Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Commentary

Leadership and resilience in adversity: The impact of COVID-19 on radiography researchers and ways forward

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Introduction: The impact of COVID-19 on society

For just over two years, humanity has been struggling to cope with the dreadful effects of the coronavirus pandemic, which has, to date, caused over 6.5 million confirmed fatalities globally [1], or between 15 and 25 million deaths, if excess deaths during this period are considered. The novel coronavirus, SARS-CoV-2, results in COVID-19 disease, which has been associated with serious long-term health-related complications [2,3]. The complications of the pandemic are multifaceted, and include socio-economic implications [4], changes in utilisation and workflows of healthcare services [5], and healthcare disparities burdening the health system [6].

Impact of COVID-19 on clinical practitioners

The impact on healthcare workers was even more pronounced. Recent research indicates that healthcare practitioners working on the frontlines during these challenging times experienced, and are continuing to experience, increased physical and psychological challenges [7]. An increase in physical and verbal violence towards them has also been reported [8]. It has been estimated that healthcare workers have a

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ten-fold increased risk of being infected by SARS-CoV-2 [9], and this has been sadly confirmed by the large number (at least 115,000 people) of fatalities within the workforce worldwide [10].

Impact of COVID-19 on radiographers: an overview of clinical, academic and research provisions

Diagnostic and therapeutic radiographers, working often on the frontline, have been greatly impacted since the start of the pandemic. They continued to provide high-quality clinical services despite experiencing staffing shortages from staff sickness, increased risk of infections, limited resources, ongoing physical and mental stress [11], increased levels of anxiety [12], social distancing, and occupational burnout [13,14]. Moreover, the pandemic has disrupted academic provision [15] and radiography education in many countries [16], with recent research acknowledging the negative impact on undergraduate diagnostic radiography students for clinical placements and the delivery of theoretical lessons, which largely turned online or assumed a hybrid format [17]. Similarly, the pandemic has affected clinical research worldwide, as many studies were suspended, and others had to negotiate an extension of their funding to cope with the additional pressures, restrictions, and new ways of working [18]. Researchers also had to learn, adopt, and implement new data collection techniques and methods of interacting with their participants to ensure ethics, integrity and rigor were ascertained [19].

Crises management: the importance of effective leadership

It is widely accepted that effective leadership during a crisis, such as the coronavirus pandemic, is vital, since it has the capacity to provide optimal decision-making skills, recognise and overcome challenges, and set appropriate goals to mitigate the negative implications of a crisis [20]. Leaders should strive to be well-prepared for the management of a crisis, and provide support and inspiration to their team, whilst also employing effective communication strategies, and demonstrating empathy towards their colleagues facing unprecedented challenges [21,22]. Crises, despite the disruption and obstruction of everyday workflows, also offer up huge opportunities for growth and learning. Such new knowledge must be harnessed to help prepare society, healthcare professionals and leaders alike for similar situations in the future [23,24]. This acquired knowledge may also be used to inform management of operations and service optimisation in what we perceive as "normality".

The aim of this article was to discuss the main challenges that radiography researchers faced during the COVID-19 pandemic and to highlight the role of effective leadership and resilience to overcome these difficulties to maintain continuity of radiography research projects.

Impact of the pandemic on research and researchers

Radiography research, like all clinical research, could not have been excluded from the negative implications of the pandemic. Medical imaging-enabled diagnosis and treatment were the cornerstone of healthcare provisions in the fight against this pandemic [25]. The need to support the clinical frontline resulted in a natural decrease in radiography research capacity during this time too. Since the original confirmed outbreak in March 2020 [26], many clinical researchers and academics chose to return to full-time clinical roles to support the frontline workforce. Many research projects were also terminated due to COVID-19-related data collection or funding restrictions [27]. Naturally, the only type of research that was prioritised and funded during the peak of the pandemic was research related to understanding the origins of COVID-19 or exploring related diagnosis or treatment options [28,29]. For the remainder of the projects, timelines were largely disrupted, the process of recruiting participants became more challenging and, in many cases, resulted in less representative samples [30].

Researchers had to find innovative and creative ways to carry out fundamental tasks, such as obtaining informed consent [31] or collecting data to maintain research progress. Postponement or cancellation globally of major conferences, the cradles of research knowledge exchange, was also a serious drawback of the pandemic. Researchers could not attend in-person and were restricted by the virtual options for a period of at least two years, which deprived them from the valuable in-person networking opportunities, fortuitous collaborations, and rich knowledge transfer events, which are normally seen as central to knowledge advancement and practice improvement initiatives. Early-career researchers, and particularly those from low resource settings or developing countries, were found to have been affected the most [32]. This was because they have not had yet the chance to establish their professional networks and collaborations, necessary for research to take place, but also, they have not yet managed to become well known in the research community and their peers. Early career researchers are less likely to have achieved tenure, and their employment status is therefore more at risk. In addition, female researchers were disproportionately affected by COVID-19 restrictions and university closures, highlighting the gender inequality in research [27]. These gender inequalities were mainly due to female researchers being primarily responsible for home-schooling, childcare, and domestic tasks [27]. The coronavirus pandemic has also accentuated inequalities in online resources and internet accessibility, with developing countries falling further behind when the world turned "online overnight." [33]

However, in every crisis there is always an opportunity. Therefore, research and innovation were also positively impacted by the pandemic, mainly in terms of the conceptualization, design and implementation of new technologies and the utilization of online resources. New tools were developed to facilitate remote research activities [31,34], online delegate interactions in virtual conferences were explored, and digital

learning environments were used to their full potential to support learning and training of students and healthcare professionals. Professional bodies developed international collaborations, led by radiography researchers, to support clinical practice and help reduce the burden of the pandemic [35]. These all led to a phenomenal global connection among researchers and academics who had to find different ways to achieve equally good outcomes relative to the pre-pandemic era, each one with its merits and challenges [27]. Much of the learning that was acquired related to the use of online technologies in research is here to stay, as it has improved workflows, maximized productivity, changed the scene in employment by offering a hybrid alternative for commuters, allowed for better work-life balance of researchers, encouraged wider research collaborations without any geographical limit and enabled people to connect in ways that it was never possible to do so before [36-39].

Leadership in times of adversity

> "Successful leaders see the opportunities in every difficulty rather than the difficulty in every opportunity." — Reed Markham [40]

Leadership can be defined as the process by which a person selects and influences other people who have diverse abilities, to jointly achieve a mission or objective [41]. Therefore, a good leader should motivate others, communicate effectively, prioritise others over themselves, create a vision, and unite their team [42-44].

The coronavirus pandemic presented significant challenges to leaders across the world. During a crisis, like the present pandemic, leaders were required to adapt to the new circumstances rapidly and effectively; it is exactly the unknown and the adversity that heighten the need for quick, agile thinking and effective decision-making [45]. Decisive leadership was vital to help overcome the difficulties faced during the pandemic, and teams with inspiring leaders and strong collaborative and support culture, were able to thrive.

The pandemic has highlighted the need for strong and effective leaders in various professional disciplines [46]. Leaders in times of adversity should acknowledge their team as individuals and need to pay attention to their staff's wellbeing, try to build trust among the team members, employ regular and effective communication, develop a future preparedness plan, while all the time maximizing the team's performance and preparing them to face the new challenges ahead [47]. Clear and adaptive communication is vital, since uncertainty can result in increased anxiety among the team members [24]. Key leadership traits in these challenging times include: attention to the individual, focus on wellbeing, respect, fairness, integrity, agility and adaptability, honesty and empathy, collaboration, collective healing and support, and thoughtful use of innovation and research as tools to raise team morale [48]. Therefore, effective leadership during the pandemic requires leaders to build trust, invest in partnerships and ensure optimal coordination between the different team members and projects to maximize use of available resources and minimise duplication of effort [49].

Resilience among healthcare workers and researchers

> "Courage doesn't always roar. Sometimes courage is the little voice at the end of the day that says I'll try again tomorrow." –Mary Anne Radmacher [50]

Resilience is the ability to respond to an unprecedented event in an adaptive manner, to ensure both physical and psychological functions are preserved while personal development also takes place [51]. In other words, resilience can be defined as positive adaptability when facing negative situations. Resilience is much needed during a crisis, and recent research corroborates that it acts as a protection against mental illnesses, and specifically depression and anxiety [52]. Psychological resilience may be affected by socio-economic status and cultural factors; during the COVID-19 crisis resilience has been very important to manage mental health concerns and to the promotion of well-being [53].

Healthcare worker resilience has been intensely discussed in recent years, and various disciplines have interpreted this term in different ways [54]. Interest in building resilience has skyrocketed due to the ongoing pandemic. Healthcare workers are people with naturally built or purposedly taught resilience as they must think on their feet, to effectively respond to public health emergencies, while also ensuring that the healthcare system will be able to sustain its routine functionality [55]. COVID-19 may be a factor in the development of many mental health conditions in healthcare workers, such as post-traumatic stress disorder (PTSD) [56], from the witnessing of frequent premature hospital deaths of patients and of co-workers, moral injury [57], for having to make difficult life or death decisions at the peak of the pandemic, when bed and medical resource, as well as personal protective equipment shortages and medicinal drug availability was scarce, and burnout [58] from navigating changes to service provision and increased demands for healthcare. It is vital to appropriately identify all the factors that create psychological distress but equally all the mechanisms that contribute to and build resilience of healthcare workers. It is widely accepted that resilience is influenced by many factors, both at individual, societal, and organizational levels [59].

To enhance resilience among the members of a healthcare team, a leader must ensure successes are celebrated, create bonding opportunities, cultivate teamwork, listen with compassion, and offer training to further grow personal and team resilience [51,60].

As mentioned above, resilience refers not only to the ability to adapt and respond to difficult situations, but also to the ability to further grow in the times of adversity. Appropriate support should be sought in cases of increased cognitive load and/or affected emotional capacity. Recent research suggests that healthcare practitioners were found to be eager to reflect on their work and take active steps to develop a positive mindset [51].

Table 1
Key themes and recommendations.

Themes	Challenges	Solutions/benefits
Impact on research conceptualization, methods, implementation, and resource availability	-Restricted access to research laboratories or/and healthcare facilities. -Restricted access to essential equipment. -Difficulties in participant recruitment. -Use of social media created biases in the recruitment of certain populations. -Need for changing research methodology. -Lack of personal close interaction with participants. -Long ethics approval times. -Delays in research timelines, difficulty to hit targets. -Continuously changing research guidelines. -Change in research directions/previous work was abandoned. -Some research questions were no longer valid or relevant.	-Research methods were adapted (e-consent, telephone interviews, online questionnaires). - Convenience sampling strategies had to be applied. -Social media used to reach more participants, accessing more diverse groups than before. -New collaborations and research exploration without geographical limits. -The pandemic triggered new research questions. -A new set of skills was learned. - Resilience and adaptability required became a new reality. -New opportunities for healthcare research. -Online activities promoted inclusivity. -Participants reading and enriching the transcripts resulted in accurate, rich data.
Restricted communication	-Lack of regular and constructive meetings with supervisors. -Need for finding new ways of communication as in-person meetings were no longer feasible. -Need for supporting/directing colleagues/participants remotely. -Lack of face-to-face meetings (conferences, school events etc.). -Lack of in-person communication with other researchers. -Regular connectivity issues. -Inability to read body language.	-Use of social media and email to contact other researchers. -Online events were more accessible (location, time, cost). - Ability to meet all supervisors (from different departments and external) in one meeting reduced mental and physical load and encouraged collaboration. -Ability to attend more events compared to the pre-pandemic period. -Creating a virtual researcher's social group for connecting and getting support and ideas. -Discussion with other researchers in radiography research groups. -Home-based IT set-ups were greatly improved.
Overburdening workload	-Increased workloads during the pandemic. -Burnout. -Working from home resulted in more hours of working. -Lack of free time due to back-to-back virtual meetings. -Difficulties managing both clinical and research roles. -Online events often coincided with other commitments. -More difficult to separate work and family life/personal time. -Juggling childcare and work challenging.	-Attendance of webinars discussing burnout etc. -Adapting the day schedule and getting used in having shorter breaks. -Timelines have to be continuously adapted. -Less commute meant more productivity on research relevant tasks like dissemination, publications, presentations. -More flexible work styles allowed for better childcare support once homeschooling was lifted.
Wellbeing and support	-Lack of motivation. -Personal stress. -Feeling of uncertainty. -Lack of family support due to travel restrictions. -Redeployment issues at work. -Effect of patient anxiety on healthcare professionals' mental health and job satisfaction.	-Online team support. -Sharing concerns with team and supervisor. -Easier to discuss mental health issues; the pandemic demystified and destigmatized discussions about mental health purely because so many people were impacted.
Impact on research participants and staff safety	-Challenges ensuring patient and staff safety during the pandemic because of added restrictions. -Limited and often contradictory or fast changing guidance available. -Not enough research on safety. -Infection control issues (across all modalities). -Need for introducing new disinfection and decontamination procedures.	-Collaboration with frontline staff. -Research to establish new guidance on infection control measures. -An instructional multi-step flowchart was created. - Collated available manufacturers' cleaning/disinfection guidance. -The use of social media was a useful way to find out what radiographers were having to deal with.

Both good leadership and resilience are necessary elements of staff wellbeing and of their ability to withstand crisis together; however, it is also vital to understand that often people will experience poor physical and mental health despite good leadership and resilience, purely because of the nature and complexity of adverse events. Below we offer some recommendations our team found useful to navigate the pandemic as radiography researchers and academics.

Recommendations for researchers moving forward

> "If your actions inspire others to dream more, learn more, do more, and become more, you are a leader." — John Quincy Adams [61]

As previously discussed, radiography researchers faced major challenges during the pandemic, affecting their academic, pro-

fessional, personal growth, and impacting their work-life balance. These challenges reflected both on the professional and personal aspects of individuals. To outline the main challenges upon researchers during the pandemic, but also to suggest ways forward, our team of researchers, academics, graduate students and research assistants from our institution has worked collaboratively to compile a list of both in a summative table, based on their experiences during the pandemic (Table 1). Key themes have been also highlighted in this table, alongside the solutions proposed and adopted by radiography researchers as a means of resilient leadership. The recommendations in Table 1 stemmed from clear communication amongst colleagues, inclusion and diversity of individuals into teams with shared interests, mutual support to provide motivation to others, and continuous adaptation of strategies and procedures as essential components of facilitating continuity of radiography research during the pandemic.

Conclusion

The coronavirus pandemic has brought on many challenges for clinical research and for radiography researchers. These included long-term physical and mental health implications, and also disruption of research workflows, methodologies, participant recruitment and deadlines, with funding and attention mainly directed towards COVID-19-related research studies. With little time to adapt and often little support, as many research events were cancelled or turned online, researchers had to find innovative, creative ways to continue working in their respective fields, leaning on their leaders for encouragement. This paper discussed challenges and solutions for the sustainability of radiography research during the coronavirus pandemic, whilst maintaining ethics, integrity and rigor. Resilient leadership was used as the theoretical framing for the reflections discussed in this paper, which provided a theoretical grounding to make sense of the challenges that researchers faced during the pandemic and to provide strategies to overcome these challenges.

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