



## Original Article

## Telemedicine trends in orthopaedics and trauma during the COVID-19 pandemic: A bibliometric analysis and review

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### المخلص

**أهداف البحث:** في أعقاب الازدهار الواسع النطاق مؤخرا بالتطبيب عن بُعد خلال حقبة كوفيد-19، قد لا يكون الكثير من جراحي العظام على دراية بمهارات الفحص السريري، وسلامة المرضى، وأمن البيانات، والمخاوف المتعلقة بالتنفيذ في التطبيب عن بُعد. نقدم تحليلاً ببيومترياً ومراجعة للمنشورات المتعلقة بالتطبيب عن بُعد بشأن رعاية جراحة العظام أثناء جائحة كوفيد-19. يمكن أن يساعد هذا التحليل جراحي العظام على التعرف على التطورات الأخيرة في الطب عن بعد واستخدامه في ممارسة جراحة العظام العادية.

**طرق البحث:** بحثنا بشكل منهجي في قاعدة بيانات ثومسون رويترز ويب أوف ساينس عن المقالات المتعلقة بالتطبيب عن بعد في جراحة العظام التي نُشرت أثناء جائحة كوفيد-19. وتم تحليل المقالات المختارة لمجلات المصدر الخاصة بهم، والمؤلفين المرسلين، ومؤسسات البحث، ودول المؤلفين المرسلين، وعدد الاستشهادات، وأنواع الدراسة. كما تم عمل مراجعة نوعية وملخص لمستويات الأدلة.

**النتائج:** تم نشر 59 مقالة تلي معايير التضمين في 28 مجلة. وأسهم 342 مؤلفاً في هذه الأوراق البحثية. ساهمت الولايات المتحدة بأكبر قدر في أبحاث جراحة العظام المتعلقة بالتطبيب عن بعد خلال حقبة كوفيد-19. واحتوت جميع المقالات على مجموع 383 اقتباساً. وكان 66.1٪ من الأوراق البحثية متعلقة بالتحليلات الاقتصادية وتحليلات القرار الخاصة بتطبيق التطبيب عن بعد. بشكل عام، كانت أدلة المستوى الرابع هي السائدة في مراجعتنا.

**الاستنتاجات:** يمكن أن يغطي التطبيب عن بعد بشكل مرض نسبة كبيرة من زيارات المرضى لأقسام العيادات الخارجية، وبالتالي يحد من عبء العمل البدني للمستشفيات. هناك دور محتمل للتطبيب عن بعد في رعاية جراحة العظام في حالات الطوارئ ورعاية المرضى الداخليين من خلال الوسائل الافتراضية. كما

يجب معالجة القضايا المتعلقة بخصوصية المريض وأمن البيانات والطب القانوني والجوانب المتعلقة بالسداد من خلال الإرشادات الوطنية أو الإقليمية الدقيقة. أخيراً، الفحص البدني لجراحة العظام هو حلقة ضعيفة في التطبيب عن بعد ويحتاج إلى تعزيز.

**الكلمات المفتاحية:** التحليل البيوميترى؛ كوفيد-19؛ جراحة العظام؛ التطبيب عن بعد؛ الاتجاهات

### Abstract

**Objectives:** In the wake of recent widespread interest in telemedicine during the COVID-19 era, many orthopaedic surgeons may be unfamiliar with clinical examination skills, patients' safety, data security, and implementation-related concerns in telemedicine. We present a bibliometric analysis and review of the telemedicine-related publications concerning orthopaedics care during the COVID-19 pandemic. Such analysis can help orthopaedic surgeons become acquainted with the recent developments in telemedicine and its usage in regular orthopaedics practice.

**Methods:** We systematically searched the database of Thomson Reuters Web of Science for telemedicine-related articles in orthopaedics published during the COVID-19 pandemic. The selected articles were analysed for their source journals, corresponding authors, investigating institutions, countries of the corresponding authors, number of citations, study types, levels of evidence, and a qualitative review.

**Results:** Fifty-nine articles meeting the inclusion criteria were published in 28 journals. Three hundred forty-two authors contributed to these research papers. The United States (US) contributed the most number of articles to the telemedicine-related orthopaedics research during the COVID-19 era. All articles combined had a

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total of 383 citations and 66.1% were related to the Economic and Decision-making Analyses of telemedicine implementation. By and large, level IV evidence was predominant in our review.

**Conclusion:** Telemedicine can satisfactorily cover a major proportion of patients' visits to outpatient departments, thus limiting hospitals' physical workload. Telemedicine has a potential future role in emergency orthopaedics and inpatient care through virtual aids. The issues related to patient privacy, data security, medicolegal, and reimbursement-related aspects need to be addressed through precise national or regional guidelines. Lastly, the orthopaedic physical examination is a weak link in telemedicine and needs to be strengthened.

**Keywords:** Bibliometric analysis; COVID-19; Orthopaedics; Telemedicine; Trends

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## Introduction

Telemedicine has emerged as a blessing in disguise during the ongoing COVID-19 pandemic.<sup>1,2</sup> With the outburst of COVID-19 worldwide, the routine patient care of non-COVID-19 patients was bound to get affected. The majority of healthcare resources were channelised in managing COVID-19 affected patients who posed a national emergency in almost every country in the world. Most of the centres around the world had completely halted outpatient services and elective surgeries for an indefinite period.<sup>3</sup> Furthermore, complete lockdowns as a part of the infection control strategy further reduced the non-COVID-19 patients' access to healthcare services. As the nations started controlling the number of cases, the outpatient services gradually resumed in a controlled manner.<sup>4</sup> However, several nations were gripped by the second wave of the pandemic, and the healthcare facilities were never restored to normal.<sup>5</sup> The COVID-19 pandemic is the new normal, and we need to find ways to maintain quality patient care while exercising extreme caution against this unpredictable biohazard. The vaccination strategy can bring down the disease severity, but that does not provide absolute protection from getting infected and infecting others.

Telemedicine has been used as an alternative for outpatient care, rehabilitation, and even emergency room visits to reduce the physical interaction between patients and caregivers. The World Health Organization (WHO) defines telemedicine as the delivery of healthcare services by healthcare professionals using information and communication technologies for the exchange of valid information in which distance is a critical factor for the diagnosis, treatment, and prevention of disease and injuries, research, and evaluation as well as for accessing continuing education, all in the interests of advancing the health of individuals and their communities. Telemedicine has received a mostly positive

response from patients as well as health caregivers. Currently, telemedicine is the need of the hour, even if the outpatient and elective surgeries have resumed to some extent.<sup>6</sup> The norms of physical distancing and other infection control measures incur additional costs and time. The number of patients that a centre can cater to will automatically reduce with the requirement of more space and resources. Moreover, uncertainty regarding COVID-19 resurges remain, which might bring back all the restrictions again. Telemedicine appears to be a backup solution and an alternative plan for patient care during such scenarios.

In orthopaedics, bone and joint care include symptom evaluation, medical management, and specialised examination, reassessment, and rehabilitative measures. Further, decision-making regarding operative and nonoperative management is required through special assessment tools. Telemedicine is new for most orthopaedists, and thus, difficulties in patient evaluation and management may arise, especially when implemented on a large scale. Up-to-date knowledge about the trends and recent developments pertaining to telemedicine-based care during the COVID-19 pandemic can help orthopaedists improve their methods and skills in managing orthopaedic diseases. A bibliometric analysis helps explore the available evidence and prospects for future research by identifying the published contributions among authors, journals, institutions, and countries. We present a bibliometric analysis of the telemedicine-related publications concerning orthopaedic care during the COVID-19 pandemic.

## Material and methods

We searched through the Thomson Reuters Web of Science database in May 2021 for the following specific keywords separated by the specified Boolean operators: ('telemedicine' or 'telehealth' or 'mobile health' or 'mhealth' or 'electronic health' or 'ehealth' or 'electronic medicine' or 'emedicine' or 'virtual consultation' or 'remote consultation' or 'virtual clinic') and ('orthopaedics' or 'orthopaedic' or 'orthopedic' or 'orthopedics' or 'fracture' or 'fractures' or 'trauma' or 'bone' or 'joint') under the 'topic' section without any language restriction. The 'topic' section covers wider results compared to the 'all fields' section. The search results were refined by placing them under the following broad categories: 'orthopedics' or 'surgery' or 'rehabilitation' or 'sport sciences', and the time frame was restricted to the years 2020 and 2021 considering the period during which the COVID-19 pandemic has been active. We then screened the titles and abstracts of the search results for articles discussing telemedicine within orthopaedics. Full texts of the publications where the abstract and titles did not specify telemedicine or its synonyms were checked for any telemedicine-related information. We excluded case reports, abstracts-only publications, letters, editorials, and the original articles and reviews not discussing telemedicine.

We used Bibliometrix R-package software for the data analysis.<sup>7</sup> The included articles were analysed for their source journal, corresponding authorship, investigating institution, country of the corresponding author, and the number of citations. The articles were then categorised according to

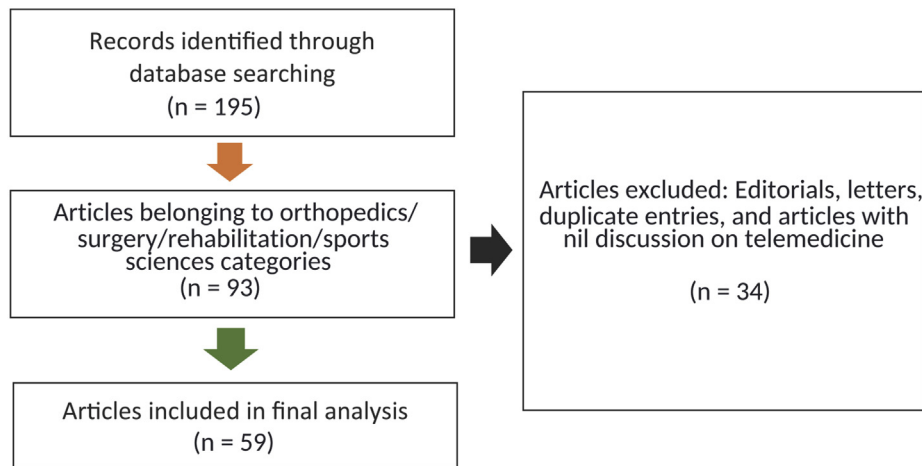
the type of study: a) Therapeutic Studies, b) Prognostic Studies, c) Diagnostic Studies, and d) Economic and Decision-making Analyses. Therapeutic Studies investigated the results of one or more treatment(s), prognostic studies investigated the outcomes of one or more disease(s), diagnostic studies investigated one or more diagnostic test(s), and economic and decision-making analyses dealt with developing economic or decision models.<sup>8</sup> The level of evidence was assigned for all clinical articles using the *Journal of Bone and Joint Surgery* ranking system, updated in early 2015.<sup>8</sup> Two senior authors then reviewed all the included articles for a qualitative review.

**Results**

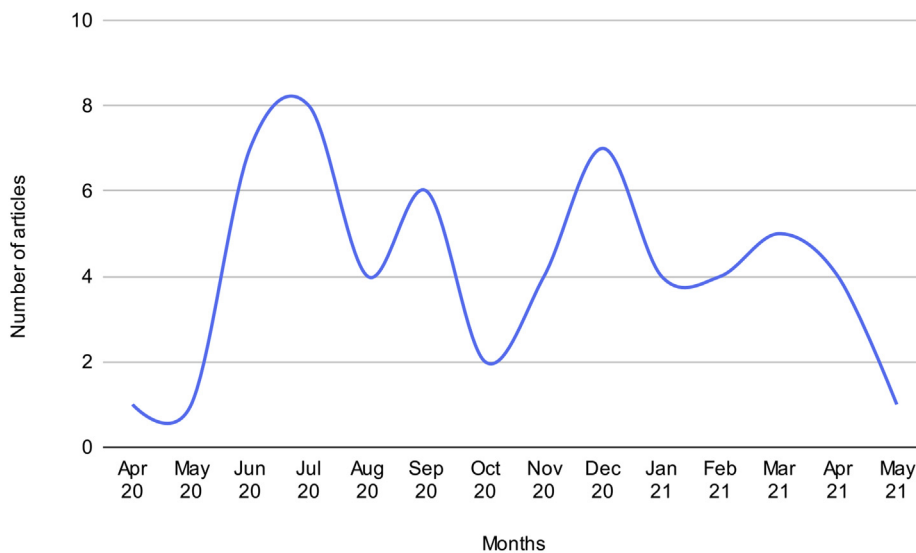
The search strategy yielded a total of 195 results, out of which 93 entries belonged to the predefined categories (orthopaedics/surgery/rehabilitation/sport sciences) and the time frame of 2020–2021. Fifty-nine articles met the

inclusion criteria and were considered for the analysis.<sup>9–67</sup> The excluded thirty-four papers were editorials, letters, duplicate entries, and articles with no discussion on telemedicine even in the full text (Figure 1). The monthly contributions trend of the orthopaedic telemedicine-related articles is shown in Figure 2.

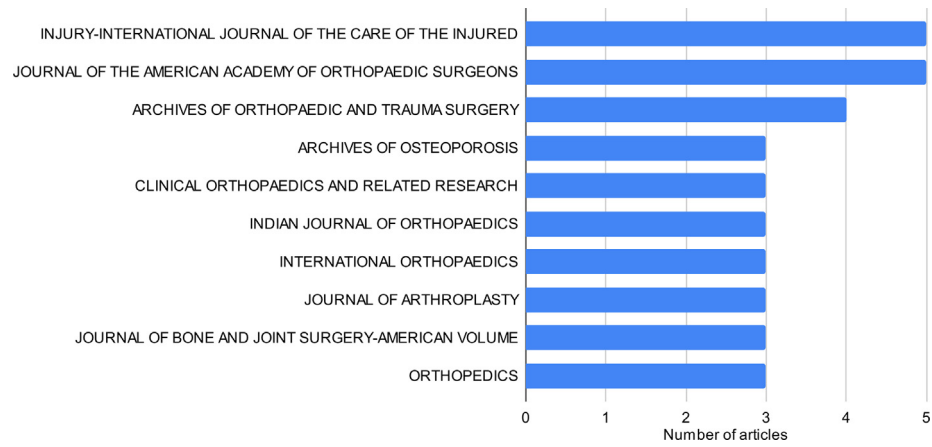
The articles discussing orthopaedic telemedicine were published in 28 journals. The top ten contributing journals are shown in Figure 3. The journals, *Injury* and *Journal of the American Academy of Orthopaedic Surgeons* carried the most number of orthopaedic telemedicine-related articles. Three hundred forty-two authors contributed, with 21 authors having two publications related to orthopaedic telemedicine. Figure 4 shows the top ten cited authors with orthopaedic telemedicine-related publications during the COVID-19 period. The United States (US) contributed the most number of articles to the orthopaedic telemedicine-related research with 26 articles (Figure 5). Among the top contributing institutions, Harvard University, Massachusetts (US) published the highest



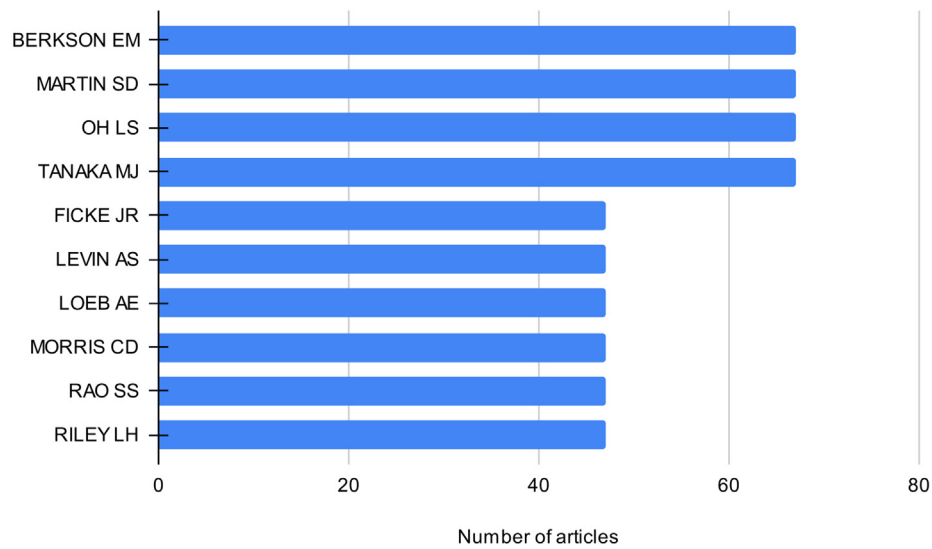
**Figure 1:** Modified PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagram detailing the selection of the papers on telemedicine application in orthopaedics during the COVID-19 pandemic.



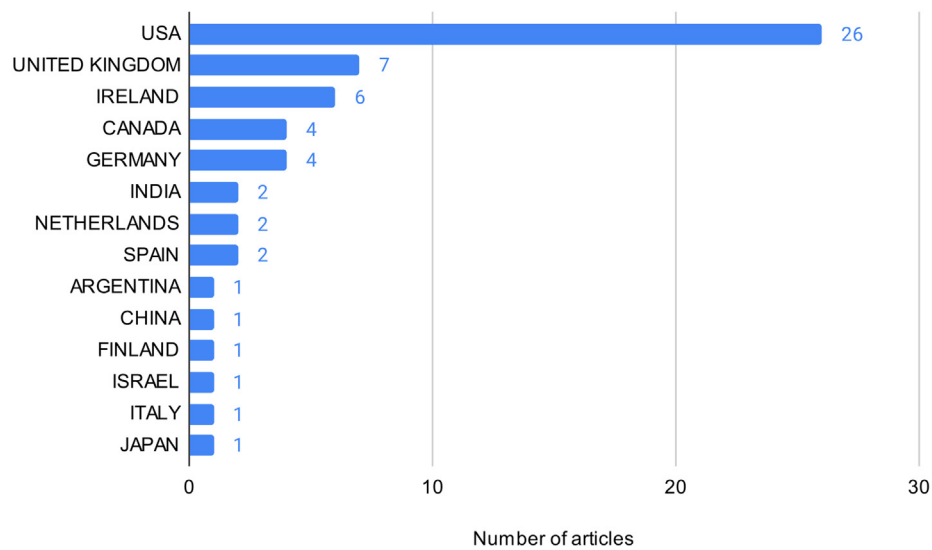
**Figure 2:** The monthly number of orthopaedic telemedicine-related publications during the COVID-19 era.



**Figure 3:** Top ten journals contributing to the papers on orthopaedic telemedicine during the COVID-19 pandemic.



**Figure 4:** Top ten cited authors contributing to the papers on orthopaedic telemedicine during the COVID-19 pandemic.



**Figure 5:** Top ten countries contributing to the papers on orthopaedic telemedicine during the COVID-19 pandemic.

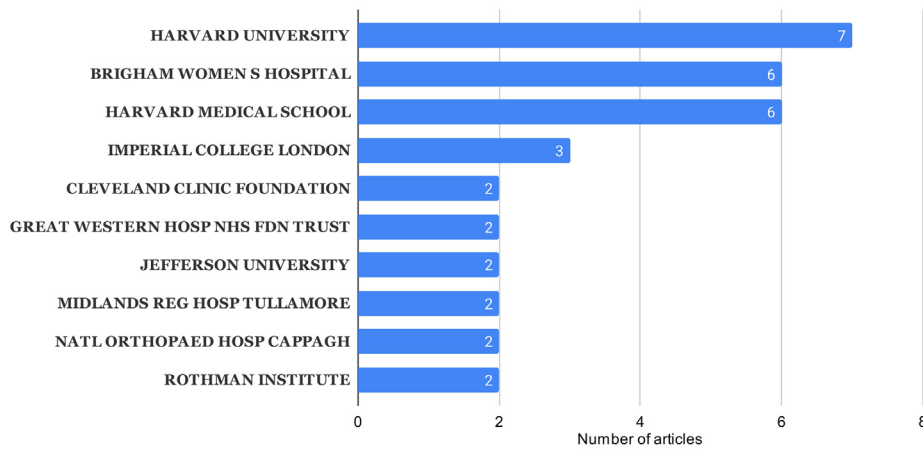
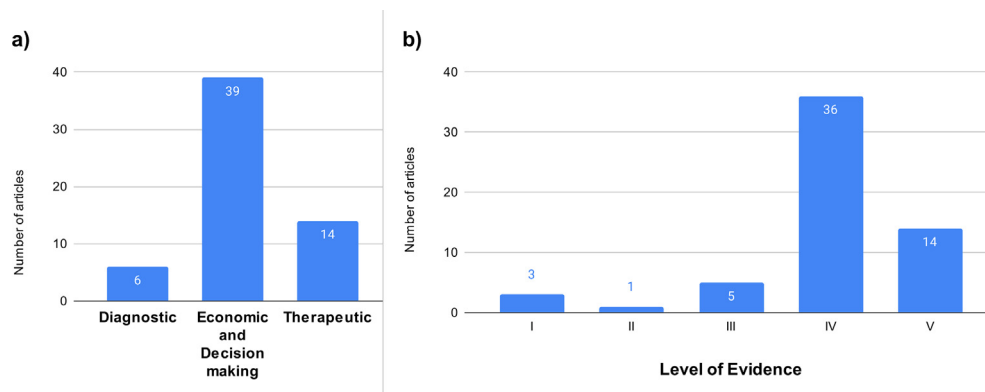


Figure 6: Top ten institutions/universities contributing to the papers on orthopaedic telemedicine during the COVID-19 pandemic.

Table 1: Characteristics of the top ten cited papers on telemedicine application in orthopaedics during the COVID-19 pandemic.

S. No.	Author (year)	Total citations	Study type	Number of patients reported	Key observations
1.	Tanaka et al. <sup>64</sup> (2020)	66	Expert opinion	Not provided	The authors highlighted the importance of proper camera positioning, audio-visual aids, and patient posture during telemedicine delivery.
2.	Loeb et al. <sup>34</sup> (2020)	46	Expert opinion	Not provided	The authors highlighted the importance of patient triage, technological resources, credentialing, education of providers and patients, scheduling, and regulatory considerations in telemedicine delivery.
3.	Parisien et al. <sup>11</sup> (2020)	32	Survey of residency programs	Not provided	Authors in a survey of orthopaedic residency programs found that 63.1% of them were providing telemedicine services. The authors stressed the need for telemedicine in academic orthopaedic institutions owing to the permanent pandemic-like situation.
4.	Massey et al. <sup>41</sup> (2020)	30	Expert opinion	Not provided	The authors observed telemedicine to be effective in the care of orthopaedic outpatients. Surgical priority, physical distancing, online clinical communications, and physician wellness governed inpatient care.
5.	Awad et al. <sup>36</sup> (2020)	27	Expert opinion	Not provided	In their evidence-based guidelines, authors recommended telemedicine and regarded it as virtual personal protective equipment. They emphasised preparation, practice, and following telemedicine start-up checklists to ensure effective implementation of telemedicine.
6.	Kane et al. <sup>18</sup> (2020)	26	Randomised controlled trial	58 patients	Patients undergoing arthroscopic rotator cuff surgery could receive safe and effective early postoperative follow-up care using telemedicine. In addition, the preference for telehealth increased for both surgeons and patients following the first-hand experience.
7.	O'Connor et al. <sup>42</sup> (2020)	23	Expert opinion	Not provided	Authors found telemedicine to be an effective alternative even after the resumption of routine services. However, concerns regarding patient privacy and the need for further development and technological advances in telemedicine were also raised.
8.	Makhni et al. <sup>43</sup> (2020)	16	Expert opinion	Not provided	The authors discussed the factors that hindered the prior implementation of the telemedicine, which included lack of awareness, implementation costs, inefficiencies introduced, difficulty in performing physical examinations, overall lack of perceived benefit of virtual care, negative financial implications, concern for medicolegal liability, and regulatory restrictions.
9.	Chhabra et al. <sup>44</sup> (2020)	9	Expert opinion	Not provided	The authors found the role of telemedicine to be effective and encouraging. However, the limitations in developing countries due to connectivity issues and lack of awareness were highlighted.
10.	Sultan et al. <sup>19</sup> (2020)	9	Survey of patients with paediatric spinal deformity	189 patients	Authors found that teleconsultations were a fast mode and satisfactory of care for paediatric spinal deformity patients comparable to physical visits.



**Figure 7:** a) Types of orthopaedic telemedicine-related research during COVID-19 pandemic. b) The level of evidence of the included research articles.

number of articles on orthopaedic telemedicine (Figure 6). The 59 published articles had a total of 383 citations, equivalent to 6.49 citations per article. The top ten cited articles are listed in Table 1. The majority of the research papers (66.1%) were related to the Economic and Decision Analyses of telemedicine implementation. The remaining papers belonged to therapeutic and diagnostic interventions (Figure 7a). The level of evidence of the research was predominantly level IV (Figure 7b).

## Discussion

Telemedicine is a hot topic in current orthopaedic practice in the COVID-19 era. It fulfils the need for patient care when physical visits can't be concluded due to the risk of infection spread. Telemedicine involves using electronic means (audio or visual) to provide clinical services to patients without a physical visit. Currently, telemedicine is frequently used for follow-up visits, management of chronic conditions, old age patients care, care of patients with difficult transportation needs, medication management, and remote patient care. The current analysis suggests that orthopaedic telemedicine has gained importance during the COVID-19 pandemic, as was evident from the consistent monthly contribution from May 2020 onwards. The contributed research appears to originate from different regions of the world, including American, European, and Asian countries, suggesting the need for telemedicine due to the rise in COVID-19 cases worldwide. However, most of the research papers have originated from the United States and some European nations. Previous familiarity with telemedicine, availability of resources, patient literacy, knowledge of operating telecommunication devices, patient awareness, healthcare infrastructure, and manpower, can all affect the implementation of telemedicine and could be the probable reasons behind its effective implementation in these countries. The articles were published in well-known journals, implying the importance of telemedicine during the COVID-19 pandemic as a topic of interest. The diversity of authors and institutes contributing to orthopaedic telemedicine research suggests the large-scale involvement of orthopaedists. The citations of the published papers also showed an increasing trend, indicating further ongoing research pertaining to orthopaedic telemedicine. Even though the interest in orthopaedic telemedicine is

increasing, the current analysis suggests that it is yet to evolve. The current phase of widespread application of orthopaedic telemedicine is in its initial phase. Most of the evidence in the aforementioned period belonged to level 4 studies, and more than half of the studies belonged to the 'economic and decision-making analyses' category. Such studies deal with the effectiveness, feasibility, policies, feedback, decision making, resource allocation for implementation, and analysis of established and planned healthcare strategies.<sup>9</sup> Thus, most clinical research deals with the effectiveness, feasibility, and patients'/doctors' perception of telemedicine.

### Qualitative analysis

The evidence projected in the orthopaedic telemedicine related research during the COVID-19 era can be discussed under the following heads:

#### Implementation of telemedicine

The studies discussing the implementation of telemedicine in orthopaedics mainly discussed the application of audio-visual technology-based virtual care in orthopaedic outpatients, rehabilitation, fracture care, postoperative care, and health education. The main target of telemedicine implementation should be reducing the physical patient load without affecting patient care. The concept of virtual screening/E-triage/virtual fracture clinics addresses this target. Most of the studies presented the institutional experiences and surveys related to telemedicine implementation during the COVID-19 pandemic. The implementational studies addressed the following aspects of telemedicine-based care in orthopaedics:

*Safety, feasibility, and effectiveness.* Telemedicine is the necessary solution for patient care during the COVID-19 pandemic. Many studies and reviews mainly focused on analysing telemedicine's safety, feasibility, and effectiveness in orthopaedics. Most surveys reported widespread adoption of telemedicine as the main patient care modality.<sup>10–17</sup> Telemedicine can address the general and specialised needs of osteoporotic patients, paediatric deformities, fracture patients, and sports injuries.<sup>18–25</sup> High patient and doctor satisfaction has been recorded with telemedicine.<sup>26</sup> It is

found to be helpful in decision-making and telephone-based follow-up care.<sup>27,28</sup>

*Screening tool.* Several studies have found that a major proportion of orthopaedic injury patients visiting outpatient clinics and emergency rooms only require basic care and are discharged without the need for specialist consultation arising.<sup>29–31</sup> Telemedicine-based care saves both cost and time in managing such patients. Telemedicine has emerged as an effective screening tool to categorise patients who require virtual consultation only and those who require physical evaluation. These services are required in high-volume centres where it is difficult to limit patient attendance due to the nature of disorders. Osteoporosis and its related morbidities and fracture care are two such fields. Lindsay et al.<sup>32</sup> highlighted the importance of the E-triage system in osteoporotic patient care centres. These centres are usually overloaded due to the high volume of elderly osteoporotic patients. Secondly, these patients belong to the ‘at-risk’ population group. Therefore, they need appropriate assessment and management. Only 73.3% of patients needed the physical visit for a detailed evaluation. The remaining patients only needed investigative workup or direct discharge without the need for a physical visit. Direct discharge refers to the practice of discharging patients directly from the screening clinic without any expert consultation.<sup>31,32</sup> Geerdink et al.<sup>31</sup> advocated for a direct discharge approach via virtual fracture clinics where simple-stable injuries were discharged directly and managed with self-assisted splints or braces and phone-based health care.

*Limitations in telemedicine implementation in orthopaedic care.* While telemedicine is a convenient mode of patient care during the ongoing pandemic situation, it has some limitations and shortcomings. Medico-legal concerns, patient privacy, and secure patient data storage need to be streamlined to strengthen patients’ and doctors’ trust in telemedicine. Gilbert et al.<sup>33</sup> observed that teleconsultations had been rapidly deployed since the onset of the COVID-19 pandemic, often without clear guidance or consensus on many important issues. They identified legal and security issues in telemedicine implementation. Therefore, there is an urgent need to address these and develop local and national guidelines to facilitate telemedicine beyond the COVID-19 era. Zhang et al.,<sup>20</sup> while supporting the effectiveness of telemedicine in orthopaedic patient management, highlighted the issues of missed or incomplete diagnosis and the absence of detailed patient counselling and monitoring as the main limitations of telemedicine. Guiroy et al.<sup>10</sup> surveyed spine surgeons and observed that almost half of them were using telemedicine. However, the main concerns with telemedicine were the lack of physical examination that posed limitations in the management of their patients.

*Review papers on the implementation of telemedicine in orthopaedics.* A major chunk of the orthopaedic telemedicine-related papers published during the COVID-19 pandemic were review articles. The review articles touch on various aspects of telemedicine implementation, its advantages, and its limitations. Most of the reviews were narrative and were based on

the authors’ personal experiences and limited COVID-19-related literature. These review articles supported telemedicine as an alternative mode of patient care to physical outpatient visits.<sup>34–40</sup> Most review articles critically analysed the available evidence to point out the limitations and ways to improve telemedicine. Loeb et al.<sup>34</sup> suggested the need for proper utilisation of resources for telemedicine to be effective. The authors stressed strengthening telemedicine using patient triage, technological resources, credentialing, education of providers and patients, scheduling, and regulatory considerations during the pandemic. Massey et al.<sup>41</sup> stressed the need for inpatient telemedicine as well, considering the limited workforce for specialities due to the COVID-19 pandemic. Awad et al.<sup>36</sup> and O’Connor et al.<sup>42</sup> advocated for strengthening telemedicine by adding more secured modalities to protect patients’ confidentiality and keeping their medical records away from any anticipated breaches. A few authors discussed the factors limiting the implementation of telemedicine. These included lack of awareness, implementation costs, difficulty performing physical examinations, negative financial implications, concern for medicolegal liability, and regulatory restrictions.<sup>43,44</sup> Hinckley et al.<sup>45</sup> emphasised the need for regulatory mechanisms to keep the data secure and code the services to make telemedicine simpler and convenient for patients. Juhra et al.<sup>46</sup> stressed on the legal considerations and reimbursement requirements before telemedicine consultations and the use of only certified software products for telemedicine conduction. Jansson et al.<sup>47</sup> highlighted the need for higher-level evidence, technological innovation, and specialised patient-specific care for the at-risk population.

#### *Therapeutic role of telemedicine in orthopaedics*

These studies analysed the impact of telemedicine on the treatment of orthopaedic patients.

*Clinical studies.* Telemedicine was satisfactorily utilised in the care, decision making, and rehabilitation of general orthopaedic disorders, including fracture care, osteoporosis, spine disorders, sports injuries, arthroplasty patients, and post-operative care of patients.<sup>48–54</sup> The common trends observed by the investigators were a significant reduction in inpatient visits, high patient satisfaction rates, and most importantly, timely care and referral of the patients requiring in-person evaluation.<sup>44,52,55</sup> Hendrickson et al.<sup>56</sup> observed better follow-up compliance among patients receiving post-discharge telemedicine-based care. The issues witnessed with orthopaedic telemedicine included limited physical examination and the need for a detailed in-person evaluation of patients with multiple comorbidities, advanced age, or obesity.<sup>57,58</sup>

*Reviews articles.* Similar to the reviews analysing telemedicine implementation in orthopaedics, the reviews on therapeutic aspects focused on the advantages and shortcomings of offering patient management through telemedicine in orthopaedics. The reviews supported the idea of telemedicine, considering it to be a cost-effective method of timely delivery of healthcare advice. At the same time, the authors raised concerns regarding inadequate physical examination, lack of proper supervised fracture care, improper brace application,

deviation from treatment protocol and resulting complications, and limited application in moderate to severe disease patterns.<sup>59–61</sup>

#### *Diagnostic studies*

The diagnostic studies concerning telemedicine in orthopaedics mainly focused on the betterment of the physical examination which was highlighted by several studies as the main limitation.<sup>62,63</sup> Tanaka et al.<sup>64</sup> reported their experience of virtual examination through standardised manoeuvres for patients. The importance of proper camera positioning, audio-visual aids, and posture was emphasised. The authors found virtual video-based teleconsultations as an effective mode of treatment delivery for common outpatient orthopaedic conditions. Eble et al.<sup>65</sup> presented a comprehensive virtual foot and ankle examination for telehealth visits, including instructions about patient convenient language. Goyal et al.<sup>66</sup> recognised that assessment of motor, sensory, and special tests performed with telemedicine had similar observations to the traditional in-person examination. However, the authors stressed that the assessment needs to be administered by an experienced clinician. Rabin et al.<sup>67</sup> observed that video examination of patients with shoulder disorders might present a valid alternative to face-to-face examination. However, the authors stressed that the video-based physical examination content might need to be modified to detect indications for specific interventions or diagnostic tests. The primary limitation of these studies is that the assessment tools need further validation.

Based on the above-stated qualitative analysis, it can be ascertained that telemedicine is the need of the hour and it has emerged as an effective alternative to conventional physical outpatient care. The main role of telemedicine lies in timely patient care and, at the same time, reducing the physical burden on hospitals. The virtual screening clinics can help differentiate patients requiring telemedicine-based care and those requiring in-person assessment. Therefore, the patients' and the hospitals' time, cost, and resources are saved and channelised to patients requiring priority attention. The future scope of telemedicine lies in expanding telemedicine to various other health aspects such as inpatient care, rehabilitation, and remote aids to assist clinical assessment. In orthopaedics, the major limitations in telemedicine-based care are the lack of precise physical examination and inadequate assessment of at-risk populations such as old age patients, cases of osteoporotic fractures, and those with comorbidities. Measures to strengthen telemedicine skills and develop new technologies providing detailed objective assessment will help assist these patients. The studies concerning the physical examination of orthopaedic patients through telemedicine were very few. This deficiency highlights the need for more evidence that would enable appropriate physical examination of orthopaedic patients. Lastly, the orthopaedic assessment needs visual information and that too with details. Therefore, infrastructure development to provide high-speed patient to doctor connectivity, visual devices for clear picture and video transmission, and artificial intelligence-assisted examination will need to be set up in the future. Although based

on our analysis, even though it is evident that telemedicine has a wide reach in developed and developing nations, the quality of telemedicine might need to be strengthened considering the limited orthopaedic evidence. Most of the studies were level IV studies, and very few addressed the therapeutic and diagnostic aspects. Therefore, more evidence is required for a sound recommendation of telemedicine use in orthopaedics.

There are some limitations in the current analysis. First, it is a cross-sectional study analysing evidence from the period when COVID-19 was active. Therefore, the past developments in orthopaedic telemedicine were not considered. Second, the bibliometric analysis is based on the results of one major scientific database. Therefore, there might be variations in the results of other databases. The data regarding citations were taken from the database statistics and minor variations from the actual citations counts may occur. Also, the database did not provide self-citation counts, which can affect the overall citation numbers. Third, the analysis is based on common keywords used for telemedicine, and the studies not covered under those keywords might have been missed. Lastly, the analysed articles were covered under orthopaedics, surgery, rehabilitation, and sport sciences-related journals. Therefore, studies outside these categories would have been missed. Nevertheless, the analysis fulfils the aim of studying the trend in orthopaedic telemedicine during the COVID-19 era, considering similar interests and concerns of the studies included.

#### **Conclusions**

The publication trends during the COVID-19 era suggest that telemedicine forms an integral model of outpatient care in orthopaedics considering the prolonged pandemic-like situation. Telemedicine can satisfactorily cover the major proportion of patients' visits to outpatient departments, thus limiting hospitals' physical burden. Telemedicine has a potential future role in emergency orthopaedic care and inpatient care through virtual aids. The issues related to patient privacy, data security, medicolegal, and reimbursement-related aspects need to be addressed through precise national or regional guidelines. Lastly, the orthopaedic physical examination is the weak link in telemedicine and needs to be strengthened.

#### **Recommendations**

Based on the findings of the current analysis, we recommend the use of telemedicine in orthopaedics. However, efforts must be made to minimise the risk of a breach in patient privacy, data security, and patient mismanagements. Besides this, orthopaedists should follow appropriate national or regional guidelines to avoid medicolegal issues.

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**Conflict of interest**

The authors have no conflict of interests to declare.

**Ethical approval**

The authors confirm that this study was prepared in accordance with COPE rules and regulations. Given the nature of the study, the IRB review was not required.

**Authors contributions**

AK conceived and designed the study, conducted research, provided research materials, and collected and organised data. AK and SS performed the data acquisition and literature review. JJ and SK make relevant inferences based on the available data and formulated the discussion and conclusions. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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