

Special issue: Risk science foundations in light of COVID-19

The outbreak of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was followed by millions of cases and deaths with Coronavirus disease (COVID-19) globally. Societies have faced significant challenges in adequately assessing, communicating, and managing risks associated with COVID-19. The Coronavirus pandemic clearly demonstrated the relevance and challenges of applying risk analysis and risk science.

Risk science represents an important knowledge base for guiding the application of concepts, principles, approaches, methods, and models for assessing, communicating, and handling risk related to the Coronavirus, as discussed at the 2021 SRA Annual Meeting roundtable “Risk analysis foundations in light of Covid-19.” Still, as discussed at the roundtable, further efforts are needed to strengthen both the foundations and practical applications of risk science. This is especially so for “wicked” problems such as COVID-19 risk management. The Coronavirus pandemic represents a rich source of challenges and inspiration for such efforts. It involved situations where risk science could not adequately inform practice and where existing risk science knowledge was available and useful but not fully used in practice.

The purpose of this special issue has been to stimulate and disseminate knowledge (i) illustrating how COVID-19 challenged risk analysis at the fundamental level (e.g., by demanding answers when knowledge was still very incomplete and perceptions differed widely) and/or advancing risk science knowledge related to such challenges or (ii) demonstrating how the application of generic, foundational risk science knowledge can help to improve risk analysis practice related to COVID-19.

This special issue seeks to advance the foundations of risk science and the risk science-informed practice of risk analysis for managing pandemic risks. The coordination of this special issue has been part of the SRA Foundational Issues in Risk Analysis Specialty Group activities.

This special issue consists of nine articles that are briefly summarized in the following.

Dawson and Hanoch (2022) investigate the role of perceived risk in dishonest decision-making during the Coronavirus pandemic. The article reports on three studies, where the first two studies assess whether perceived risk influenced the decision to behave dishonestly to gain access to vaccines and furlough payments, while the third study assesses to what extent such dishonesty was discouraged by the communicated probability (“objective risk”) and the subjective probability (perceived risk) of being detected. The article finds that heightened health risk perceptions were positively correlated with lying to obtain a vaccine but finds no evidence

of such a relationship between financial risk perceptions and lying to access furlough payments. The article also finds that the probability of detected dishonesty negatively correlated with dishonest behavior. The article ends with a discussion of how policymakers can use the findings to prevent and detect dishonest behaviors in future similar crises more effectively.

Glette-Iversen et al. (2023) discuss the understanding, perception, communication, and handling of vaccine risk by adopting a contemporary risk science perspective. The article starts by reviewing key events in vaccination history, illustrating how public perception and expert handling of risks have evolved. Next, the article conceptualizes risks related to vaccines and vaccination according to the contemporary risk perspective. This analysis distinguishes between two categories of vaccination risk: (i) the risk related to contracting the disease, with and without the vaccine, and (ii) the risk related to side effects of the vaccine. A key part of the analysis relates to clarifying the relationship between the risk concept and terms like uncertainty, knowledge, and probability. The article ends with a discussion of the challenges of balancing individual and societal vaccine risks, the importance of the time dimension of risk, how to characterize risk and vulnerability, and the role of trust in relation to the understanding, perception, and handling of vaccine risk.

Hupman et al. (2024) examine the use of data-driven models to predict pharmaceutical supply chain disruptions before and during the COVID-19 pandemic. The article develops models based on the naïve Bayes algorithm to predict such disruptions, with the aim of studying how well the models perform during emergent events characterized by deep uncertainty. The analysis reveals statistically significant changes in the relationships of nearly all the variables studied linked to product supply disruptions during the pandemic. The results also show how the sensitivity, specificity, and false positive rates of predictive models were affected by the pandemic and that maintaining model sensitivity is more difficult than maintaining specificity and false positive rates. The study also demonstrates the benefits of regularly updating such models.

Korzebor and Nahavandi (2023) present a system dynamics model of the COVID-19 outbreak that considers risk perception and factors influencing risk perception, such as different media types, awareness and public acceptable death rate. The model, which is based on the classical SEIR model, incorporates the possibility of reinfection as well as feedback loops related to risk perception, media influence, and behavioral changes, allowing for the simulation of multiple pandemic waves. A case study of Iran is included. The model indicates that reducing the accepted death rate is the most effective policy for managing pandemics. The paper

concludes that risk perception is key to managing pandemics and that policies should focus on controlling risk perception through effective communication, media management, and health protocols.

Kundzewicz et al. (2023) identify lessons from the COVID-19 pandemic by studying mortality impacts in Poland versus the European Union (EU). Using data from March 2020 to February 2022, the article illustrates how COVID-related deaths and all-cause deaths in Poland were higher than the EU average for most months in the study period, and that higher vaccination rates were typically associated with lower mortality. In addition to highlighting the benefits of medical science, the authors argue that using a risk science toolbox would have been valuable to COVID-19 management in Poland. A key argument made is that an improved understanding of the risk perception of the pandemic and COVID-19 vaccines would have improved the management of vaccine hesitancy, which could have led to better pro-vaccination measures.

Li et al. (2023) review several animal transmission experiments conducted to study respiratory virus transmission, with particular emphasis on SARS-CoV-2. The review aims to provide insights into how transmission occurs and into implications for controlling the spread of viruses such as SARS-CoV-2. The article finds that close contact and short-range transmission are the main ways viruses spread, with long-range aerosol and fomite transmission being less significant. Furthermore, environmental conditions such as temperature, humidity, and airflow significantly impact virus decay, reducing transmission risk over time. The article concludes that when evaluating the transmission risk of SARS-CoV-2, it is essential to consider the biological mechanisms of virus transmission, environmental factors, and virus decay, and that failure to do so may lead to overrating the risk of certain transmission routes, such as long-range and surface (fomite) transmission, which could result in unnecessary public fear, ineffective responses and misallocating epidemic prevention resources.

Niu et al. (2023) explore how blockchain technology can improve the resilience of global supply chains by facilitating emergency production shifts during pandemics, such as the COVID-19 pandemic. Blockchain systems can integrate various sources of information, including data from health agencies, governments, and supply chain partners. Brands can then react quickly to emerging risks, such as production delays caused by factory shutdowns or government restrictions. The authors use a game-theoretic model to analyze when it is profitable for global brands to adopt blockchain, finding that this is most beneficial when competition is intense, crash costs are low, and the likelihood of production delays is high.

Shaw and Scully (2023) explore how risk science discourse shaped national and local government actions during COVID-19, using Foucault's theory of governmentality. The authors theorize that national government policymakers and local government risk managers were objectified by (and

subjectified themselves to) risk science models, results, and discourses. From this theoretical position, the study analyzes observations of risk science discourse as well as 22 interviews. The analysis identifies the challenges these groups faced in navigating the uncertainty of the pandemic and shows how competing discourses emerged, with policymakers using selected aspects of risk science to legitimize their decisions. The authors also highlight how risk managers, though initially objectified by government policies, used their human agency to resist this objectification and take independent action. The study illustrates the role of power, knowledge, and discourse in shaping government responses during the pandemic.

Soltanisehat et al. (2023) analyze the socioeconomic and health impacts of pandemic control policies across different US states and industries. The authors propose a multiobjective mixed-integer linear programming model that optimizes the closure and reopening of states and industries while balancing three objectives: minimizing epidemiological impact, ensuring social fairness, and reducing the economic disruption caused by industry closures. The proposed model is applied to a dataset covering 50 states, the District of Columbia, and 19 industries in the United States. The Pareto-optimal results reveal that any decision regarding the closure or reopening of states and industries leads to opposing effects on the economy and epidemiological outcomes.

This special issue brings together a collection of research that demonstrates the important role of risk science in managing the challenges posed by COVID-19. The included articles highlight both limitations and opportunities that were revealed by the pandemic and demonstrate the need for continuous improvement of, for example, risk conceptualizations, risk assessment methods, predictive models, and risk communication strategies. The articles collectively push for stronger foundations in risk science to better manage future global challenges.

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Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

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