

Evolutionary Mechanisms and Prevention Strategies of Social Risks in Major Public Health Emergencies

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Abstract: Major public health emergencies are characterized by their hazardous nature, widespread impact, and interconnected effects. These events typically generate multi-faceted and cross-regional damages to socioeconomic systems and public welfare, potentially inducing multi-tiered systemic risks that may escalate into public crises. Building on the disaster lifecycle theory, this study employs a dual-risk analytical framework to distinguish between primary risks (direct consequences) and derivative risks (emerging from interactions between event-specific factors and external environments). Through systematic analysis of risk evolution patterns, we propose an integrated prevention system featuring: (1) a three-stage defense mechanism (identification-assessment-early warning) and (2) a comprehensive governance framework covering emergence, diffusion, outbreak, and recession phases. The research outcomes provide both theoretical insights and practical strategies for managing social risks in public health crises. Keywords: major public health emergencies; social risk; evolutionary mechanism; risk prevention and control.

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1. Introduction

The social risk of major public health emergencies constitutes a complex, multi-dimensional systemic risk. From the perspective of risk generation mechanisms in such emergencies, various social risk categories are inherently interconnected and mutually reinforcing. The region affected by a public health emergency does not constitute a completely closed system, with risk diffusion existing not only in physical domains but also manifesting in virtual domains [1]. From the virtual domain perspective, public health emergencies may trigger single or multiple derivative social risks. Although the initial derivative risk sources might appear relatively minor, their amplification through digital dissemination in cyberspace can escalate into major public concerns, stimulating the emergence of public opinion crises and the proliferation of panic. Furthermore, their interaction with risks in physical domains increases the likelihood of other physical domain risks materializing (e.g., social stability risks), thereby generating chain-reaction risk effects. Therefore, it is imperative to systematically identify the diverse risk categories and their developmental characteristics in major public health emergencies, comprehensively understand the evolutionary processes and mechanisms of social risks, enhance integrated risk prevention and control capabilities through effective coordination among all participating stakeholders, and proactively manage risks by timely interrupting risk escalation pathways.

2. Mechanisms of Social Risk Generation and Evolution of Major Public Health Emergencies

The emergence of social risks in public health emergencies inevitably stems from complex interactions between internal event factors and external environmental conditions. Specifically, from the event perspective, major public health emergencies under the "social amplification of risk"

framework tend to generate multiple social risks. These risks undergo evolutionary processes from inception to dissipation, manifesting distinct characteristics at different phases. Building upon existing lifecycle theory research, this study categorizes the social risk evolution of major public health emergencies into four sequential stages: germination, diffusion, outbreak, and recession.

2.1. Generation and Identification of Social Risks

The formation of social risks in public health emergencies is primarily influenced by the inherent attributes of the events themselves. Given that such events are deeply embedded within social systems, their development triggers comprehensive societal reactions involving public sentiment, political dynamics, and media engagement [2]. In terms of risk origins, they primarily consist of primary public risks and induced public risks.

2.1.1. Primary public risk

Primary public risks denote directly observable damages to stakeholders caused by public health emergencies, typically encompassing two dimensions: life-health risks and economic loss risks. Life-health risks refer to health threats posed by disease outbreaks, such as viral infections. Economic loss risks manifest as potential financial damages incurred by economic entities through direct/indirect channels, resulting from containment measures, macroeconomic uncertainty [3], or other factors, including property damage [4] and corporate reputation deterioration [5].

2.1.2. Induced public risks

Induced public risks primarily emerge from derivative social risks triggered by external stimuli during event progression, including public psychological panic and information dissemination dynamics. Specifically, these encompass:

(1) Social psychological risks: Individuals with pessimistic traits (e.g., anxiety, distrust, relative deprivation) demonstrate

heightened risk perception compared to optimistic populations, leading to psychological stress responses and prolonged mental tension [6]; (2) Social opinion risks: As macro-level public discourse topics, public health emergencies facilitate continuous information fermentation and cross-topic convergence, creating opinion clusters that may escalate into societal crises [7]; (3) Political trust risks: Defined narrowly, this refers to public skepticism toward governmental credibility, shaped by evaluations of policy transparency, crisis management capacity, and alignment with public expectations [8]; (4) Social stability risks: The potential for events to disrupt social order, impede development, and provoke conflicts through scaled collective stress behaviors.

2.2. Evolutionary Processes and Mechanisms of Social Risk

The evolutionary process of social risks in public health emergencies is fundamentally divided into four phases according to lifecycle theory: germination, diffusion, outbreak, and recession. Each phase exhibits distinct characteristics influenced by temporal nodes of event progression, inherent attributes of the event, and the scope/depth of risk impacts, as shown in Table 1. These evolutionary phases demonstrate continuity without clear transitional boundaries. During evolution, risk events interact with social, institutional, cultural, and psychological factors to amplify or attenuate public risk perception and associated risk behaviors [9].

Table 1. Social risk cycle and manifestations of major public health emergencies

life cycle	form of expression
budding period (i.e. when a plant is in the bud)	Initial negative impact on public life, health and property safety
diffusion period	Breeding of public fear, questioning of government measures and rumors, and the emergence of regional conflicts
explosion period	Maximum level and scope of risk impacts
waning period	The source of the incident was largely contained and the risk began to diminish and gradually recede

2.2.1. Risk emergence period

The social risk emergence period refers to the initial stage following a public health emergency, triggering the formation and incubation of primary risks such as health security threats and economic losses. Public health emergencies share commonalities with disaster events, analyzable through the disaster triad framework comprising hazard factors, vulnerable populations, and predisposing environments [10]. As the starting point of social risks, the interrelationship between hazard factors, predisposing environments, and vulnerable populations constitutes essential conditions for risk activation. Three commonalities exist across different risk sources:

First, risk probability correlates with environmental stability - the predisposing environment (political, economic, cultural, social domains) serves as the "incubator" where environmental chaos directly induces risks. Second, hazard intensity determines risk activation likelihood. Third, population vulnerability significantly influences risk manifestation. The risk triangle theory posits dynamic

interactions between hazard severity, population vulnerability, and emergency management resilience [11]. Risk inherently exists wherever pathogens (hazard factors) persist. Post-outbreak, initial disaster precursors emerge, posing moderate yet destabilizing threats to local public health systems and economic actors. Psychologist Paul Slovic's findings indicate heightened public risk perception towards novel, uncontrollable, and lethal phenomena [12], characteristics inherent to public health emergencies. This triggers instinctive vigilance and risk overestimation, fostering psychological anxiety and localized risk diffusion that may escalate into systemic social risks.

2.2.2. Risk diffusion period

The diffusion period marks the nonlinear intensification of primary risks into induced risks at social opinion and stability levels. Multifactorial in nature, public health emergencies involving life/property safety gain immediate attention upon exposure. Like combustion dynamics, risk events act as ignition sources that reach critical thresholds ("flashpoints") when damage scales accumulate [13]. During diffusion, escalating epidemic impacts and diminishing public resilience create fertile ground for risk proliferation. Psychological panic intertwines with grief over infected relatives, material shortages, economic pressures, and information distortions, fostering irrational compliance. Though panic originates individually, it permeates communities through psychological contagion, generating collective anxiety atmospheres that cyclically transmit "negative energy" to similarly situated groups. For instance, media reports document compulsive disinfection behaviors (e.g., half-hourly handwashing) and hypochondriacal reactions to normal physiological coughs under rumor influences. Compounding this, public reliance on online information channels coexists with pervasive distrust. In the current digital ecosystem, algorithmic recommendation systems exacerbate information cocoons, polarizing content consumption. Concurrently, rising numbers of "critical citizens" - skeptics challenging governmental actions - erode institutional trust through networked interactions. Such environments increase susceptibility to extremist rhetoric and impulsive behaviors that disrupt social order.

Furthermore, epidemic impacts demonstrate spatial inequalities. Geographical proximity to outbreak epicenters determines infection risks and mortality probabilities, creating concentric circles of severity from core disaster zones to peripheral areas. During risk diffusion, mobility restrictions and quarantines imposed on high-risk populations, while epidemiologically necessary, generate secondary psychological effects. Confinement-induced boredom and frustration, coupled with persistent disease stigmatization [14], provoke trauma responses and challenges to containment rationality. These dynamics transform social risk sources from direct event damages to systemic societal risks.

2.2.3. Periods of high risk

The risk escalation period denotes the phase where social impacts of public health emergencies reach maximum intensity and scope following germination and diffusion stages. During this phase, public attitudes and emotions accumulate to peak levels [15], while affected populations increasingly demand normalization of socioeconomic order. When disparities emerge between expected and actual relief outcomes, latent social risks accelerate into systemic crises: risks evolve from direct event-induced damages into systemic social risks through expanding stakeholder involvement and

collective mobilization. Conflict behaviors typically originate with "key opinion leaders" (KOLs) within affected groups. Their dissatisfaction and anger rapidly disseminate to broader populations through shared disaster experiences and psychological trauma. Unaddressed collective demands regarding health security and livelihood concerns precipitate extreme rhetoric and group actions. As cluster behaviors proliferate, social order becomes critically destabilized.

Manifestations during outbreak phase: Direct stakeholders mobilize and congregate, amplifying event visibility and influence. Fragmentary pandemic-related information circulates widely, attracting non-stakeholders and bystanders who exploit the situation for personal grievances. This catalyzes regional collective resistance. Escalating negative sentiment synergizes with heightened public emotions, triggering rapid amplification of social opinion risks. Public information demands (e.g., real-time updates, scientific guidelines, resource allocation details, disclosure channels) peak [16], intensifying scrutiny over governmental actions - particularly regarding information transparency, relief efficacy, and policy responsiveness. If governmental measures fail public expectations, especially under media pressure, perceived bureaucratic avoidance and misaligned public interests exacerbate societal tensions. Widespread panic and distrust, compounded by rumor propagation, escalate into systemic distrust of governance institutions, significantly eroding governmental credibility.

2.2.4. Risk mitigation period

Risk The mitigation period involves governmental and expert entities employing multidimensional strategies to attenuate risks [17], transitioning social impacts toward stabilization. Active interventions improve epidemic control outcomes, reduce perceived threats, and diminish public engagement. Opinion participation declines, risk-related discourse subsides, and social order transitions from chaos to normalization. Enhanced regulatory controls over social media platforms (e.g., Weibo, WeChat) reduce misinformation dissemination [18]. As material crises resolve, public attention wanes, institutional trust gradually rebuilds, and socioeconomic activities resume. Concurrent psychological interventions alleviate public anxiety, effectively resolving psychosocial risks. However, risk recursivity and uncertainty persist. Social opinion and stability risks associated with public health emergencies may enter "pseudo-quiescence" [19]. Rediscovery of event triggers during mitigation could reactivate latent risks through new informational exposures, reigniting public crises, undermining trust reconstruction, and initiating renewed risk cycles. Sustained post-crisis monitoring remains imperative.

3. Construction of Social Risk Prevention and Control Mechanism for Major Public Health Emergencies

Social risks associated with public health emergencies exhibit characteristics of abruptness, pervasiveness, and trans-regionality. Effective risk management necessitates establishing a comprehensive prevention-control network that integrates risk mitigation and governance systems.

3.1. Establishing an "Identification-Analysis-Early Warning" Risk Prevention Mechanism

The critical path for preventing and resolving social risks lies in timely detection, systematic analysis, and proactive forecasting. This requires optimizing the tripartite mechanism encompassing risk identification, analytical assessment, and early warning systems.

Risk identification constitutes the foundational phase. Specifically: (1) Strengthen information infrastructure development for social risk prevention, expanding data collection channels through advanced technologies to actively aggregate multi-source emergency-related information, ensuring robust data support. (2) Leverage historical case studies of public health emergencies, integrate real-time monitoring data, analytical outcomes, and expert consensus to identify potential risk vectors and multidimensional influencing factors, enabling early-stage risk detection and response prioritization. Risk analysis requires meticulous execution across three operational phases [20]: Preparatory Phase: Mobilize specialized agencies and functional departments to clarify task allocation and interdepartmental coordination. Monitoring Phase: Employ technical means to accurately determine risk-affected populations, spatial scope, and hazard magnitudes, maintaining real-time data tracking and dynamic surveillance. Assessment Phase: Conduct multidimensional risk evaluation by synthesizing current incident data with historical precedents, stratifying risk levels to inform governmental early-warning decisions. As probabilistic indicators of future losses, timely risk warnings significantly influence developmental trajectories. China's Regulations on Public Health Emergency Response mandates county-level governments to establish comprehensive surveillance and early-warning systems. Accordingly, health administrations should: (1) Define risk thresholds and quantitatively delineate warning zones based on epidemic phase-specific data patterns. (2) Refine warning protocols to enable tiered alert issuance and preemptive contingency preparations.

3.2. Establishing a Comprehensive Full-cycle Risk Governance Mechanism for "Emergence-Diffusion-Outbreak-Recession"

The evolutionary trajectory of social risks in public health emergencies typically progresses through four sequential phases: emergence, diffusion, outbreak, and recession. Effective governance necessitates adaptive strategies aligned with the unique characteristics and developmental patterns of each phase.

3.2.1. Source Governance in the Risk Emergence Phase

Proactive intervention at the risk origination stage represents the most critical strategy for containing social risk proliferation. Given the cumulative nature of risk evolution, unaddressed aggregation during the emergence phase may escalate into systemic crises. Timely governance during this golden window requires dual approaches. First, substantial investments in pathogen diagnostics and therapeutic development are imperative, as advancements in detection reagents, vaccines, and antiviral treatments form the scientific foundation for epidemic containment. Second, the integration of intelligent technologies—encompassing big data analytics,

artificial intelligence, and cloud computing—enables real-time epidemiological surveillance systems. Such infrastructure supports dynamic data monitoring, precision contact tracing, and optimized resource allocation, thereby facilitating evidence-based decision-making during early outbreak phases [21].

3.2.2. Risk Containment Strategies During Diffusion Phase

The diffusion phase demands coordinated efforts to mitigate both primary and induced risks through multi-stakeholder engagement. Central to this phase is the establishment of transparent information disclosure mechanisms that ensure timely, granular, and accessible public communication, thereby reducing information asymmetry and alleviating societal anxiety. Concurrent implementation of multi-dimensional public opinion monitoring systems allows for early detection of online mobilization patterns and offline collective action precursors. Complementing these measures, nationwide health literacy campaigns should be deployed through partnerships with medical institutions, focusing on psychological resilience building and rational risk perception cultivation. These integrated strategies collectively enhance public compliance with containment policies while counteracting misinformation dissemination.

3.2.3. Outbreak Phase Containment Protocols

When risks materialize into full-scale societal impacts, governance priorities shift toward rapid impact mitigation. This necessitates the creation of cross-departmental coordination frameworks that integrate public health, emergency management, and social service agencies under unified command structures. Strategic collaboration with influential opinion leaders, particularly those shaping digital discourse, becomes crucial for moderating risk amplification narratives. Parallel to these institutional efforts, differentiated psychological intervention programs must target specific vulnerable subgroups—healthcare workers, confirmed patients, marginalized populations, and the general public—through customized counseling protocols addressing occupation-specific burnout, stigma management, and anxiety reduction.

3.2.4. Post-Recession Rehabilitation Strategies

The recession phase focuses on building systemic resilience against risk resurgence while addressing lingering societal impacts. Socioeconomic rehabilitation requires multidimensional initiatives spanning employment protection schemes, supply chain stabilization measures, and scaled mental health service provision. Institutional learning mechanisms, including after-action reviews and best practice documentation, should be implemented to optimize governance frameworks. Longitudinal monitoring systems must track public sentiment evolution and economic recovery trajectories, while resilience engineering principles inform the development of scenario-based preparedness protocols. Concurrent integration of psychological services into local governance metrics ensures sustained attention to population mental well-being, thereby completing the cyclical governance continuum from crisis response to sustainable recovery.

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