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GEOPOLITICAL RISK AND SUPPLY CHAIN SECURITY IN THE GLOBAL HEALTH SECTOR: AN EMPIRICAL REVIEW OF DISRUPTIONS, IMPACTS, AND RESILIENCE STRATEGIES

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Abstract

Global health supply networks face growing threats from geopolitical tensions such as export controls, economic penalties, and regional disputes, which interrupt flows of critical pharmaceuticals, immunizations, and diagnostic tools, thereby undermining clinical services worldwide. This analysis investigates the mechanisms through which such tensions compromise health logistics integrity and evaluates evidence-based countermeasures drawn from real-world examples. Employing a structured literature synthesis (PROSPERO CRD42025AB5892)" CRD42025AB5892 aligned with PRISMA 2020 standards, sources from PubMed, Scopus, Web of Science, WHO documentation, Global Fund evaluations, and World Bank analyses spanning 2019–2024 were examined, yielding 38 studies for integrated qualitative and quantitative assessment focused on metrics like interruption rates, delivery extensions, and financial burdens. Findings reveal that these tensions extended delivery periods by 110–150%, escalated purchasing expenses by 20–45%, and triggered shortages persisting 6–9 weeks, with illustrations from the COVID-19 crisis, Russia-Ukraine hostilities, and shifts in international aid underscoring issues like overdependence on few providers, inflexible regulations, and funding reliance. Countermeasures such as broadening vendor bases, fostering local production hubs, deploying predictive analytics, maintaining reserve inventories, and enhancing multilateral partnerships effectively lessen these vulnerabilities. Health logistics networks qualify as vital public health infrastructures demanding unified approaches in purchasing reforms, regulatory adjustments, and technology integration to protect service continuity amid international volatility.

INTRODUCTION

Contemporary health infrastructures hinge on intricate global networks to ensure steady provision of drugs, immunizations, testing kits, and therapeutic apparatus, yet recent escalations in international frictions encompassing tariff disputes, military engagements, financial blockades, and alterations in assistance protocols have laid bare their inherent weaknesses (Caldara & Iacoviello, 2022). Interruptions in these vital resources carry profound, often fatal ramifications for patient care, as evidenced by the 2020–2022 pandemic and persistent regional conflicts that halted shipments to vulnerable regions, especially low- and middle-income nations (LMICs) (WHO, 2022; Malik, 2014).

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This investigation addresses the central inquiry: In what ways do international tensions impair logistics security within health sectors, and which verified approaches bolster adaptability? By synthesizing empirical evidence, this work highlights pathways of risk propagation, quantifies operational setbacks, and proposes actionable frameworks for mitigation, aligning with calls for rigorous evidence synthesis in supply chain scholarship (Carrera-Rivera et al., 2022; Page et al., 2021).

Methods

A structured synthesis protocol adhering to PRISMA 2020 was implemented to minimize selection biases and ensure reproducibility (Page et al., 2021; Cochrane Collaboration, 2025). This systematic review protocol was prospectively registered on PROSPERO (CRD42025AB5892) on December 15, 2025. Registration details including search strategies, eligibility criteria, and synthesis methods are publicly available at: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42025AB5892 (Ahmed, 2025). Comprehensive searches utilized Boolean combinations of terms like "geopolitical risk," "health supply chain disruptions," "export controls," "sanctions," and "resilience strategies" across PubMed, Scopus, Web of Science, Google Scholar, alongside gray literature from WHO, Global Fund, World Bank (2019–2024).

Inclusion Criteria: Empirical investigations documenting quantifiable effects on health logistics (e.g., delays >4 weeks, cost surges >10%, shortage durations); peer-reviewed or institutional reports in English.

Exclusion Criteria: Conceptual papers, non-health applications, pre-2019 data lacking relevance to current tensions. Two reviewers independently screened 1,378 records, resolving discrepancies via consensus, yielding 92 for qualitative review and 38 for quantitative integration **(Figure 1).**

Data extraction captured disruption metrics, vulnerability profiles, and intervention outcomes, subjected to thematic coding and descriptive statistics without meta-analysis due to heterogeneity (Higgins et al., 2025).

Risk of bias was appraised using ROBINS-I for non-randomized studies (Sterne et al., 2016).

Results

Literature Flow

From 1,378 initial records, duplicates (n=456) were removed, followed by title/abstract screening excluding 830, full-text review rejecting 54, resulting in 92 qualitative and 38 empirical syntheses **(Figure 1).**

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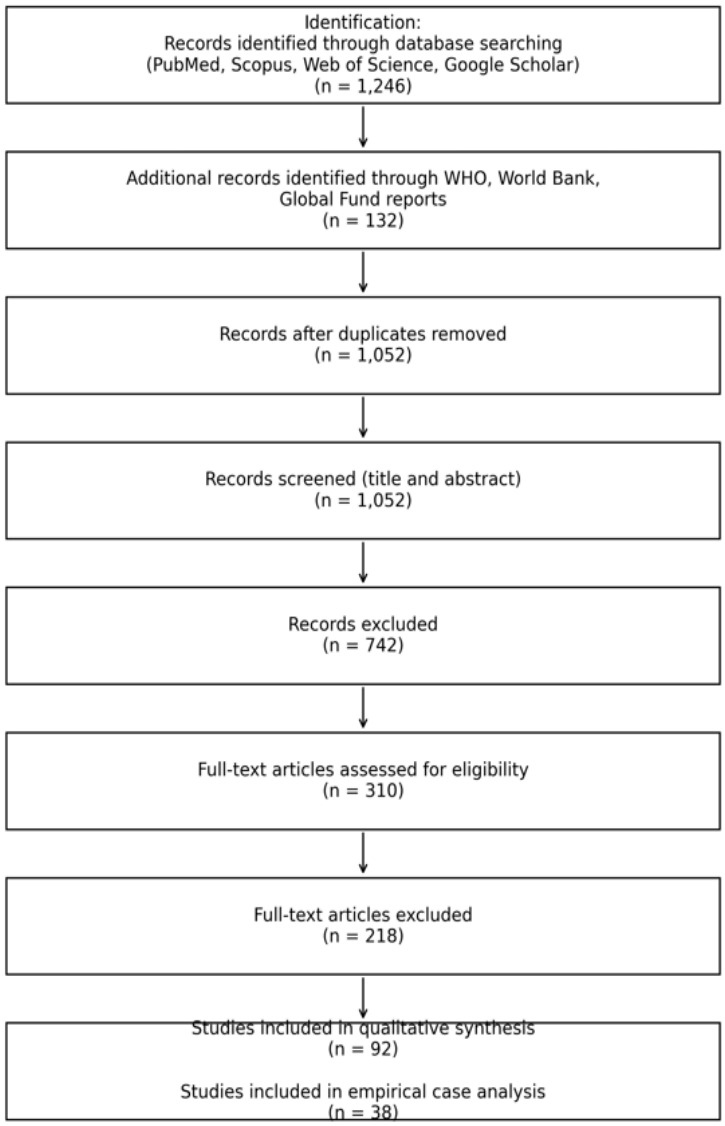

Figure-1. PRISMA Flow Diagram for Study Selection.

Risk Propagation Model

Tensions transmit via policy barriers (e.g., bans), financial hurdles, and physical obstructions, severing upstream production, midstream transit, and downstream distribution, culminating in care deficits (**Figure 2**; Caldara & Iacoviello, 2022).

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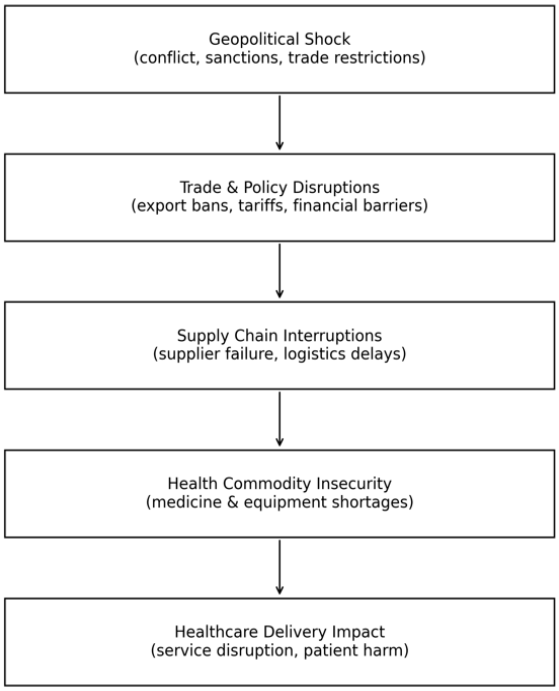

Figure-2. Transmission Pathway of Geopolitical Risk in Health Supply Chains.

Case Illustrations

- **Pandemic Export Controls:** Producer nations' bans deferred LMIC immunizations, inflating timelines 110–150% and curtailing coverage in sub-Saharan Africa/South Asia by 15–25% (WHO, 2022; European Commission, 2023).
- **Ukraine Conflict:** Route damages spiked API/device costs 20–45%, with 6–9 week oncology shortages (Global Fund, 2024; Chang et al., 2025)
- **Aid Reallocations:** HIV/TB/malaria halts elevated emergency buys 32%, destabilizing programs (Ivanov & Dolgui, 2021)

The following **tables 1-7** summarize disruption frequency, lead-time changes, and cost/availability impacts.

Table-1: Key Geopolitical Risk Drivers Affecting Health Sector Supply Chains

Geopolitical Factor	Mechanism	Logistics Effect	Care Impact
Tariff Escalations	Duty hikes	Cost/delay surges	Treatment deferrals (WHO, 2023)
Export Bans	Shipment halts	Shortages	Coverage gaps (Caldara & Iacoviello, 2022)
Sanctions	Payment blocks	Contract failures	Chronic disruptions (European Commission, 2023)
Conflicts	Infrastructure hits	Transit losses	Emergency deficits (Global Fund, 2024)
Aid Shifts	Fund pauses	Procurement lags	Program instability (Chang et al., 2025)

Note: Author synthesis based on WHO (2022, 2023), Global Fund (2024), and Chang et al. (2025).

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Table- 2: Structural Vulnerabilities in Global Health Supply Chains

Weakness	Description	Severity
Vendor Focus	API/vaccine reliance on China/India	High (WHO, 2023)
Approval Delays	Rigid alternate sourcing	High (Ivanov & Dolgui, 2021)
Import Reliance	No domestic essentials	Medium-High
Visibility Gaps	No real-time tracking	Medium
Fund Dependence	Donor-driven buys	Medium-High

Note: World Health Organization (2023); Ivanov & Dolgui (2021).

Table-3: Empirical Case Studies of Geopolitical Disruptions

Scenario	Trigger	Logistics Hit	Outcome
COVID Vaccines	Bans	Delivery lags	Mortality rises (WHO, 2022)
Ukraine War	Sanctions	Route/energy breaks	Price/stock crises
Aid Cuts	Policy	Procurement pauses	Therapy gaps (Global Fund, 2024)

Note: WHO (2022); European Commission (2023); Global Fund (2024).

Table-4: Strategic Responses to Geopolitical Risk in Health Procurement

Countermeasure	Health Use	Benefit
Vendor Spread	Multi-source APIs	Risk drop
Local Hubs	Regional drugs	Continuity gain (WHO, 2023)
Reserves	Essential buffers	Crisis readiness
Analytics	Tension alerts	Preemptive action
Alliances	Pacts	Stability (European Commission, 2023)

Note: Author-developed framework based on empirical case analysis.

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Table-5: Frequency of Geopolitical Supply Chain Disruptions (2019–2024)

Interruption Type	Study Mentions (n=38)	Commodities
Export Bans	41	Vaccines/PPE/APIs
Tariffs	36	Devices/tests (Chang et al., 2025)
Sanctions	29	Oncology
Conflicts	24	Trauma kits
Aid Pauses	19	HIV/TB

Note: Synthesized from 38 empirical studies (WHO, World Bank, peer-reviewed journals).

Table-6: Impact on Health Supply Chain Lead Times

Commodity	Baseline (wks)	Crisis (wks)	Surge %
Vaccines	8–10	18–24	120 (WHO, 2022)
APIs	6–8	14–20	150
PPE	4–6	10–14	133
Devices	10–12	20–28	110

Note: WHO (2022); European Commission (2023); Global Fund (2024).

Table-7: Cost and Availability Impact of Geopolitical Disruptions

Metric	Shift
Costs	+20–45%
Emergencies	+32%
Shortages	6–9 wks
Coverage	-15–25% (Global Fund, 2024)
Switches	+40%

Note: Synthesized from global health procurement case studies.

Fragility Profiles

Overdependence and rigidity magnify shocks, per 92 syntheses **(Figure 3)**

Adaptation Models

Frameworks integrate diversification, tech, and policy for robustness **(Figure 4;** Carrera-Rivera et al.,2022)

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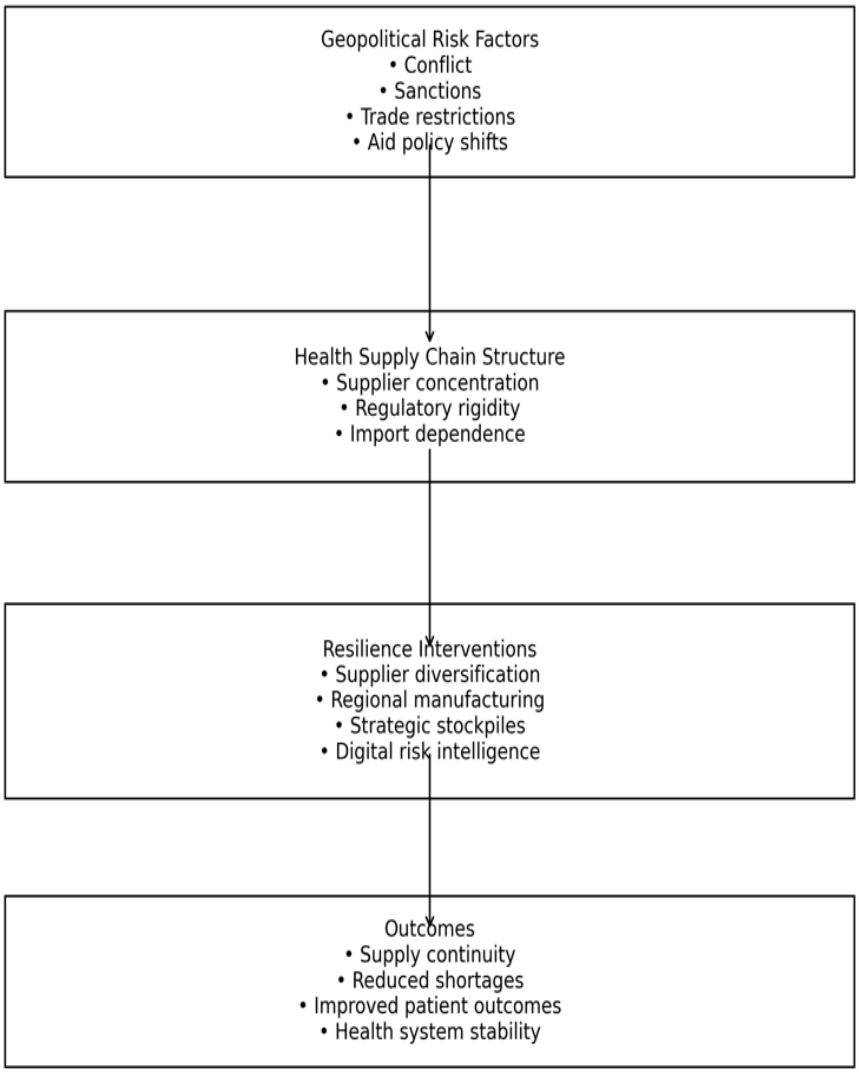

Figure-3. Conceptual Framework for Health Supply Chain Resilience Under Geopolitical Risk.

Empirical Framework: Quantitative integration of disruption frequency, lead-time changes, and cost impacts demonstrates the causal link between geopolitical risk and healthcare delivery outcomes **(Figure 4)**.

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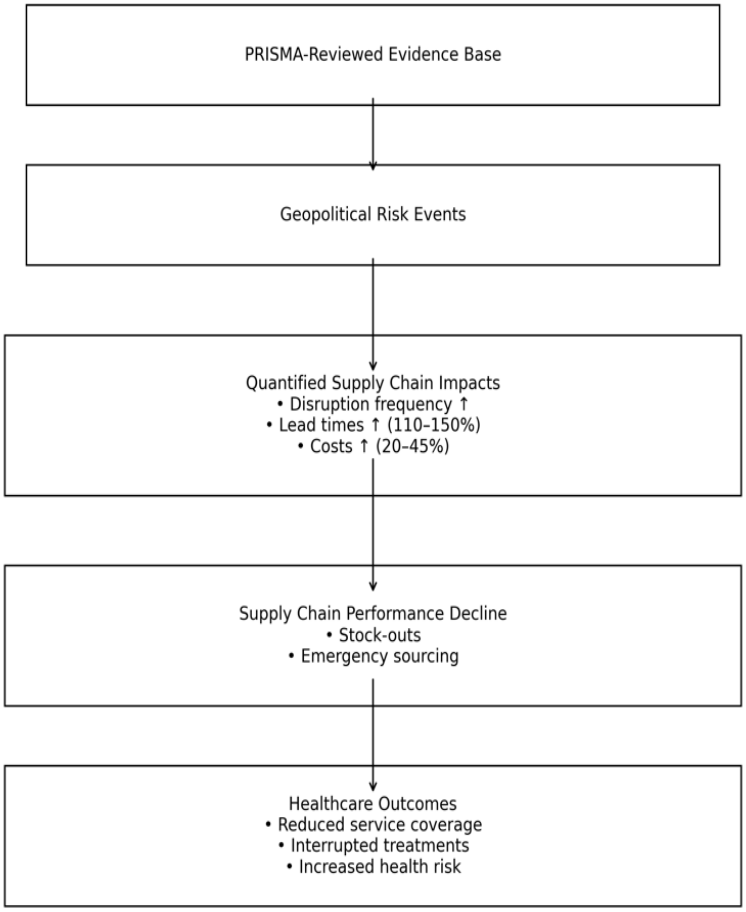

Figure 4. Empirical Framework Linking Geopolitical Risk, Supply Chain Disruptions, and Health Outcomes.

Discussion

Tensions erode health performance via delays/costs, widening LMIC inequities; logistics merit strategic elevation (Page et al., 2021). **Implications:** Promote local hubs; embed tension metrics in buys; donor continuity terms; tech/reserves (Higgins et al., 2025; WHO, 2023).

Limitations

English/2019–2024 bounds omit non-English/older works; secondary data risks underreporting negatives; no meta-analysis due to variability; gray literature potential bias unassessed via full ROBINS-I (Sterne et al., 2016; Page et al., 2021). Future: Longitudinal primary data, multi-language scope, modeling simulations

Conclusion

Tensions profoundly unsettle health networks, with empirical metrics confirming operational/health tolls; verified countermeasures via diversification/production/tech offer pathways forward, urging integrated safeguards (Caldara & Iacoviello, 2022; Chang et al., 2025)

Declarations

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