinos Exarchos, Konstantina Gaitanou, Panagiotis Mpogiatzidis

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## SYSTEMATIC REVIEW

## TELEMEDICINE IN EXTREME CONDITIONS: QUALITY ASSURANCE, CHALLENGES, AND DIRECTIONS FOR IMPROVEMENT: A SYSTEMATIC REVIEW

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**Abstract**

**Background:** Telemedicine has become an important approach for delivering healthcare in settings where physical access to services is limited, disrupted, or impossible. Its relevance is particularly evident in extreme conditions, such as disasters, conflict-affected areas, remote locations, and other resource-constrained environments. However, the quality assurance of telemedicine services in such settings remains insufficiently clarified. This systematic review aimed to synthesize the current evidence on the quality assurance of telemedicine services in extreme conditions and to identify major challenges, quality-related considerations, and directions for improvement.

**Method and Material:** A systematic review was conducted in accordance with the PRISMA framework. Literature searches were performed in PubMed, Scopus, and Web of Science for studies published between January 2020 and July 2025, with a supplementary search of relevant open-access material. Eligible studies examined telemedicine applications in extreme, crisis-related, remote, or resource-constrained settings, or addressed quality-related dimensions of telemedicine relevant to such contexts. Fifteen studies met the inclusion criteria and were included in the final synthesis.

**Results:** The included studies suggest that telemedicine can improve access to specialist expertise, support continuity of care, and enhance responsiveness in unstable or disrupted environments. At the same time, recurrent challenges were identified, including limited connectivity, infrastructure constraints, insufficient institutional support, inadequate user training, and legal or regulatory uncertainty. Eleven studies were of moderate quality and four were of high quality.

**Conclusions:** Telemedicine appears to offer substantial value for healthcare delivery in extreme conditions, but its quality cannot be assumed on the basis of feasibility or technological availability alone. More robust quality frameworks, context-sensitive implementation models, and stronger evaluative evidence are needed.

**Keywords:** Telemedicine, quality assurance, extreme conditions, disaster response, conflict zones, remote monitoring.

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**INTRODUCTION**

Telemedicine has become an increasingly important component of contemporary healthcare delivery, offering new possibilities for improving access, continuity, and coordination of care across distance. The World Health Organization (WHO) defines telemedicine as the delivery of healthcare services when distance is a critical factor, through the use of information and communication technologies for diagnosis, treatment, prevention, re-

search, evaluation, and continuing education of health professionals. In recent years, telemedicine has evolved from a peripheral or pilot-level innovation to a more established mode of service delivery in many health systems, particularly following the rapid expansion of remote care during and after the COVID-19 period. However, eminent international bodies have also emphasized that the advantages of telemedicine cannot be taken for granted and are contingent on suitable implementation, governance, and continuous evaluation.<sup>1</sup>

Its relevance is especially pronounced in extreme conditions, including natural disasters, humanitarian emergencies, armed conflict, and remote or severely resource-constrained environments. In these settings, conventional service delivery may be subject to disruption due to a range of factors, including damaged infrastructure, staff shortages, population displacement, transportation barriers, insecurity, and unstable communications. Under such circumstances, telemedicine has the potential to support clinical decision-making, extend specialist input to areas where services are limited, and help maintain service continuity when in-person care is delayed, limited, or impossible. Recent literature in the domain of humanitarian and conflict settings suggests that telemedicine can function as a practical mechanism for remote support even in highly unstable environments, although its deployment is often shaped by contextual limitations rather than by standardized models of care.<sup>2</sup>

Notwithstanding this potential, telemedicine in extreme conditions is not merely a matter of access or feasibility. The clinical usefulness and sustainability of the aforementioned system depend on the quality of the service delivered, including the reliability of technology, the adequacy of workflows, patient safety, data protection, professional readiness, and institutional integration. The OECD has observed that the future of telemedicine is contingent not only on its adoption but also on the capacity of existing systems to evaluate its impact, regulate its utilization in an appropriate manner, and integrate it within the broader framework of health system performance evaluation. Concurrently, WHO/Europe has recently developed a Telehealth Quality of Care Tool and a support tool to strengthen telemedicine services, explicitly recognizing the need for more structured assessment, continuous monitoring, and quality improvement across different levels of health systems. These developments indicate that the quality of telemedicine has evolved from a secondary implementation issue to a central policy and service delivery concern.<sup>3</sup>

This necessity for quality assurance assumes even greater significance in extreme settings, where environmental instability can directly impact service performance and patient outcomes. Literature pertaining to war zones and humanitarian contexts re-

peatedly identifies various barriers that impede the effective delivery of aid. Such barriers include, but are not limited to, disrupted internet connectivity, limited technical infrastructure, legal and ethical uncertainty, fragmented workflows, and insufficient training or support for frontline personnel. Concurrently, emerging research on telemedicine quality frameworks and indicators suggests that health systems are still working towards more balanced and operationally useful ways of measuring safety, experience, technical success, equity, and clinical outcomes in virtual care. Collectively, these findings suggest that the challenge is not merely whether telemedicine can be used in extreme conditions, but how its quality can be defined, assessed, and improved under such circumstances.<sup>4</sup>

Despite the increasing utilization of telemedicine in disaster response, conflict-affected settings, and remote or resource-constrained environments, the literature remains heterogeneous in scope, study design, evaluation methods, and quality-related outcomes. Available evidence varies in technological maturity, institutional embedding, and methodological rigor, while common standards for assessing telemedicine quality under extreme conditions remain limited. A systematic synthesis of the literature is therefore required to clarify how quality assurance of telemedicine services has been addressed in such settings, what major challenges have been identified, and which directions for improvement emerge from the available evidence. The objective of this systematic review was to synthesize the current evidence on the quality assurance of telemedicine services in extreme conditions and to identify major challenges, quality-related considerations, and directions for improvement. The specific objectives of the review were as follows: firstly, to examine how quality assurance of telemedicine services has been described and evaluated in extreme conditions; secondly, to identify the main effectiveness-related findings reported across the included studies; thirdly, to explore the key technological, organizational, legal and educational challenges affecting telemedicine quality in such settings; and finally, to synthesize the main directions for improving the quality and delivery of telemedicine services in crisis and resource-constrained environments.<sup>5</sup>

## METHOD AND MATERIAL

### Study design

This study was conducted as a systematic review of the literature focusing on the quality assurance of telemedicine services delivered under extreme conditions. The review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework.<sup>6,7</sup> The review process was guided by predefined eligibility criteria and a structured search and appraisal strategy. In consideration of the heterogeneity of the included studies in terms of design, context, and reported outcomes, a narrative synthesis was employed for the synthesis of findings, with organization into thematic categories as opposed to quantitative pooling.

### Search strategy

A structured literature search was conducted in PubMed, Scopus, and Web of Science for studies published between January 2020 and July 2025. A supplementary search of relevant open-access material available through the MDPI platform was also undertaken. The search strategy was developed around four groups of keywords: (a) extreme conditions, including extreme conditions, crisis, disaster, emergency, conflict zone, and remote area; (b) telemedicine, including telemedicine, telehealth, e-health, remote healthcare, and m-health; (c) quality assurance, including quality assurance, quality control, quality management, and QA; and (d) evaluation, including evaluation, assessment, monitoring, and performance. Terms within each group were combined using the Boolean operator OR, whereas the four concept groups were combined using AND. A representative search string was as follows: ("quality assurance" OR "quality control" OR "QA" OR "quality management") AND ("telemedicine" OR "telehealth" OR "e-health" OR "remote healthcare" OR "m-health") AND ("extreme conditions" OR "crisis" OR "disaster" OR "emergency" OR "conflict zone" OR "remote area") AND ("evaluation" OR "assessment" OR "monitoring" OR "performance"). Minor adaptations were made depending on the indexing requirements and search interfaces of each source. Retrieved records were exported to Mendeley for organization and screening.

### Eligibility criteria

The inclusion criteria for the study encompassed empirical research that focused on the utilization of telemedicine in contexts

characterized by extreme or challenging circumstances. These settings encompassed situations involving crisis, disaster, conflict-affected regions, remote areas, or those experiencing resource constraints. Additionally, the research evaluated the quality-related aspects of telemedicine that were deemed pertinent to these environments. The quality-related aspects encompassed safety, efficiency, availability, reliability, and service performance. In view of the paucity of studies specifically conducted in extreme conditions, broader telemedicine studies with clear relevance to quality assurance in comparable settings were also considered.

Studies involving animal subjects and studies published before 2020 were excluded from the analysis. No language restrictions were applied, and non-English abstracts or full texts were translated when necessary. In addition, a comprehensive review of the reference lists of the included studies was conducted to identify any further relevant publications.

### Study selection process

Study selection was conducted in accordance with the PRISMA framework. The preliminary search yielded 1,256 records across all sources. After removal of duplicate records and exclusion based on predefined limits and filters, 118 records remained for title and abstract screening, of which 2 were excluded. Full texts were sought for 116 reports; 8 were not retrieved, leaving 108 reports for eligibility assessment. Following full-text review, 93 reports were excluded due to absence of relevant results ( $n = 12$ ), non-compliance with the inclusion criteria ( $n = 68$ ), or other documented reasons ( $n = 13$ ). Ultimately, 15 studies were included in the final synthesis. The study selection process is illustrated in the PRISMA flow diagram (Figure 1).

### Quality appraisal and level of evidence assessment

The methodological quality of the included studies was appraised using the Quality Assessment Tool for Studies with Diverse Designs (QATSDD),<sup>8</sup> which was selected because of its suitability for evaluating heterogeneous evidence. In parallel, the level of evidence of each included study was classified according to the Levels of Evidence (LOE) hierarchy proposed by Melnyk and Fineout-Overholt (2023).<sup>9</sup> Studies were retained in the final synthesis if they had a level of evidence of  $LOE \leq 5$  and achieved a minimum QATSDD score of 50%. Based on the predefined

quality thresholds, studies scoring 50%–69% were classified as moderate quality, whereas studies scoring  $\geq 70\%$  were classified as high quality. Following this appraisal, eleven studies were categorized as moderate quality and four as high quality. No studies below the minimum quality threshold were included in the final review.

### Data extraction and synthesis

The data extraction process was executed through the utilization of a meticulously designed extraction form, thereby ensuring a systematic and methodical approach to the collection of pertinent information. For each included study, the following information was recorded: author(s), year of publication, study design, study context, methods, level of evidence (LOE), QATSDD score, and principal findings relevant to the quality assurance of telemedicine services (Table 1). The extracted data were tabulated to support systematic comparison across studies. As the included studies found to be heterogeneous in terms of methodological design, settings, and outcome reporting, quantitative pooling was deemed inappropriate. Instead, the findings were synthesized narratively and grouped into five thematic categories reflecting the dominant areas identified in the literature: disaster response, conflict zones, quality assessment, remote monitoring and austere conditions, and education and training support. The organization of the Results section and the interpretation of the overall evidence base were informed by these thematic axes.

## RESULTS

The comprehensive literature search and study selection process resulted in the inclusion of 15 studies in the final review. The included evidence was heterogeneous in terms of study design, setting, and methodological approach, comprising empirical, qualitative, quantitative, review-based, and conceptual contributions relevant to telemedicine quality in extreme or comparable high-pressure environments. Following a thorough evaluation of the methodological approach, eleven studies were classified as moderate quality and four as high quality. In consideration of the heterogeneity observed, the findings were synthesized narratively and organized into five thematic categories.

### Disaster response

Within this thematic category, four studies addressed the use of telemedicine in disaster-related or highly austere contexts. Across the included studies, the evidence suggested that telemedicine may improve responsiveness and operational flexibility during emergencies, particularly through teleconsultation, remote interpretation, tele-education, tele-psychiatry, and tele-surgery applications.

Concurrently, the findings indicated that the efficacy of telemedicine in disaster settings is strongly conditioned by implementation requirements and contextual constraints. As posited by Mohammadzadeh et al.,<sup>10</sup> a plethora of services can be used during natural disasters. The necessity for appropriate communication tools and timely interpretation of transmitted information was also emphasized. In their seminal work, Okoh et al.,<sup>11</sup> articulated the notion of telemedicine as a pivotal support mechanism within the paradigm of emergency and disaster response. However, they concomitantly identified the presence of entrenched technological and logistical impediments, thereby underscoring the complexity of implementing such a system in real-world settings. Concurrently, the comprehensive synthesis of this thematic group indicated that integration into crisis operations frequently impeded by systemic, technical, and legal limitations.<sup>12</sup> Conversely, the review by Ting and Wilkes<sup>13</sup> provided the most robust evidence for the utility of telemedicine in austere and expeditionary environments, exhibiting high methodological quality (QATSDD 90%; LOE=1). The collective findings of these studies suggest that telemedicine has the potential to make a significant contribution to disaster response. However, the quality and reliability of this contribution is contingent upon three factors: technological readiness, operational planning, and context-sensitive implementation.

### Conflict zones

Telemedicine emerged across the included studies as an increasingly important approach to sustaining healthcare delivery in conflict-affected settings, mainly by improving access to clinical expertise, supporting continuity of care, and helping address service gaps created by insecurity, displacement, and shortages of specialized personnel. Within this thematic category, five studies examined telemedicine use in war-affected or politically

unstable environments. Across this thematic category, the evidence suggested that telemedicine may strengthen access to care and professional support in conflict zones, particularly when conventional health services are disrupted or difficult to maintain.

Concurrently, the findings indicated that the implementation of telemedicine in conflict settings is shaped by substantial quality-related challenges. Eljack et al.,<sup>14</sup> in a quantitative study involving 2,463 Sudanese physicians, reported generally supportive attitudes toward telemedicine while also identifying concerns related to the completeness of clinical information and medico-legal issues. Koehlmoos et al. (2024)<sup>15</sup>, through a qualitative exploration of telemedicine implementation in Ukraine after the Russian invasion, highlighted barriers such as data security risks, connectivity disruptions, and the need for better system integration. Parkes et al.,<sup>16</sup> provided a broader theoretical analysis of digital health interventions in conflict zones, whereas Tagne et al.,<sup>17</sup> and Alansari et al.,<sup>18</sup> emphasized the potential of innovation and cross-sector collaboration to improve access to care in fragile settings. Taken as a whole, these studies suggest that telemedicine can offer meaningful support in conflict-affected environments, but its quality and sustainability of such support is dependent on stronger institutional support, more reliable connectivity, and greater attention to security, governance, and implementation capacity.

### **Quality assessment**

Three studies specifically addressed quality assurance in telemedicine and related digital health applications. Collectively, these studies emphasized that quality in telemedicine depends on the systematic integration of quality management principles into digital workflows, rather than on ad hoc or purely technology-driven implementation.

Beckers and Stellmacher<sup>19</sup> focused on the logic of quality management in telemedicine and suggested that existing healthcare quality frameworks require further adaptation in order to respond adequately to digital care processes. Alelyani et al.,<sup>20</sup> approached the issue from a broader systems perspective, highlighting the need for frameworks, design strategies, and management processes that address reliability, availability, and

maintainability in telemedicine systems. Mahmood et al.,<sup>21</sup> contributed a more operational quality perspective by describing key elements of quality assurance and quality control, including acceptance testing before clinical use, continuous monitoring, and user training. Collectively, these studies indicate that quality assurance in telemedicine should be viewed as a multidimensional and context-sensitive process, requiring technical oversight, institutional responsibility, and structured mechanisms for safe implementation and ongoing performance evaluation.

### **Remote monitoring and austere conditions**

Two studies contributed to this thematic area, showing that telemedicine can support real-time data transmission, remote clinical consultation, and decision-making across a broad range of austere settings, including expeditions, military or expeditionary environments, remote industrial locations, and extreme sports contexts. In general, these findings suggest that telemedicine can help bridge physical distance and extend clinical oversight in settings where conventional healthcare delivery is difficult to sustain.

Doarn<sup>22</sup> emphasized the adaptability of telemedicine across multiple austere environments, including spaceflight, battlefields, alpine regions, jungles, ships at sea, and oil rigs, and argued that telehealth solutions can improve access to care in settings characterized by limited resources and restricted infrastructure. Pegoraro et al.,<sup>23</sup> further illustrated the operational potential of telemedicine in extreme sports, where data transfer, remote medical consultations, and imaging-based support were used for performance monitoring, injury assessment, and emergency response. Across these studies, key quality-related considerations included the efficiency of remote monitoring tools, the flexibility of technological solutions, and the need for interoperability in order to support safe and timely use. Viewed together, the findings indicate that telemedicine in austere conditions is not limited to communication alone but increasingly depends on integrated monitoring capacity and context-appropriate technological design.

### **Education and training support**

Three studies addressed the educational dimension of telemedicine, highlighting its use for remote mentoring, simulation-based learning, knowledge transfer, and support of healthcare

personnel working in demanding environments. Across this thematic area, telemedicine was presented as a means of strengthening clinical readiness and expanding access to expertise beyond traditional training settings.

Aylward et al.,<sup>24</sup> emphasized the role of telehealth in disaster preparedness and educational continuity, particularly through virtual simulations and remote training approaches. The same study also highlighted broader implementation needs, including training, standardization, and institutional support, all of which are relevant to workforce preparedness in challenging settings. Ting and Wilkes,<sup>13</sup> in the highest-quality study of the review, also underscored the broader value of telemedicine in austere and expeditionary settings, including its contribution to training, readiness, and the support of healthcare delivery under operational constraints. Collectively, these findings suggest that educational and training applications of telemedicine may enhance service quality indirectly by improving competence, preparedness, and the effective use of remote clinical support systems.

## DISCUSSION

This systematic review explores how the quality assurance of telemedicine services has been addressed in extreme conditions, including disaster settings, conflict-affected environments, remote or austere contexts, and educational support applications. The findings suggest that telemedicine has considerable potential to support healthcare delivery in unstable and resource-constrained settings by extending access to specialist expertise, strengthening continuity of care, and improving responsiveness when conventional services are disrupted. However, the review indicates that the value of telemedicine in such contexts is contingent not only on technical feasibility, but also on the incorporation of quality-related requirements such as reliability, safety, organizational support, user preparedness, and structured evaluation into implementation. Across the included studies, telemedicine was rarely presented as a fully standardized model of care; rather, it appeared as a promising but inconsistently evaluated service approach shaped by local constraints and variable institutional embedding.

A fundamental conclusion of this review is that the quality as-

urance in telemedicine under extreme conditions remains underdeveloped in relation to the growing use of telemedicine across crisis and remote settings. Despite the included studies indicating significant advantages in terms of access, response speed, remote consultation, monitoring, and training support, they also demonstrated that formal quality frameworks, standardized indicators, and consistent evaluation procedures continue to be limited in their application. This is of particular importance in extreme environments, where instability, infrastructure disruption, and operational pressure increase the risk that telemedicine will be used as an emergency workaround rather than as a quality-assured healthcare service. In this regard, the primary challenge is no longer the utilization of telemedicine in extreme conditions, but rather the implementation, monitoring, and sustainability of this approach in a manner that ensures safety, reliability, and service effectiveness.

The review also identified recurring barriers that appear to limit the quality and sustainability of telemedicine services in extreme conditions. Across the thematic areas, common challenges included suboptimal connectivity, limited infrastructure, insufficient institutional support, inadequate user training, and ambiguity in legal and regulatory frameworks. These barriers are of particular significance as they impact not only the feasibility of the process, but also its consistency, safety, and overall service reliability. The recurring nature of these barriers indicates that the quality assurance of telemedicine should be regarded as a system-level issue, rather than as a purely technical characteristic of digital platforms. The quality of service is contingent upon the interplay between technological reliability, organizational preparedness, governance structures, workforce competence, and mechanisms for ongoing evaluation. This is particularly salient in contexts where fragmented implementation and inadequate coordination can have amplified consequences.

From a practical and policy perspective, these findings suggest that telemedicine in extreme conditions should not be planned solely as an emergency-access solution, but rather as a service model requiring structured quality-oriented design. Health systems and organizations operating in crisis, remote, or resource-constrained settings may benefit from clearer governance ar-

rangements, context-appropriate protocols, staff training pathways, and mechanisms for monitoring service performance over time. The review also points to the significance of interoperability, technological adaptability, and user support, particularly in environments where infrastructure is unstable and clinical decision-making must occur under pressure. Enhancing the quality of telemedicine may necessitate not only the allocation of resources to digital tools, but a commitment from institutional entities to evaluation, accountability, and integration into comprehensive service planning.

The available evidence base remains methodologically heterogeneous and only moderately developed in terms of evidential strength. Although all included studies satisfied the predefined minimum quality threshold, the majority were classified as moderate quality, while only a smaller proportion were categorized as high quality. Moreover, the evidence base encompassed not only empirical studies, but also narrative reviews, case studies, and conceptually oriented contributions. This pattern suggests that literature on telemedicine in extreme conditions is still evolving and that current knowledge is shaped partly by exploratory and descriptive work rather than by consistently robust comparative research. Consequently, the findings of this review should be interpreted as a meaningful synthesis of an emerging field, while taking into account the methodological and contextual limitations of the available literature and of the review process itself.

### LIMITATIONS

This present review should be interpreted in light of several limitations. The included studies exhibited significant heterogeneity in terms of design, setting, and reported outcomes, which impeded the establishment of direct comparability and the execution of quantitative synthesis. In addition, the majority of studies exhibited moderate methodological quality, with a significant proportion of the evidence base comprising conceptual or review-based works. Finally, given the paucity of literature specifically focusing on the quality assurance of telemedicine in extreme conditions, broader telemedicine studies with relevance to comparable austere or resource-constrained settings were

also included. While this methodological approach served to enhance the breadth of the synthesis, it is conceivable that it may have concomitantly diminished the specificity of the conclusions.

### CONCLUSIONS

The findings of this systematic review indicate that telemedicine has the potential to make a significant contribution to healthcare delivery in extreme conditions. The review suggests that this can be achieved by improving access to expertise, facilitating continuity of care and enhancing responsiveness in unstable or resource-constrained environments. The findings indicate that the quality of telemedicine services in such settings cannot be assumed on the basis of technological availability alone. The issue of quality assurance has been shown to be multidimensional in nature, involving such factors as technological reliability, organizational preparedness, workforce training, governance, and ongoing evaluation. Despite the compelling evidence supporting the practical relevance of telemedicine in extreme conditions, it is equally important to acknowledge the persistent gaps in standardization, quality measurement, and institutional integration that have been revealed. Consequently, future endeavors should concentrate on the establishment of more robust quality frameworks, context-sensitive implementation models, and stronger evaluative evidence to support safe, reliable, and sustainable telemedicine services in extreme settings.

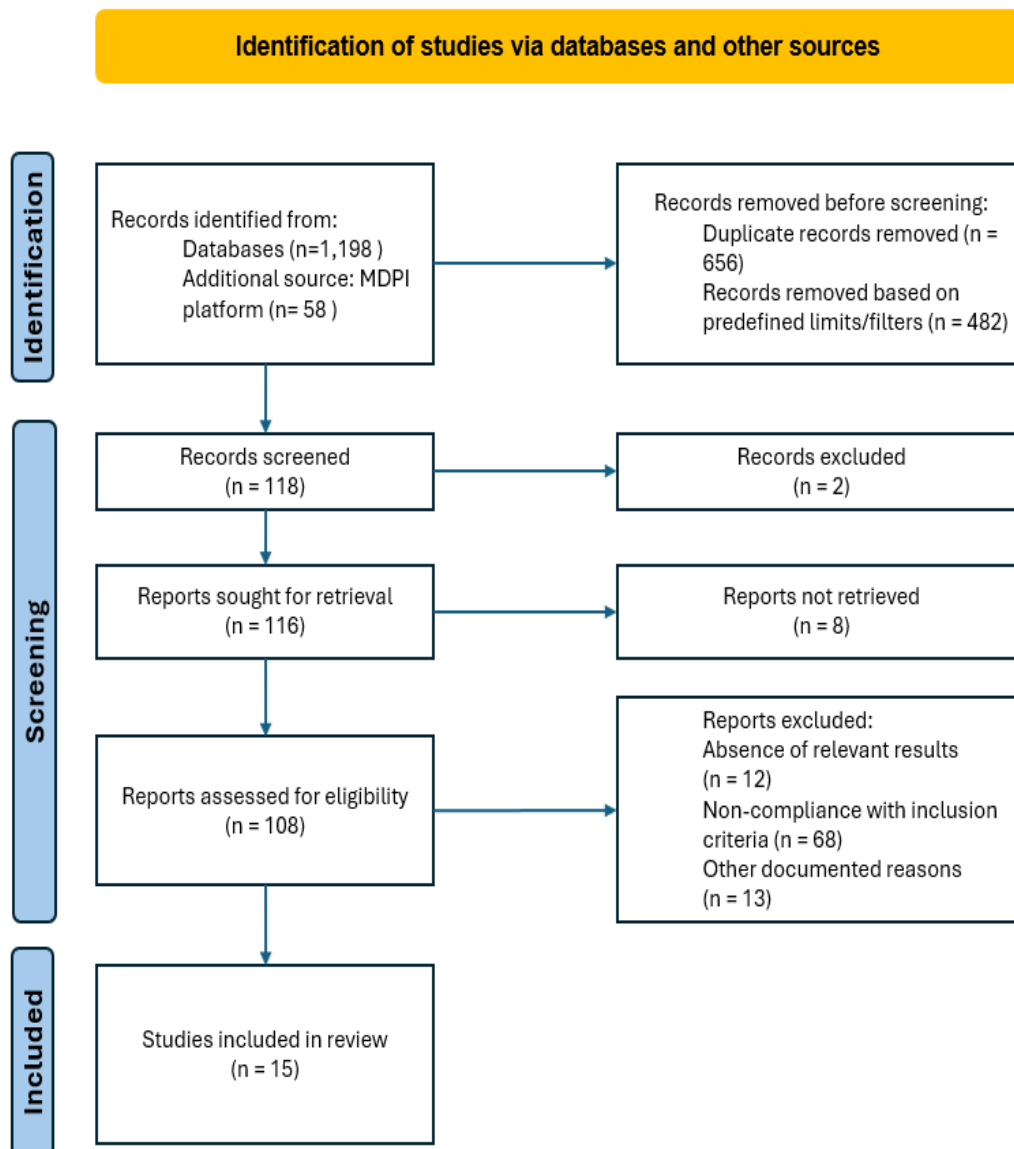
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## ANNEX

**FIGURE 1.** PRISMA (2020) Flow chart of Literature Review.

**TABLE 1.** Characteristics of the studies included in the systematic review.

a. LOE – level of evidence: level 1 very high, level 2 high, level 3 moderate to high, level 4 and level 5 moderate, level 6 low, level 7 very low

b. QATSDD: level of reliability and validity: low (< 50%), medium (50– 69%) or high quality (≥ 70%).

Author (year)	Main focus/setting	Study design	LOE	QATSDD	Key contribution
Tagne et al. (2025)	Remote patient monitoring in rural/regional Australia	Qualitative study	5	71%	Identified barriers and facilitators for remote patient monitoring implementation in resource-constrained regional settings.
Alansari et al. (2025)	Pediatric emergency surgery and trauma	Systematic review	1	66.7%	Suggested telemedicine may improve access, triage, and specialist support in emergency care contexts.
Parkes et al. (2022)	Telemedicine in conflict-affected countries of the Eastern Mediterranean Region	Systematic review	1	62.5%	Demonstrated feasibility of low-cost telemedicine in conflict settings, while highlighting funding, confidentiality, and evaluation gaps.
Okoh et al. (2024)	Emergency and disaster response in Sudan	Case study	5	58.3%	Described telemedicine as a useful emergency support tool but limited by logistical and technological barriers.
Mohammadzadeh et al. (2022)	Telemedicine in natural disasters	Narrative review	5	60%	Identified key disaster-response telemedicine services and emphasized communication and implementation requirements.
Ting & Wilkes (2021)	Patient management in remote and austere environments	Systematic review	1	90%	Provided the strongest support for telemedicine use in austere settings to improve timely access and patient management.
Doarn (2021)	Telemedicine in austere conditions	Review	5	54%	Highlighted the adaptability of telemedicine across diverse austere settings such as battlefields, ships, and remote locations.
Pegoraro et al. (2023)	Telemedicine in extreme sports	Review	4	92%	Showed the value of data transfer, teleconsultation, and remote diagnostics in extreme sports medicine.
Eljack et al. (2023)	Teleconsultations during conflict in Sudan	Quantitative cross-sectional survey	3	78%	Reported supportive physician attitudes alongside concerns about incomplete information, missed diagnoses, and medico-legal issues.
Koehlmoos et al. (2024)	Telemedicine for trauma care in Ukraine after the Russian invasion	Qualitative study	5	73%	Identified data security risks, connectivity disruptions, and the need for secure, integrated systems.
Beckers & Stellmacher (2021)	Quality assurance in telemedicine	Theoretical review	5	50%	Emphasized the need to adapt quality management systems to digital care processes.
Mahmood et al. (2024)	Quality assurance and control for artificial intelligence in medicine	Conceptual/theoretical paper	5	71%	Described quality assurance, quality control, and acceptance testing as essential for safe adoption of medical digital technologies.

Anwari et al. (2024)	Opportunities and barriers in telemedicine implementation	Critical analysis	5	50%	Highlighted policy, standardization, data security, and training needs for successful telemedicine implementation.
Alelyani et al. (2021)	Holistic view of telemedicine systems	Systematic review	2	75%	Proposed a system-level perspective emphasizing reliability, availability, maintainability, and security.
Hadian et al. (2024)	Challenges of implementing telemedicine technology	Systematized review	3	79%	Identified legal, economic, bandwidth, insurance, and social barriers affecting telemedicine implementation.