



Research article

Scientific uncertainty and the challenges of applying criminal law: Lessons from China's COVID-19 response

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ABSTRACT

This study addresses the complexities of applying criminal law during public health emergencies, particularly under the shadow of scientific uncertainty, and explores the challenge of balancing public health protection with individual rights. The primary aim is to dissect the application of criminal law in the context of the COVID-19 pandemic in China, focusing on the impact of scientific uncertainty on legal decision-making and the efficacy of criminal law interventions in public health crises. This study utilized a doctrinal method combined with case studies, integrating theoretical frameworks on risk and uncertainty with an analysis of China's legal responses to COVID-19. It involved assessing legislative and policy documents alongside judicial decisions, focusing on their alignment with evolving scientific understanding and public health strategies. The study reveals significant hurdles, including the limitations of empirical rules in judicial judgments, the emergence of technocratic bureaucracy, and the complexities surrounding risk mitigation and legal attribution under uncertain conditions. It highlights the inadequacy of traditional criminal law mechanisms to respond dynamically to the evolving landscape of public health emergencies. To address these challenges, the study recommends the development of temporary criminal legislation tailored to public health emergencies, the adoption of risk-based criminal law approaches, and the refinement of individualized risk assessment procedures. These measures aim to provide a more flexible and effective legal framework capable of safeguarding public health while ensuring the protection of individual liberties during crises.

1. Introduction

COVID-19, also known as the 2019 coronavirus disease, is an infectious disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The first case was reported in Wuhan, China, in December 2019. On March 11, 2020, the World Health Organization declared the COVID-19 outbreak a global pandemic. The virus is primarily transmitted through respiratory droplets and close contact, with the potential risk of airborne transmission [1]. The pandemic has severely impacted various sectors, including the economy, society, and education. To curb the spread of the virus, governments worldwide have implemented various control measures, such as lockdowns, travel restrictions, and work-from-home policies [2]. Among various preventive measures, criminal penalties for virus spreaders are the most noteworthy.

Throughout the pandemic, nations globally grappled with the imperative to bolster their criminal policies in response to COVID-19. The approach to penalizing virus transmission behaviors varied significantly across countries. The nations implemented criminal

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sanctions for behaviors that contravened COVID-19 preventive and control measures, delineating two primary strategies [3].

The first strategy, termed the “disorderly conduct mechanism,” treated non-adherence to COVID-19 regulations as a form of disorderly conduct within certain legal frameworks. This approach viewed virus transmission behaviors as disruptions of public order, warranting more lenient penalties. South Korea serves as a notable example, with its Infectious Disease Control and Prevention Act prescribing penalties for non-compliance that include imprisonment or fines, yet these are substantially less severe compared to traditional offenses like homicide or injury. For instance, a violation of quarantine measures could result in a maximum of one year’s imprisonment or a fine, with increased penalties for actions resulting in actual disease transmission due to intentional or grossly negligent acts (the penalty for such crime shall be increased by up to 1/2 of the penalty specified for that crime) [4].

Conversely, the second strategy, known as the “serious crime mechanism,” classified violations leading to virus transmission as grave offenses, endangering public safety and equated to intentional harm or homicide. This approach facilitated the imposition of severe criminal sanctions, reflecting the magnitude of the offense. For instance, in the Middle East, Lebanon considers the intentional spread of COVID-19 as tantamount to serious crimes, including intentional homicide, injury, or terrorism [5]. Bahrain’s Penal Code and Jordan’s regulations articulate similar positions, with severe penalties for the intentional spread of diseases [6]. Beyond the Middle East, Australia has adopted comprehensive legislation criminalizing virus transmission behaviors, ranging from minor public health order violations to acts potentially charged as manslaughter or murder if transmission results in death [7].

While the penalization of COVID-19 transmission behaviors appears theoretically feasible in most jurisdictions, its practical implementation varies. In Japan and Germany, there is acknowledgment among scholars that virus transmission could be prosecutable under offenses such as assault or negligent bodily harm [8]. However, the practicality of treating COVID-19 transmission as a serious crime faces theoretical and ethical challenges. Japanese scholars highlight the difficulties in establishing the requisite legal components of *actus reus* and causation, especially given the initial uncertainties around COVID-19’s fatality rate [8]. Similarly, in North America, the experiences with HIV criminalization offer a cautionary tale. Legal experts in the United States and Canada have advised against a direct transposition of the HIV legal framework to COVID-19, citing the risk of disproportionately infringing upon the rights of marginalized populations [9]. The intent behind HIV criminalization laws—to safeguard individuals from unconsented health risks—contrasts with the broader social protection and public health imperatives posed by COVID-19 [10]. Therefore, extending the HIV legal framework to COVID-19 without adjusting for its unique transmission characteristics and public health implications may not be appropriate. Reflecting these considerations, widespread criminalization of COVID-19 transmission has been approached with caution, and instances of such behavior being prosecuted as severe crimes remain rare.

During the COVID-19 pandemic, China also tightened its criminal policies, adopting the serious crime mechanism in its legislative approach. During the COVID-19 pandemic, Chinese legal institutions, including the Supreme People’s Court, Supreme People’s Procuratorate, Ministry of Public Security, and Ministry of Justice, jointly issued the “Opinions on the Legal Punishment of Offenses Hindering the Prevention and Control of the COVID-19 Epidemic” (hereafter “the Opinions”). The Opinions specified typical behaviors related to the dissemination of the COVID-19 virus that could constitute crimes, such as intentional injury, obstructing the prevention and treatment of infectious diseases, and endangering public safety by dangerous means. Regulation of COVID-19 transmission included:

- Patients or carriers of the novel coronavirus who violate isolation protocols, enter public spaces, or use public transportation are classified as committing the crime of endangering public safety through dangerous means.
- Intentional harm to medical personnel (e.g., tearing protective equipment and spitting on medical personnel) resulting in infection falls under the crime of intentional injury.
- Refusal to comply with the control measures proposed by health and epidemic prevention organizations, leading to viral transmission or posing a severe risk, constitutes the crime of obstructing the prevention and control of infectious diseases.

After the promulgation of the aforementioned “Opinions,” Chinese scholars have increasingly focused their research on two main levels: conceptual and technical. On the conceptual level, scholars have examined the shifts in criminal law concepts during the pandemic by integrating perspectives from criminal law doctrine, criminal policy, and criminology. Some scholars have keenly observed that the illegality of pandemic-related crimes should still be judged individually, and that traditional legal standards and existing policy standards should be equally clear to strike a balance between reasonableness and strictness [11]. It is essential to fully consider the severe impact of the pandemic on the social environment, and the overall criminal policy must adequately account for these influences [12]. Some scholars have taken the opportunity of the pandemic to emphasize the preventive value of criminal law from the perspective of biological criminal law [13].

On the technical level, research has primarily focused on the interpretive pathways of specific crimes in the context of the pandemic, particularly concerning the “Opinions.” Scholars have conducted detailed discussions on the relationship between the crime of endangering public safety by dangerous means and the crime of obstructing the prevention and treatment of infectious diseases [14], the subjective elements of the crime of obstructing the prevention and treatment of infectious diseases [15], and the application of the crime of endangering public safety by dangerous means [16]. Notably, healthcare workers and judges have also participated in academic discussions, providing more valuable insights. From the perspective of medical practice, there has been confusion in judicial practice between the concepts of “Class A infectious diseases” and “infectious diseases managed as Class A,” stemming from a lack of understanding among judicial practitioners about the relevant types of infectious diseases [17]. From the judicial practice perspective, there are issues with the subjective culpability forms and the difficulty in establishing causality of the actual harmful results in crimes such as obstructing the prevention and treatment of infectious diseases [18].

Similar to the research of Chinese scholars, Western scholars have also paid attention to the application of criminal law during the

pandemic, adopting a cautious attitude. They argue that criminal provisions related to virus transmission must be precisely and narrowly defined, with criminal prosecution and punishment being reasonable only in rare cases [7]. Unlike Chinese scholars, Western scholars have focused more on whether the legal framework originally applied to HIV transmission cases should be applied to COVID-19 transmission behaviors [10] and the risks associated with over-criminalization, including issues of unfair affirmative defenses, stigmatization, and hindrance to pandemic control [9].

Overall, existing research has recognized the challenges posed by the pandemic to the application of criminal law, acknowledging the need for discussion on issues such as the risk assessment of virus transmission and the boundaries between different crimes. However, constrained by the closed nature of criminal law, theoretical research has overly emphasized systemic coherence without incorporating methodological achievements from other disciplines [19]. For instance, Chinese scholars have identified normative and functional issues with the “Opinions” but have sought solutions within the criminal law theory itself [20], with much research presupposing the precise assessment of transmission risks and consequences. While this research trend ensures the coherence of the criminal law system, it fails to provide clearer methodological guidance, such as determining the timing of criminal law interventions in pandemic control, conducting risk assessments in specific cases, and addressing the relationship between permanent and temporary legislation within the criminal law system.

Given the evolving nature of the pandemic, the rules for applying criminal law must adapt and reference research findings from fields like risk management. This study, unlike existing research, addresses these issues by introducing analytical tools such as uncertainty matrices and public health reasoning. Using China’s criminal law practice as a case study, it examines the legitimacy and methods of criminal intervention during different stages of the pandemic’s development from a methodological perspective and proposes recommendations for improvement.

The objective of this study is to analyze the challenges and difficulties of applying criminal law in public health emergencies using the COVID-19 pandemic in China as a case study. Specifically, it (1) examines how scientific uncertainty, risk assessment, and attribution principles affect legal decision-making under emergent circumstances; (2) evaluates criminal law intervention’s role in protecting public health and individual rights and the balance between them; and (3) provides a theoretical framework and empirical evidence to improve China’s criminal emergency legal system and enhance its adaptability and rationality in managing public health crises.

The paper is structured to systematically address the application of criminal law in the backdrop of public health emergencies, such as the COVID-19 pandemic. The introduction lays the groundwork by contextualizing the study within the broader challenges posed by the pandemic. We proceed by detailing our methodology, which combines doctrinal analysis with case studies, to evaluate China’s legislative and judicial responses against the backdrop of public health strategies and evolving scientific insights. Following this, we explore the theoretical framework that guides our analysis, focusing on concepts of risk, uncertainty, and the precautionary principle in criminal law enforcement. The subsequent section presents our findings, where we identify critical challenges in legal decision-making amid scientific uncertainty and the rise of technocratic governance. Solutions are proposed next, advocating for the adoption of temporary criminal legislation, the implementation of risk-based criminal law approaches, and the enhancement of individualized risk assessments. The paper culminates in a conclusion that summarizes our findings and outlines recommendations for future policy and research directions.

2. Method

The research methodology employed in this study encompasses a multifaceted approach aimed at understanding the interplay between scientific uncertainty, criminal law application, and public health crisis management. From the perspective of legal studies, this article employs the doctrine method [21] as its foundational approach. By integrating legal norms with actual cases, it examines whether the application of criminal law in China can achieve its intended objectives under conditions of uncertainty. Initially, the study constructs a robust theoretical framework, engaging deeply with both legal and scientific literatures to articulate and explore the concepts of risk, uncertainty, and the precautionary principle as they pertain to criminal law enforcement during public health crises. This foundational work supports a detailed case study analysis of China’s legal response to COVID-19, meticulously examining legal documents such as “the Opinions” issued by Chinese legal authorities and assessing their alignment with the evolving scientific understanding of the virus and the strategic public health response. Complementing this, qualitative analysis is employed to scrutinize judicial decisions, legal frameworks, and public health policies, aiming to uncover the impact of scientific uncertainty on legal reasoning and the adjudication process within the criminal justice system during the pandemic. Finally, the study proposes and evaluates potential solutions to the challenges identified, suggesting enhancements to China’s criminal law framework through mechanisms like temporary criminal legislation, individualized risk assessment, risk-informed criminal law, and judicious risk allocation, thereby aiming to bolster the adaptability and rationality of the legal system in managing ongoing and future public health emergencies. This comprehensive methodological approach ensures a nuanced understanding of the intersections between law, science, and public health policy, offering valuable insights and practical recommendations for navigating the legal challenges posed by pandemics.

3. Concepts and issues: scientific uncertainty, China’s criminal law and COVID-19

Conventionally, judicial decisions require a scientific foundation. In criminal justice, the elements of a crime, such as harm and causation, usually depend on forensic science as the basis of judgment. Criminal causation cannot be established without the conclusive scientific laws of cause and effect [22]. However, during a public health emergency, a nation’s response measures can only

be formulated based on uncertainty. Therefore, scientific uncertainty significantly influences decision-making [23]. The recurring scenario of scientists continuing their research while the state enacts response measures highlights the need to reevaluate the role of concepts such as “risk” and “uncertainty” in legal decision-making. Practical lessons emerge from erroneous decisions made under a state of scientific uncertainty. For instance, in China, public safety authorities prematurely label speculative information as “rumors” before new infectious diseases are categorized, critically affecting the credibility of public safety departments.

The notion of “uncertainty” occupies a seminal position within the discourse on emergency decision-making. Tracing its history, the distinction between “risk” and “uncertainty” was first posited by Frank H. Knight in 1921, where “risk” was characterized as a quantifiable form of uncertainty [24]. Subsequently, this conceptual framework found expansive utility within the field of economics. As society transitioned into the post-industrial era, the intricate challenge of managing uncertainty effectively precipitated the evolution of new institutional architectures, often leading to the deconstruction of certain antecedent theoretical axioms [25]. The advent of risk-based criminal jurisprudence serves as an illustrative case in point.

The concept of “risk-based criminal law” is relatively common in the study of Chinese criminal law theory. However, discussions integrating uncertainty with criminal law are not as prevalent. As previously mentioned, the reason lies in the foundation of criminal law theory on certainty, making its application challenging under scientifically uncertain circumstances. During the COVID-19 pandemic, Chinese scholars’ research perspectives predominantly assumed “certainty” as a premise, examining the applicability of criminal law during the pandemic through legal doctrinal studies and criminal policy studies. Traditional legal doctrinal methods do not address the legality of intervening in pandemic prevention and control through penal measures. Most scholars believe that classifying virus transmission actions as crimes is “without much doubt,” with the issue being the specific circumstances under which virus transmission actions constitute crimes endangering safety through dangerous methods, or intentional homicide, among others, based on existing legislation [15,26]. Such research typically does not consider the medical proof challenges of causation and transmission risk, and there exist some more radical views theoretically, such as some scholars who argue that criminal punishment measures against “suspected patients” who cause virus transmission do not violate the criminal law principle of “in dubio pro reo” [27]. Scholars researching from a criminal policy perspective also present a more aggressive stance, where “severe punishment for critical assaults” is deemed reasonable [28]. Some scholars, after reflection, believe that ordinary people during the pandemic, who cause virus transmission due to “avoiding discrimination and fearing quarantine,” should generally be treated leniently and distinctively in criminal policy, whereas those who intentionally spread the virus should not be given special consideration in criminal policy [12]. Overall, Chinese scholars’ research assumes the routes and severity of COVID-19 virus transmission can be fully determined in practice as a premise, that is, criminal legislation and criminal law theory have not focused on the challenges brought by uncertainty.

This stance, in fact, has led to a disconnection between legislation and practice. This aspect is prominently reflected in the case handling data of the prosecutorial authorities. As demonstrated in the following table (Table 1), during the initial phase of the epidemic, the procuratorial organs intervened and handled a substantial number of virus transmission cases. However, by March 11th of the same year, there was a sharp decline in the number of cases, indicating that many cases filed and investigated by public security organs during this period were revoked. By March 26th, the charges of “endangering public safety by dangerous means” and “negligently endangering public safety by dangerous means” had disappeared from the procuratorial organs’ bulletins, leaving only crimes of obstructing the prevention and control of infectious diseases.

Several factors contributed to this shift. First, as the pandemic control efforts stabilized, the public adopted a more lenient stance towards initial transmission behaviors. Individuals who had travelled to affected areas and inadvertently contracted the virus were increasingly viewed as “victims” within a “community of shared destiny,” resulting in calls for more moderate criminal penalties. Second, because of the harsh penalties for charges like “endangering public safety by dangerous means,” criminal policy shifted towards using the less severe charge of “obstructing the prevention and treatment of infectious diseases.” the “Opinions” revived this previously dormant charge, which saw subsequent widespread application. It is evident that although China adopted a serious crime mechanism in the initial stages of the pandemic, judicial authorities, in fact, abandoned this stance within a few months, turning instead to seek a disorderly conduct mechanism. This approach entails treating the crime of obstructing infectious disease prevention and control as a panacea for resolving disorderly conduct.

An examination of China’s “Judicial Documents Network” revealed no cases where transmission behaviors were characterized as

Table 1

The data on prosecutorial authorities’ handling of criminal cases involving virus transmission.

Release Date	Case Handling Status
As of February 25, 2020	Procuratorial organs nationwide intervened and handled 383 cases involving 481 individuals for crimes related to resisting epidemic prevention and control measures leading to the spread of the novel coronavirus (including crimes of endangering public safety by dangerous means, crimes of negligently endangering public safety by dangerous means, and crimes of obstructing the prevention and control of infectious diseases) [29].
As of March 11, 2020	Procuratorial organs nationwide legally approved the arrest of 10 cases involving 12 individuals. They prosecuted 17 cases involving 20 individuals for crimes related to resisting epidemic prevention and control measures leading to the spread of the novel coronavirus (including crimes of endangering public safety by dangerous means, crimes of negligently endangering public safety by dangerous means and crimes of obstructing the prevention and control of infectious diseases) [30].
As of March 26, 2020	Procuratorial organs nationwide legally approved the arrest of 12 cases involving 14 individuals and prosecuted 16 cases involving 18 individuals for crimes of obstructing the prevention and control of infectious diseases [31].
As of April 16, 2020	Procuratorial organs nationwide legally approved the arrest of 13 cases involving 15 individuals and initiated public prosecution for 24 cases involving 26 individuals for crimes of obstructing the prevention and control of infectious diseases [32].

“endangering public safety by dangerous means.” Contrarily, the charge of “obstructing the prevention and treatment of infectious diseases” was widely used. In our case study analysis, behaviors initially classified under the severe charge were ultimately recategorized as “obstructing the prevention and treatment of infectious diseases” post-trial. Selected examples illustrating these behavioral patterns and legal characterizations are presented in the table (Table 2) that follows.

In summary, China’s criminal legislation and theory follow a tradition based on “certainty,” a tradition that is no longer effectively addressing the constantly evolving pandemic. The uncertainties introduced by public health emergencies profoundly affect the applicability of criminal law. Unlike previous studies, this research incorporates scientific uncertainty into the discussion of criminal law doctrine, examining the impact of scientific uncertainty on the application of criminal law and how criminal law should respond to the challenges posed by uncertainty. This study effectively fills the gap in China’s existing criminal law theory in addressing public health emergencies and offers valuable insights into the development of criminal law theory worldwide, using China’s COVID-19 response as an illustrative example.

4. Theoretical framework: The relationship between scientific uncertainty and criminal law decision-making

Scientific uncertainty holds significant implications for criminal law decision-making. As conceptualized by scholars, the uncertainty matrix [33](Fig. 1) illustrates the correlation between uncertainty and decision-making. This study uses Stirling’s uncertainty matrix structure, which was partially modified for this research.

Scientific uncertainty refers to a gap in human knowledge regarding a specific subject. This gap implies the need to clearly understand the probability of an event’s occurrence and its outcomes. The uncertainty matrix (illustrated above) divides uncertainty into four distinct “quadrants” based on the probability of an event occurring and the level of certainty associated with its outcome. The term “risk,” widely used in criminal law, falls within a definitive quadrant where the knowledge of an event’s probability and outcome exists in a state of low uncertainty. Consequently, the risk is defined as “measurable uncertainty.” Individuals also face three other types of uncertainty: “Narrow Uncertainty” is a state where minimal doubt exists regarding the event’s outcome probability, but existing knowledge and cognitive models fail to provide an epistemic foundation for the event’s occurrence; “Ambiguity” is characterized by heightened doubt concerning the outcome’s occurrence, but with minimal questioning of its probability; and “Ignorance” is defined by a lack of understanding about both the event’s occurrence and development [34].

4.1. Uncertainty and the legitimacy of criminal intervention

Little is known about the viral transmissibility, mortality rate, or other issues at the initial public health event stage. A lack of clinical and epidemiological evidence exists regarding the contagiousness of the disease and whether it is preventable or controllable. Individuals can take precautions to manage an outbreak, which is a crucial aspect of this principle. Under such circumstances, can we use punitive measures that infringe on citizens’ rights, such as criminal sanctions? Such actions are inappropriate from the perspective of rights protection. During the initial COVID-19 outbreak, some people issued public warnings, which could be considered conjecture based on their previous experience in an unknown state. Based on professional experience, such a warning should not be considered a rumor because determining information to be a rumor must be based on scientific certainty. In this case, people have the right to discuss the outcome or probability academically; the government should not interfere, let alone punish individuals, unless the person intentionally disrupts the social order using the unknown state [35].

Can criminal law play a role in the other three uncertain “quadrants”? In the “risk” state, scholars and policymakers encounter the

Table 2

Typical cases of virus transmission behavior during the COVID-19 period.

Case Number	Behavior
(2022) Shandong 0613 Criminal First Instance No. 73	The defendant violated the home quarantine rules to handle personal matters. After the wife showed symptoms similar to a cold, the defendant still went out into public places, leading to 543 close contacts and 362 secondary contacts being quarantined for medical observation.
(2022) Guangxi 1421 Criminal First Instance No. 48	The defendant transported eight Vietnamese nationals who had illegally entered from Vietnam, a country with a severe epidemic, to Nanning City and received 1500 yuan.
(2020) Anhui 1524 Criminal First Instance No. 71	The defendant failed to comply with epidemic prevention measures. Despite being required to quarantine after returning from Wuhan, the defendant dined with others at home and participated in various gatherings. This led to seven neighbors and four family members being directly or indirectly infected with COVID-19 and 253 contacts being quarantined for medical observation.
(2021) Shaanxi 1022 Criminal First Instance No. 4	The defendant intentionally concealed a travel history to Hubei and symptoms like coughing and fever after returning. The defendant also violated the 14-day home quarantine requirement, either visiting friends and relatives or allowing family members to do so. This led to over 700 people who had direct or indirect contact with the defendant’s family being medically or home quarantined.
(2021) Liaoning 0105 Criminal First Instance No. 693	The defendant was the person in charge of a hospital. He violated the Law on the Prevention and Treatment of Infectious Diseases by refusing to implement epidemic prevention and control measures. This led to 37 confirmed cases of COVID-19 in Shenyang, 27 of which had direct or indirect contact with the hospital. A total of 206 people became primary close contacts, 179 of whom were medically quarantined.
(2020) Henan 0304 Criminal First Instance No. 155	The defendant showed symptoms of fever and dry cough but did not register with the community as required by epidemic prevention regulations after returning from Wuhan. The defendant was later diagnosed with COVID-19, resulting in three family members being infected and over 80 close contacts being quarantined for medical observation.

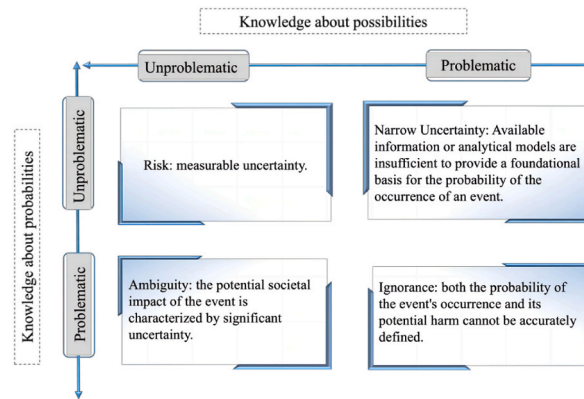


Fig. 1. The uncertainty matrix.

concept of risk criminal law [36]. Although the theory of risk in criminal law is disputed and many scholars do not recognize this view [37], criminal law is increasingly used to manage emerging risks in society. As risk is a measurable uncertainty, the probability of an act occurring and the likelihood it will result in harm are both assessable under the state of risk. Therefore, criminal law interventions are feasible.

Moreover, if criminal law does not intervene beforehand, the risk will likely materialize into actual harm. Therefore, from the criminal policy perspective, criminal law intervention is relatively reasonable. The early protection of legal interests [38] and establishment of abstract danger offenses [39] are to some extent aimed at reducing the possibility of risk causing substantial damage. Therefore, we can believe there is room to apply criminal law to the risk quadrant. However, governments should describe specific measures to protect against human rights abuse, ensure consistency with human rights obligations, and support evidence-based public health responses [40].

Epistemic gaps exist in the two quadrants of “narrow uncertainty” and “ambiguity.” Under these two states, conducting risk assessment in criminal law is complex. Both affect discretion in criminal law, regardless of whether the outcome or the probability of occurrence is uncertain. First, people’s lack of understanding of event outcomes affects their judgment of an offense’s harmful element. Whether the harm is actual, or potential requires event outcome knowledge. Second, people’s perceptions of an event’s occurrence probability affect their assessment of causal relationships in criminal law. What is the transmission of infectious diseases? How likely are these individuals to be infected through routine social contact in daily life? These questions affect the judgment of causal relationships (conditionality) and significantly affect objective attribution at a normative level. According to criminal law theory, resorting to illegal legal measures before addressing this problem is not rational. Criminal law intervention can only be justified when infectious disease perceptions shift from “narrow uncertainty” and “ambiguity” to “risk.”

However, this does not mean that criminal law interventions can only occur after a public health crisis has subsided. Although judgments made at the overall natural science level may be uncertain (narrow uncertainty and ambiguity), risk assessments based on individual cases may be relatively specific. For instance, when medical resources are severely strained and infected individuals struggle to receive treatment, the probability of harm occurring in individual cases is relatively certain. A different approach could be taken if the severity of a disease, such as COVID-19, is determined not based on the general population but on specific groups, especially characteristics such as their age, prior conditions, and other vulnerabilities [7]. In other words, criminal law intervention is reasonable if risk can be assessed on a case-by-case basis.

4.2. Uncertainty and the reasoning method in criminal decision-making

Legal decision-making, especially in the criminal law context, in these states of uncertainty, presents an essential issue warranting considerable attention. Deficits in situational understanding primarily influence reasoning. When confronted with novel problems, expert decision-making invariably originates from a place of ignorance or existing experiences. Consequently, in a public health emergency, the predominant reasoning methods are different from conventional reasoning. Scholar Cummings has postulated four distinct models of public health reasoning: argumentation from ignorance, analogical reasoning, argument from authority, and circular reasoning [41]. Argumentation from ignorance and analogical reasoning are commonly employed in legal decision-making. This discussion will focus on these two types of reasoning methods while deferring argument from authority to the section on “Technocratic Bureaucracy.” The Argument from Ignorance is an argumentation mode premised upon a singular presumption that “if there is an absence of knowledge or evidence affirming P’s veracity, then P is false.” For instance, in its report on Bovine Spongiform Encephalopathy, more commonly known as “mad cow disease,” the UK government stated that “On the basis of the work done so far, there is no evidence whatever that BSE causes Creutzfeldt-Jakob disease (CJD) and, similarly, not the slightest evidence that eating beef or hamburgers causes CJD” [41]. This reasoning pattern typifies the argument of ignorance, which is ubiquitous in epidemic prevention and control.

Unlike the argument based on ignorance, the argument based on analogy attributes an understanding of novel events to preexisting

knowledge. It relies on the similarities between the novel and previous issues to elucidate the problem. For instance, the World Health Organization explicitly stated that its document titled, “Infection Prevention and Control during Health Care when Novel Coronavirus Infection is Suspected,” was adapted from its experience with Severe Acute Respiratory Syndrome coronavirus and Middle East Respiratory Syndrome coronavirus [42]. This indicates that in the absence of precise descriptions and interpretations of new issues (the novel coronavirus and related matters), countermeasures were formulated based on the most analogous knowledge base (information regarding the Middle East Respiratory Syndrome coronavirus and other related topics).

From a logical perspective, forms of reasoning, such as arguments from ignorance and analogy, fail to effectively preclude potential fallacies. However, they are prevalent in public health emergencies. Legal professionals face formidable challenges in this setting, as legal decisions must be made under the state of uncertainty brought about by public health emergencies. For example, in the absence of definitive evidence that a pathogenic factor originates from or is transmitted by animals, is it permissible for the government to prohibit the trade of wild animals or to undertake culling measures? This uncertain state of reasoning profoundly affects criminal justice, primarily because the conviction standard prohibits excessive uncertainty in fact-finding. In essence, legal reasoning and public health reasoning are distinct. Determining how to conduct risk assessments based on public health reasoning and achieving certainty in individual cases is key to addressing the issue.

Scientific uncertainty poses significant challenges to applying criminal law. Public health decision-making under a state of uncertainty is typically grounded in risk assessments of epidemiological significance, whereas legal decisions necessitate consideration of certainty at the individual case level. Finding solutions between public health and legal decision-making, epidemiological (statistical) assessment, and individual criminal case assessment is complex for legal practitioners. Bridging the gap between scientific uncertainty and legal standards requires a multidisciplinary approach, integrating insights from the scientific and legal communities. As we navigate these challenges, it becomes imperative to develop frameworks and guidelines that can guide legal professionals in making informed decisions despite uncertainty, ensuring justice while safeguarding public health.

5. Findings: The difficulties in characterizing COVID-19 transmission behavior

According to “the Opinions”, some transmission behaviors may constitute crimes, such as intentional injury, obstruction of prevention and control of infectious diseases, and endangering public safety by dangerous means. However, this paper does not discuss the applicability of these crimes but instead focuses on the challenges of legal decision-making in the context of scientific uncertainty. Even if a behavior falls under a specific crime, some questions must still be answered, such as whether this behavior has caused harm, whether there is a causal relationship between this behavior and harm, or whether this behavior can be attributed to the actor. As scholars have noted, the “problem with the coronavirus will inevitably be establishing a connection between acts and consequences, between the behavior of a person infected with the coronavirus and the illness of somebody new” [43].

5.1. The ineffectiveness of empirical rules in judicial judgments

During the epidemic prevention and control period, the reasoning process involves a certain level of expertise, and professionals make relevant inferences based on appeals to ignorance or analogies. In the era of self-media, news practitioners often emphasize those fact fragments that have a shocking effect, such as “Concealment is equal to harm! Deliberately concealed the report so that more than 3000 people were isolated and observed” [44]. Accompanied by the public’s psychological fear of major emergencies, this type of news can attract attention and form “public opinion” that calls for severe punishment for related behaviors. However, being isolated does not equate to having a positive diagnosis of infection, and determining whether it poses a significant transmission risk requires scientific evidence. If the prosecutor argues that the actions in question have caused a significant risk of infectious disease transmission by citing “more than 3000 people were isolated and observed,” then the validity of this inference is questionable. In the context of pandemic prevention and control, some regions in China have adopted stringent policies, and large-scale isolation measures are sometimes considered excessive. Therefore, it is difficult to argue that proving the element of harm by pointing out that multiple people have been isolated meets criminal law requirements.

In China’s judicial practice, the lack of scientific evidence and unreliability of empirical rules have led judges to adopt an evasive attitude when determining whether transmission risk exists. They no longer argue about the transmission risk caused by behavior in the judgment reasoning. By contrast, in practice, as long as the defendant’s conduct causes large-scale isolation, it can be determined that the defendant’s behavior has caused a significant transmission risk. In the case of Yang (case number [(2020) Chuan 0603 Xing Chu No. 248]), the judge argued that the defendant’s behavior was dangerous, stating that “he knowingly should have reported his travel history in Hubei and the relevant personnel in his family, but deliberately concealed it, resulting in his residential building being sealed off, the residents of the building being home quarantined, causing a danger of spreading the novel coronavirus.” This demonstrates that the judge determined the defendant’s behavior to pose a severe virus transmission risk because the residential building was sealed off (267 residents of the 97 households in the building were home-quarantined). During the trial, the defense lawyer challenged this argument by claiming that “there was no direct causal relationship between the result of sealing off the building and the defendant’s behavior, and the responsibility could not be attributed to the defendant.” The judge rejected this argument.

According to criminal law theory, the harm of an offense refers to the actual harm to legally protected interests caused by the behavior and the state of factual danger [45]. The harm of an offense should have actuality, and even in abstract endangerment offenses, the illegal effect can be manifested through actions that change, affect, or hinder legally protected interests and can be concretized to some extent [46]. That is, harmful elements should have actuality and relative certainty. However, how should criminal law determine the reality and inevitability of results when natural science lacks cognition about specific issues? This issue warrants

serious consideration.

First, in a state of scientific uncertainty, relying on social experiential knowledge as a basis for common sense becomes ineffective and assessing the risk of certain behaviors becomes challenging. Traditional criminal law theory emphasizes the role of common sense and knowledge in judicial decisions. Nevertheless, social and experiential judgments may become blind when faced with expertise issues.

Second, professional experts take time to reach a consensus on understanding a disease. These temporary professional conclusions should not be used directly as a basis for criminal judicial judgments. When the infectiousness and toxicity of the virus cannot be accurately assessed, determining the transmission behavior as punishable may be too rash. As observed in epidemic prevention and control, the virus mutates continuously, changing the transmission capacity and fatality rates of different strains. The emergence of vaccines and effective drugs undoubtedly influences the evaluation of the dangers of relevant behaviors. Therefore, the impulsive use of criminal punishments will be unfair because the ability to punish an act no longer depends on the act's harmfulness but on the judge's level of cognition of a particular phenomenon.

Third, due to the immediate nature of an epidemic, careful consideration of all variables regarding the hazardous nature of transmission behavior is challenging. This necessitates the extrapolation of findings based on incomplete data. Several factors contribute to the harm caused by infectious diseases, including, but not limited to, the mortality rate of the virus itself, the potential risks associated with treatment methods (such as post-therapy complications), and the accessibility of medical resources. This suggests that the social harm caused by transmission behavior requires careful and comprehensive assessment. When medical resources are scarce, the harmful effects and perilous nature of deliberate transmission behavior escalate.

Conversely, in regions with a relatively mild epidemic situation and a sufficient supply of medical resources, the risk posed by deliberate transmission decreases as treatment options for infected individuals are accessible. Public safety and judicial bodies must refrain from relying on intuition or societal experiences to make judicial judgments. Instead, determining transmission behavior's real-world hazards requires case-by-case evaluation.

Fourth, a crucial point to note is that when empirical rules no longer hold, the foreseeability of criminal laws becomes difficult to ensure, leaving individuals unable to discern whether their actions constitute a crime. On a practical level, the application of criminal law during the pandemic was fraught with professional judgments. Judges were required not only to consult opinions from the field of epidemiology to determine the presence of actions and outcomes related to virus transmission but also to make legal judgments on whether such actions and outcomes posed a threat to public safety or infringed upon others' health. These professional judgments significantly undermined the predictability of criminal law. When the highest judicial authority in China issued judicial interpretations, it did not fully consider these issues.

5.2. The emergence of technocratic bureaucracy

When conventional wisdom and logic fall short of judicial rulings, they are supplanted by professional technical standards. Within a risk society, "Technocratic Bureaucracy" [47] is vital in emergencies and denotes the propensity for decision-making power to coalesce with technical bureaucrats in emergent situations. Technical experts have increasingly become decision-makers rather than advisors and are essential for pandemic prevention and control. Both legislative and judicial processes have demonstrated signs of restraint, affecting the application of criminal law primarily through epidemiology's impact on judicial judgments.

Regarding professionalism, Chinese judges abandoned the examination of expert evidence. Material facts formed by epidemiological experts have become the core evidence for judicial adjudication. In the case of Xu (case number [(2021) Er 2825 Xing Chu No. 39]), the judge argued that "he went out multiple times in violation of the rules, causing many people to be infected." The judge inferred a causal relationship between the transmission behavior and the infection result based on two types of evidence: first, witness testimony to prove that the infected people had contact with the defendant, and second, official documents from the local disease prevention and control center to prove the infection of the people who had contact with the defendant. In other words, the judge considered that anyone who had contact with the defendant and was later diagnosed with a confirmed case (i.e., a related case in epidemiology) was infected by the defendant. The judge did not consider whether other possible causes could lead to infection, which has rarely been discussed in practice. In such cases, the judge was "lazy" and directly adopted epidemiological causality as legal causation.

Individuals must understand novel phenomena to make decisions based on social experiences and conventional wisdom in different situations. However, they may also be forced to forgo certainty and instead seek probabilistic knowledge as a foundation. This is also true of legal work. Forensic epidemiology emerged from this phenomenon as a specialized discipline related to legal issues. Forensic epidemiology addresses the causal relationship between a specific event and a disease outbreak. However, because forensic epidemiology mainly employs statistical data for inference, causation assessments within this domain represent a form of probabilistic correlation. The question then arises of whether this correlation satisfies the standards outlined in criminal law. Practically speaking, epidemiological labels, such as "linked cases" and "index cases," inherently involve elements of causation judgment, but they are not a direct foundation for assigning criminal responsibility.

Conventionally, the contingent relationship between behavior and consequences is founded on the principles of causation. Nonetheless, against the backdrop of public health crises, knowledge about causation exhibits an element of uncertainty and relies heavily on temporary consensus in epidemiology. This is evident in the Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia disseminated by the Health Administrative Departments of China. The viral transmission route delineated by these authorities has undergone continuous amendments. For instance, the sixth version modified "contact transmission" to "close contact transmission," confined aerosol transmission to cases of "long-term exposure to high-concentration aerosols in a relatively enclosed

environment,” and deleted the method of digestive tract transmission. The eighth edition introduced “contact with virus-contaminated objects” as a potential transmission route. In situations with fewer confirmed cases, the origin of infection can be determined with relative precision through epidemiological investigation. However, if the reality presents numerous potential factors capable of inducing viral infections (individuals or items posing transmission risks), making judgments about causation becomes considerably challenging. A responsible approach would exhaustively enumerate and exclude unrelated options to achieve the evidentiary standard of beyond reasonable doubt. Traditional criminal law theories reject causal relationships based on probability. Scholars have argued that academic attitudes toward the use, harm, or harmlessness of certain drugs, foods, and other substances often fluctuate. As such, it would be unjustified to establish criminal judgments based on frequently changing academic majority opinions [36].

In criminal judicial practices, technocratic bureaucracy manifests itself in two primary ways. First, “epidemiological investigation reports” from disease control institutions have become the most frequently employed evidence to delineate causation and ascertain the real-world danger associated with a behavior. The correlation between the diagnosed and subsequent secondary cases forms the basis for factual acknowledgment. Second, within individual cases, the function of epidemiological investigation reports goes beyond “opinion” to become “conclusion.” This suggests that it is challenging for judicial entities to scrutinize investigation report contents and problematic for defendants to question the evidentiary value and probative force related to this content. Theoretically, epidemiological investigations are based on statistical analyses. Although the work of forensic epidemiologists does not constitute evidence-based statistics, this does not imply that the acceptance of epidemiological evidence must establish a causal relationship [48]. Rigidly adhering to the epidemiological conclusions of disease control institutions is tantamount to relinquishing judicial review authority and bolstering the premise of autocratic technocracy.

Regarding the uncertainty related to judgments of causation, criminal law theory indeed proposes a unique resolution, namely “epidemiological causality.” This term describes the process of verifying the existence of a correlation between a specific element in the living environment and disease incidence using statistical methods and subsequently documenting the probabilistic causal relationship between the element and disease [49]. Epidemiological causality utilizes statistical data to probe causality-related queries, which typically occur post hoc; that is, potential harmful causes are sought after the incident’s resolution. Conversely, causation assessments during emergencies often occur in fluctuating circumstances.

5.3. *The complexities of risk mitigation and attribution principles*

The dissemination of infectious diseases involves a comparatively complex process in which the same transmission behaviors could result from different propagation pathways. Infected individuals may infect others, creating chain-like structures [50]. In response to this chain linking transmission behaviors and infection outcomes, criminal law must address which infection outcomes should be attributed to the initial transmission behavior.

Notions such as “super-spreaders” and “Patient Zero” are neutral within the epidemiology field yet often stigmatized within social discourse, attributing the transmission outcomes within a defined range to the initial spreader indefinitely. In practice, to limit the scope of punishment, adjudicators attempt to consider factors such as whether the transmitter is a confirmed case and aware of their infection. Nonetheless, legal professionals must further scrutinize related issues from the perspective of risk and attribution. From a medical standpoint, “a substantial proportion of individuals with COVID-19 do not transmit the virus, resulting in no secondary cases. However, a small subset of infected patients exceeds the primary reproduction number (more than three), leading to more than three secondary cases, which constitute super-spreading events” [51]. Under these circumstances, if a more cautious attribution principle is not employed, the punishment scope inevitably expands.

Generally, when an initial spreader engages in close contact with others or exposes them to respiratory droplets, resulting in subsequent secondary infections, this indicates an inherent transmission risk in the initial spreading behavior. For instance, stringent social isolation measures were implemented in some areas during the peak of the infectious disease. If someone infected with COVID-19 or in close contact with an infected individual does not follow social isolation guidelines, it could result in an investigation into whether the initial spreader should be held accountable for additional cases. From the practical perspective of epidemic control, transmission chains engendered by so-called super-spreaders warrant scrutiny from a normative perspective. In the notable case of Yin from Shenyang, her disregard for quarantine measures resulted in widespread virus transmission. Following this, she encountered substantial public criticism, with some media framing the situation as “8.3 million people in Shenyang undergoing nucleic acid tests overnight due to one individual’s actions.” In this case, three primary transmission chains emerged: among family members, between neighbors, and through medical treatment.

Regarding the social transmission chain, Yin’s neighbor voluntarily visited Yin while she was required to isolate at home, resulting in an infection. Regarding the medical transmission chain, the two involved medical institutions “did not strictly enforce relevant regulations nor took effective epidemic prevention and control measures as required,” contributing to the epidemic’s spread [52]. This demonstrates that even if Yin held subjective faults, subsequent transmission risks and results could not be indiscriminately attributed to her, as both neighbors and hospitals share an obligation to control risks.

In criminal law theory, concepts such as “adequate causation theory” and “prohibition of retroactivity” [53] have been proposed to tackle the issue of infinite attribution along the causal chain. However, applying these existing theoretical tools to the current COVID-19 situation is challenging. In China’s criminal justice field, the attribution of COVID-19 transmission behavior involves two tricky issues. First, vertically, what is the scope of attribution in criminal law? China’s epidemic prevention and control policy includes many concepts, such as “related cases,” “close contacts,” “secondary close contacts,” “spatiotemporal companions,” etc., and it is difficult to define how much damage or risk the virus transmission behavior has caused. If a specific risk assessment is not performed, the criminal punishment scope will undoubtedly expand. Second, horizontally, does transmission within a close community (i.e.,

among family members) require criminal punishment? In practice, transmission among family members forms the basis for criminal prosecution in some cases. In the case of Xu mentioned above, the prosecutor charged the defendant with “causing his son who lived with him to be infected with the virus” as part of the criminal indictment. This practice is inappropriate because the family represents a community that faces risks together, and infection among family members is almost inevitable. The judge considers that the prosecutor’s accusation “does not conform to the objective reality and relevant regulations, and this part of the factual accusation cannot be established.”

When implementing risk control, risk distribution always leads to self-entitlement. In the context of an epidemic, attributions in criminal law cannot be determined merely based on who the perpetrator and victim are: “An essential criterion for criminal attribution is that the victim should be responsible for the non-occurrence of the result” [54]. During epidemic control, cluster outbreaks are common, in which both spreader issues and victim-based reasons coexist. Following local disease control agencies’ issuance and enforcement of orders to abstain from participating in clustered activities, individuals who knowingly engage in social activities posing an infection risk yet flout the epidemic prevention requirements embody a typical “self-risk” scenario. Determining the factors comprising the real incentive for risk realization in cluster outbreaks is a crucial standard for responsibility attribution.

In conclusion, whether it pertains to the uncertainties associated with secondary infection risk or the distribution of obligation between the perpetrator and victim to prevent the threat from materializing, COVID-19 transmission behavior provides ample room for discussing attribution.

6. Possible solutions to address the challenges of criminal law intervention

Criminal jurisprudence must inevitably respond to numerous issues when implementing national emergency social control measures. Admittedly, the challenge of legal decision-making under uncertainty encompasses a broad range of topics, the resolution of which constitutes a comprehensive system. Given the constraints of this discourse, it is only possible to present a macro-level discussion.

6.1. Temporary criminal legislation

Under emergent circumstances, criminal jurisprudence must first address the time constraints imposed by scientific uncertainty. While experts require time to understand novel problems, the dynamics of emergencies, such as infectious disease transmission, demand a responsive criminal law strategy. The law’s stability is significant for criminal legislation. According to the legislative law of China, matters concerning crime and punishment can only be stipulated by the laws passed by the National People’s Congress. This suggests that formulating and revising criminal laws must adhere to a stringent process. When the scientific understanding of a situation remains uncertain, flexible and temporary criminal legislation may be more effective than conventional legislation in highlighting the policy value of criminal law.

First, temporary criminal legislation is crucial for addressing unknown risks. Applying conventional criminal sanctions to evolving situations is unsuitable before professionals make accurate risk-probability assessments. However, this does not imply an inability to use criminal means. Legislative bodies can initially regulate order-violating behaviors via temporary legislation, thereby implementing preventive criminal policies. Significantly, as risks and perceptions of risks evolve and if the novel coronavirus gradually transitions toward an influenza-like state, the relevant provisions of the Opinions should be reconsidered. If effective solutions to the pandemic can be found, the penalizability of the related transmission behaviors will no longer be relevant.

Second, temporary criminal legislation is essential to criminal legislative systems. The application of criminal law during the pandemic has highlighted deficiencies in existing criminal legislation. For instance, a long-established but seldom used legal clause regarding the crime of obstructing the prevention and control of infectious diseases must be revised when confronting new challenges. Before the “Criminal Law Amendment (Eleven)” was issued, this crime was confined to Class A contagious diseases. However, the Health Administrative Departments classified the COVID-19 virus as a “class B infectious disease subject to prevention and control measures for class A infectious diseases.” This classification compelled further extension of criminal law provisions, a move that sparked significant theoretical controversy.

Nevertheless, the normative effect of opinions changed in parallel with the pandemic’s development. Numerous new COVID-19 transmission cases were initially investigated as crimes that endangered public safety by dangerous means. However, as the situation improved, the trend favoring severe punishment waned and most cases were not classified as crimes. Understanding the significance of temporary laws in improving emergency capabilities in criminal justice is essential.

An illustrative example is the “Special Regulations for the Prevention, Control, and Relief of Severe Special Infectious Pneumonia,” promulgated in Taiwan. These regulations address typical pandemic response problems through temporary legislation, including crime and punishment provisions. For example, one provision states, “Individuals who suffer from, or are suspected of suffering from, severe special infectious pneumonia and do not comply with instructions of health authorities at all levels, and thereby pose a risk of infecting others, shall be sentenced to a fixed-term imprisonment of not more than two years, detention, or a fine of not less than 200,000 and not more than 2 million New Taiwan dollars.” This regulation imposes strict temporal constraints (from January 15, 2020 to June 30, 2022; extension requires the legislative organ’s approval). The document explicitly states that the criminal law part “shall be implemented from the date of promulgation.”

In China, temporary legislation, especially criminal legislation, remains a relatively new phenomenon that needs to be expanded in theory and practice. Whether this is reasonable needs to be investigated from a legislative law perspective.

6.2. Individualized risk assessment

Pandemic prevention, control, and legal decisions (judicial rulings) require risk assessments. However, these two types of evaluations differ significantly: pandemic prevention and control are based on populations, whereas judicial rulings are based on individual cases. When making judgments based on general social experience is difficult, a mechanism is needed that can use reviews from other professional fields as references for criminal justice decisions. However, whether empirical science standards can be used directly as a basis for criminal justice rulings remains unresolved.

With scientific uncertainty, knowledge based on statistical data cannot effectively explain particular circumstances or accurately predict future issues. Legal professionals are required to distinguish between two types of causal relationships: aleatory causality (related to individual events) and statistical causality [55]. The former focuses on event processes and reasonably explains individual cases, whereas the latter is often used to predict event trends. Undoubtedly, causation in criminal law belongs to the former type, as the latter satisfies the purpose of predicting trends, often excluding or filtering out some non-typical factors in individual cases. However, certain elements of individual cases may be crucial for determining criminal responsibility. For example, risk assessments conducted by national health administrative departments and research institutes have targeted the overall pandemic situation, and data on transmission risks, fatality rates, and other issues in target nations have been collated. Therefore, it should be used with caution in individual cases, and local disease control agencies must provide clear conclusions in judicial body cases and face scrutiny at the judicial level.

Judicial adjudication is not an empirical science but should be based on scientific grounds. Judicial adjudication includes two kinds of rather extreme methods of discretion: one uses scientific measurement as a basis for adjudication [56]; for instance, turning the recognition of causality into a probability issue, thus replacing actuality with a highly abstract and vague possibility (or so-called contingency) to ascertain causation. The other method is the “free evaluation of evidence” based on the judge’s social experience, replacing natural laws with subjective conviction [36]. However, both of these extreme methods have drawbacks. A more reasonable approach is to combine empirical judgments in science with value judgments in jurisprudence to determine whether legal rules can be applied based on scientific measurements. Even in states of scientific uncertainty, the decision-making process should be based on clinical medicine and epidemiological judgment. However, since criminal judicial decisions are case specific, adopting conclusions from clinical medicine and epidemiology must be based on adjudicated cases, considering all variables related to the crime.

China’s criminal justice system focuses less on causation judgments in public health and must establish a public health risk assessment mechanism for individual cases. Empirical scientific methods can be used to assess infectious disease risk in specific objects and environments, providing a basis for judicial discretion and administrative decision-making. Case-based practical scientific judgments benefit judicial decisions in public health and have potential applications in environmental protection and food safety. Compared with judicial adjudication based solely on empirical rules, this approach is more flexible and adaptable to changing circumstances and uncertainties, can better balance public health and individual rights protection, and reflects the complexity and diversity of real-world situations and challenges.

6.3. Risk-based criminal law

According to the Chinese scholar Liu Yuan, security, rights, and order are fundamental values that transcend the relativity of specific social structures. Based on these values, he proposed classifying crimes as security, rights, or order crimes. Security crimes directly endanger social security, rights crimes violate citizens’ rights, and order crimes are defined by legislators as crimes to manipulate national policies and disrupt the order the policies intend to establish [57]. Among the COVID-19 transmission-related crimes, endangering public security by dangerous means is a security crime, intentional injury is a rights crime, and obstructing the prevention and control of infectious diseases has both security and order aspects. From a legislative perspective, obstructing infectious disease prevention and control is a security crime, which requires “causing the spread of specific infectious diseases or having a serious risk of spreading” as an element of its constitution. However, judges do not conduct detailed judicial reviews when identifying this criminal element, as mentioned earlier. Therefore, obstructing the prevention and control of infectious diseases, a security crime in legislation, has been transformed into an order crime by the judiciary and is widely applied. From the criminal policy perspective, this transformation was inevitable. The government should not punish people after the occurrence of disease transmission or severe risk of transmission. By contrast, they must maintain the order built by epidemic prevention and control. This is why the crime of obstructing the prevention and control of infectious diseases is prevalent.

In criminal law theory, legal protections, such as the enactment of preparatory actions and the institution of abstract endangerment offenses, offer a degree of resolution to the discussed issues. As emphasized by the renowned Chinese scholar Dongyan Lao, the judicial interpretation of abstract endangerment offenses does not necessitate investigating the particulars of each case, nor does it require determining specific consequential threats [58]. Based on ubiquitous societal experiences via typification techniques, abstract endangerment offenses are designed to preclude specific threats and infringements, thereby serving the legislative motive rather than forming a prerequisite for their constitution. This strategic approach effectively addresses the inherent uncertainty in managing epidemic responses as it circumvents the need for bespoke assessments of risk and consequential outcomes.

Despite the applicability of abstract endangerment offenses that do not necessitate the consideration of consequential risks, assessing typified risks during the legislative process is essential. Abstract endangerment offenses do not exclude consequential risks; instead, they transfer the risk assessment typically conducted during judicial rulings to the legislative stage. Thus, the legislator must meticulously determine whether a given act presents a typified risk of criminal punishment. Criminal law confronts the unknown during sudden public health incidents, and it is pertinent to question whether pre-established typified risks can effectively address

these unforeseen risks. For example, COVID-19 was not classified as a Class A infectious disease primarily because its “virulence” (toxicity) did not reach the standards established for such classification [59]. Furthermore, the idea that COVID-19 will eventually cause influenza supports the view that a single fixed typified risk in the penal code may not be a feasible solution for unknown future risks.

This study suggests that order offenses should be established based on the preceding discussion of provisional criminal legislation to reduce risky behaviors. The law should target behaviors that breach epidemic prevention and control rules and disrupt social order, thus fulfilling a preventive role. Such offenses would specifically address the contravention of social control measures under defined circumstances. For instance, Taiwan’s “Special Act for Prevention, Relief, and Revitalization Measures for Severe Pneumonia with Novel Pathogens” presents an excellent reference point. The act stipulates a provisional penalty for “those suspected of having a severe novel infectious pneumonia and disobeying health authorities’ orders, thus creating a risk of transmitting the disease to others,” while setting a relatively mild legal punishment. Unlike the crime of obstructing the prevention of infectious diseases, which necessitates the conditions of “causing the spread of Class A infectious diseases or posing a serious risk thereof,” this provision emphasizes only the “risk of infecting others.” Consequently, judges need not assess whether a group-level risk of causing the spread exists but only consider the risk of transmitting the disease to others on an individual case basis.

Additionally, the establishment of order crimes must adhere to the rule of law’s fundamental principles, including proportionality and clarity. To adapt to the evolving pandemic prevention and control situation, legislators must establish clear sunset clauses for order crimes to minimize their impact on citizens’ rights.

6.4. Implementing more prudent risk allocation rules

As posited by scholars, a “risk society is one where risk management is inevitable and pervasive” [60]. In contemporary society, risk production and realization are no longer simple or predictable. Both actors and recipients can predict and mitigate risks, necessitating greater emphasis on the role of risk allocation in attribution issues in criminal law. The overlap of risk-causing elements has led to an increasingly complex causal relationship, rendering empirical rules insufficient for confirmation [61]. Thus, the current criminal justice system must reevaluate risk allocation practices to manage epidemic prevention and control. Amid an epidemic outbreak, different parties—the transmitter, the infected individual, and third parties within society—bear distinct risks in generating, escalating, and actualizing danger.

During the onset of a public health emergency, the “risk community” is a society’s primary risk management unit. During a pandemic, a cohabitating family, or passengers trapped in vehicles, such as ships, constitute risk communities. The identification and scope of a risk community are related to the nation’s epidemic containment measures. Risk community members are accountable to other at-risk communities, and the infection of some individuals implies that the entire community is exposed to disease risk. Hence, the transmission behavior of external agents who intentionally infect risk community members puts everyone in the risk community at risk. Thus, external agents should be responsible for infection in the community. Second, if a risk community member intentionally exposes themselves to infection (self-risk, deliberately contacting confirmed patients outside the community), the causal link between external transmission behavior and internal infection will be broken because risk community members are responsible for other people within the community. Under these circumstances, external transmitters in the community are not liable for infections occurring within the community’s confines. Third, acts of transmission not based on intention typically do not constitute a crime within a risk community. On this point, China’s Supreme Court opines that “those causing spread and infection among family members in shared living environments should not, as a rule, be criminally processed” [62]. The rationale behind this opinion is that contagion among family members does not threaten public health.

From a dynamic standpoint, addressing the “priority of duties” among different entities of social interaction is crucial. The priority of duties refers to the hierarchy or precedence of responsibilities among different entities or individuals, particularly when multiple parties have obligations or liabilities. Determining which duty takes precedence is essential for assessing legal responsibility, particularly in complex scenarios involving various stakeholders. During a pandemic, some unique entities, such as hospitals or clinics, must bear specific duties and require preventive measures for disease transmission. As these entities possess more technology and resources, their preventive duties have priority over those of ordinary citizens. Therefore, if citizens and unique entities neglect to follow prevention and control regulations and contribute to viral transmission, entities with priority duties must be held accountable. For example, in Yin’s case mentioned above, during the reception process, the hospital staff failed to rigorously implement preventive measures, such as pre-check triage and individual disinfection, and admitted Yin without due procedures, exposing hundreds of people to the virus. Judicial bodies charged the hospital authorities with obstructing the prevention and control of infectious diseases. Although Yin violated the quarantine rules applied in such scenarios, the hospital assumed the risk of Yin seeking medical attention due to fever. Any subsequent or potential transmission within the hospital due to negligence during the patient reception process should be attributed to the hospital, not Yin. Overall, following the outbreak of an unforeseen public health event, legal authorities should not indefinitely attribute the outcomes of secondary infections to the initial spreader. Instead, they should adopt a more versatile attribution mechanism by scrutinizing whether intervening factors break the causal chain.

7. Conclusions and recommendations

7.1. Conclusions

This study has critically examined the complexities and challenges of applying criminal law during public health emergencies,

utilizing the COVID-19 pandemic response in China as a case study. Our analysis reveals that scientific uncertainty, legal decision-making intricacies, and the necessity for adaptable legal interventions are pivotal in effectively managing such crises. We found that a risk-based criminal law framework, coupled with the development of temporary criminal legislation, can significantly enhance the rationality and adaptability of legal responses to public health emergencies. Furthermore, the study underscores the importance of collaboration between legal and scientific communities to ensure that legal interventions are informed by the latest scientific evidence and understanding.

7.2. Recommendations

Based on the conclusions drawn from this study, the following recommendations are proposed:

- (1) For Policymakers: Develop and implement temporary criminal legislation that can be quickly adapted or revised in response to evolving scientific understanding and circumstances of public health emergencies. Such legislation should include clear sunset clauses and mechanisms for periodic review.
- (2) For Legal Practitioners: Embrace a more individualized approach to risk assessment in legal decision-making, which considers the specific circumstances and potential risks associated with behaviors during public health emergencies. This approach should integrate scientific expertise into the judicial process, ensuring decisions are informed by current and relevant scientific insights.
- (3) For Future Research: Further exploration is needed into the effectiveness of risk-based criminal law frameworks in managing public health emergencies. Future studies should also investigate the impacts of temporary criminal legislation on protecting public health while safeguarding individual rights and legal justice. Additionally, research into the mechanisms for enhancing collaboration between the legal and scientific communities could provide valuable insights into improving the legal response to public health crises.

By implementing these recommendations, it is anticipated that legal systems can become more responsive and effective in navigating the complexities of public health emergencies, ensuring both the protection of public health and the upholding of legal principles and individual rights.

8. Limitations

This study provides insights into China's criminal law application during COVID-19 but has limitations. The lack of specific sample size makes generalizing findings difficult, as it is based on qualitative document analysis and case studies without quantitative data. Future studies could improve by including empirical data to broaden conclusions. Additionally, the absence of empirical data from those directly affected by legal interventions during the pandemic limits understanding of their practical impact. Future research should also aim to collect firsthand experiences from the target population to understand the effects of legal measures better. Addressing these gaps, future work should integrate quantitative methods and direct engagement with affected individuals to enhance findings' representativeness and inform policy more effectively.

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