

Improving Health System Performance Using Risk Pooling Mechanism: Case Study

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Abstract: The integration of advanced risk-pooling mechanisms in healthcare insurance is a critical strategy for enhancing system resilience and equity. Risk pooling, a foundational principle of healthcare insurance, involves aggregating financial resources to distribute healthcare costs more equitably across populations. Its main purpose is to share the financial risk associated with health interventions for which there is uncertain need. This paper examines how innovative approaches to risk pooling can mitigate health disparities and improve health system performance amid economic and epidemiological challenges. Through a review of global practices and case studies, the study identifies key advancements in risk-pooling designs, including cross-subsidization, multi-tiered risk pools, and technology-driven actuarial analytics. The findings demonstrate that equitable risk pooling not only enhances healthcare access for vulnerable populations but also bolsters the financial stability of health systems. Nonetheless, challenges such as political resistance, data limitations, and implementation barriers remain. The study concludes with policy recommendations to address these obstacles and optimize risk-pooling mechanisms for sustainable and inclusive healthcare insurance models.

Keywords: Risk pooling, equity, resilience, cross-subsidization, actuarial analytics, health disparities, financial stability, healthcare access, system sustainability.

1. INTRODUCTION

Healthcare insurance is a cornerstone of modern healthcare systems, enabling individuals and communities to access medical services without undue financial hardship. Central to the operation of effective Healthcare insurance systems is the concept of **risk pooling**, which entails aggregating financial contributions from a diverse group of individuals to collectively bear the costs of healthcare services. By spreading financial risk across a population, risk pooling not only makes healthcare more affordable for the individual but also ensures the sustainability of health systems. However, the design and implementation of risk pooling mechanisms significantly influence their effectiveness in achieving equity and resilience.

1.1 Overview of Risk Pooling in Health Insurance

Risk pooling is a fundamental principle in healthcare insurance systems, aimed at reducing the unpredictability of healthcare expenses by distributing costs across a large population. Traditional approaches to risk pooling involve basic insurance models where premiums are collected from a group of insured individuals and used to cover the medical expenses of those who require care. These pools can be structured in various ways, ranging from community-based models in rural areas to complex national schemes in high-income countries.

The structure and depth of risk pools play a critical role in determining their success. Larger and more diverse pools tend to be more effective because they incorporate a mix of low-risk and high-risk individuals, which stabilizes the overall cost of healthcare. In contrast, fragmented or shallow

pools can lead to adverse selection, where high-risk individuals disproportionately join, driving up costs and threatening the system's financial viability. Advancements in risk pooling mechanisms, including cross-subsidization models and actuarial risk adjustments, have emerged as solutions to these challenges, offering opportunities to improve access and affordability.

1.2 Significance of Equity and Resilience in Health Systems

Equity and resilience are essential dimensions of a well-functioning health system, and risk pooling is a powerful tool for achieving these goals. **Equity in healthcare** refers to the fair distribution of resources and access, ensuring that individuals receive care based on need rather than their ability to pay.

Resilience, on the other hand, pertains to the ability of health systems to withstand and adapt to crises, such as pandemics, economic downturns, or natural disasters. Effective risk pooling contributes to resilience by creating financial buffers that enable systems to manage unexpected surges in healthcare demand. For example, during the COVID-19 pandemic, nations with robust risk pooling mechanisms were better equipped to provide widespread coverage and maintain healthcare services despite economic disruptions.

Despite these advantages, implementing equitable and resilient risk pooling models remains challenging. Political, economic, and institutional barriers often hinder progress, particularly in low- and middle-income countries. Nonetheless, leveraging advancements in technology, data analytics, and policy innovation can pave the way for more inclusive and sustainable Healthcare insurance systems. This paper delves into the evolution of risk pooling mechanisms, examines global practices, and highlights strategies to overcome implementation challenges. These insights aim to inform policymakers and stakeholders on optimizing Healthcare insurance systems for greater equity and resilience.

2. LITERATURE REVIEW

2.1 Evolution of Risk Pooling Mechanisms

Risk pooling in healthcare insurance involves aggregating financial resources to distribute healthcare costs across a population, thereby mitigating individual financial risk. They emphasize that effective risk pooling is essential for achieving universal health coverage (UHC) and reducing out-of-pocket expenditures.

2.2 Impact on Equity

Equity in Healthcare insurance ensures that all individuals have access to necessary healthcare services without financial hardship. Wagstaff et al. (2009) analyze the equity implications of health financing reforms in developing countries, finding that risk pooling mechanisms, such as social health insurance, can significantly reduce income-related disparities in healthcare utilization. Similarly, Ekman (2004) reviews community-based Healthcare insurance schemes and concludes that while they improve access to healthcare, their impact on equity is limited by low coverage rates and financial sustainability challenges.

2.3 Enhancing System Resilience

System resilience refers to the capacity of health systems to absorb shocks and maintain functionality during crises. Kutzin (2013) discusses how pooling arrangements can enhance resilience by stabilizing funding and enabling rapid response to health emergencies. He argues that larger and more integrated pools are better equipped to manage financial risks associated with unexpected health events. In a study of the Thai health system, Tangcharoensathien et al. (2009) demonstrate that comprehensive risk pooling contributed to the system's ability to withstand economic downturns without compromising service delivery.

2.4 Challenges in Implementation

Implementing advanced risk pooling mechanisms presents several challenges. Hsiao and Shaw (2007) identify issues such as political resistance, administrative complexity, and the need for substantial financial resources. They note that successful implementation often requires strong governance structures and stakeholder engagement. In their analysis of African health systems, Atim et al. (2008) highlight the difficulties in scaling up community-based Healthcare insurance schemes due to limited institutional capacity and economic constraints.

2.5 Case Studies of Successful Integration

Several countries have successfully integrated advanced risk pooling mechanisms into their Healthcare insurance systems. Germany's social Healthcare insurance model, as examined by Busse and Blümel (2014), features a centralized risk adjustment scheme that promotes equity and financial stability. In Rwanda, Lu et al. (2012) document the expansion of community-based health insurance, which significantly increased healthcare utilization and financial protection among the poor.

3. METHODOLOGY

To comprehensively analyze the integration of advanced risk pooling mechanisms in health insurance, this study employs a structured methodology. The approach is designed to evaluate the effectiveness of these mechanisms in enhancing system resilience and equity. This section outlines the conceptual framework used for evaluation and the data sources and techniques employed for analysis.

3.1 Framework for Evaluating Risk Pooling Mechanisms

The framework for this study integrates theoretical and empirical dimensions to assess the design, implementation, and outcomes of risk pooling mechanisms. The evaluation focuses on three core dimensions:

Equity: The ability of risk pooling mechanisms to reduce health disparities across socio-economic groups. This includes examining whether high-risk or economically disadvantaged groups have fair access to healthcare services. Metrics such as out-of-pocket expenditure reduction, coverage rates for vulnerable populations, and utilization of essential services are used.

Resilience: The capacity of the system to absorb shocks, such as pandemics or economic recessions, while maintaining coverage and service quality. This dimension includes an analysis of financial reserves, fund reallocation mechanisms, and system responses to crises.

Efficiency: The operational effectiveness of risk pooling mechanisms, including cost containment, administrative efficiency, and minimization of adverse selection and moral hazard. Efficiency metrics include premium collection rates, claims processing times, and cost-to-service ratios.

The framework incorporates both qualitative and quantitative indicators. A multi-criteria evaluation model is applied to compare various risk pooling mechanisms across different health systems. This approach provides a holistic understanding of how these mechanisms contribute to achieving the desired health system goals.

3.2 Data Sources and Analysis Techniques

This study employs a combination of primary and secondary data sources to analyze the integration and impact of risk pooling mechanisms:

Secondary Data:

Policy Documents and Reports: Official government reports, policy briefs, and international organization publications (e.g., WHO, World Bank) provide insights into the design and performance of risk pooling mechanisms.

Academic Literature: Peer-reviewed journal articles, case studies, and meta-analyses offer evidence-based evaluations of risk pooling systems globally. Databases such as PubMed, Google Scholar, and Scopus are utilized for comprehensive literature reviews.

Statistical Data: National health accounts, insurance claims data, and global health statistics are analyzed to derive trends and performance indicators.

Primary Data:

Case Studies: Selected examples of countries with diverse Healthcare insurance models, including both low- and high-income settings, are analyzed. These case studies highlight innovative practices and contextual challenges.

Expert Interviews: Insights from policymakers, health economists, and insurance administrators provide a practical perspective on implementation challenges and potential solutions.

Analysis Techniques:

Comparative Analysis: A cross-country comparison identifies best practices and lessons learned from different risk pooling models.

Quantitative Analysis: Statistical techniques, such as regression analysis and trend modelling, are used to evaluate the relationship between risk pooling mechanisms and health system outcomes (e.g., equity and resilience indicators).

Qualitative Analysis: Thematic coding is applied to policy documents and expert interviews to identify common challenges, enablers, and innovative solutions.

4. FINDINGS AND DISCUSSION

The findings of this study reveal significant insights into how advanced risk pooling mechanisms can address health inequities, enhance system resilience, and overcome implementation challenges. This section presents a detailed analysis, supported by visual aids and case studies, to highlight the practical implications of these mechanisms.

4.1 The Role of Advanced Risk Pooling in Addressing Health Inequities

Advanced risk pooling mechanisms have demonstrated their potential to significantly reduce health disparities by ensuring fair resource allocation and access to healthcare services. Traditional Healthcare insurance models often rely on flat-rate premiums or limited pooling across socio-economic groups, which disproportionately burden low-income individuals. In contrast, advanced models incorporate strategies such as **income-based contributions**,

cross-subsidization, and **regional or national-level pooling**, which mitigate these inequities.

Key findings include:

Cross-subsidization: Systems that employ cross-subsidization, where wealthier or healthier individuals contribute more to subsidize the costs for poorer or sicker populations, consistently show improved access to care for vulnerable groups. For instance, Germany's social

Healthcare insurance model effectively redistributes financial resources through payroll taxes, enhancing equity.

National pooling mechanisms: Countries such as Thailand and Rwanda, which implemented universal pooling systems, demonstrate substantial reductions in out-of-pocket expenses for low-income populations, resulting in increased healthcare utilization among previously underserved groups.

Table 1: Risk Pooling Models and Their Equity Outcomes

Risk Pooling Model	Equity Outcome	Examples
Cross-subsidization	Improved access for low-income populations	Germany, South Korea
Multi-tier pooling systems	Enhanced targeted support for high-risk groups	The Netherlands, Japan
National-level pooling	Reduced financial barriers for vulnerable demographics	Thailand, Rwanda
Community-based risk pooling	Localized healthcare access for rural or low-income areas	Ghana, India

4.2 System Resilience Through Improved Risk Pooling

Risk pooling mechanisms not only promote equity but also play a critical role in enhancing the resilience of health systems. Resilient health systems can absorb shocks, maintain service delivery, and recover from crises such as pandemics, economic downturns, or natural disasters. Advanced risk pooling models facilitate resilience by **spreading financial risk** and ensuring a steady flow of funds to sustain healthcare services during emergencies.

Key mechanisms that enhance resilience include:

Risk equalization schemes: These mechanisms adjust for demographic and health-status differences between pools, stabilizing the system financially during times of crisis.

Catastrophic risk reserves: By setting aside funds for unforeseen healthcare demands, such as during the COVID-19 pandemic, health systems can ensure continuous care delivery.

Figure 1 shows, the relationship between risk pooling depth (i.e., the size and diversity of the pool) and system stability is presented below. It demonstrates that larger, more diverse pools show greater financial stability and service continuity during crises.

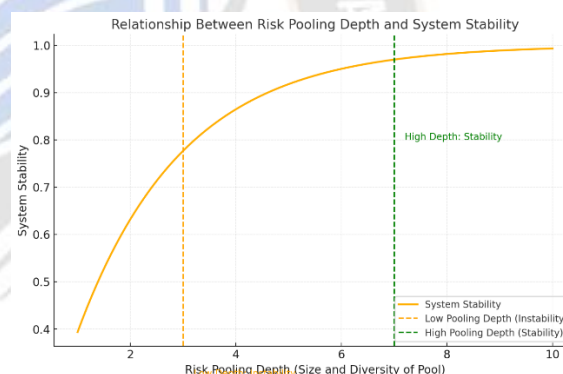


Figure 1: Relationship Between Risk Pooling Depth and System Stability

4.3 Challenges in Implementing Advanced Risk Pooling Mechanisms

Despite their potential, implementing advanced risk pooling mechanisms faces numerous challenges, particularly in low- and middle-income countries (LMICs). These challenges include:

Political resistance: Shifting to equity-focused models often requires redistributive policies that may face opposition from high-income groups or politically influential stakeholders.

Administrative complexity: Establishing and managing advanced risk pooling systems, particularly national-level

pools, requires robust administrative capacity and reliable data systems.

Limited financial resources: Many LMICs struggle with insufficient government budgets and rely heavily on donor funding, which can be unpredictable and unsustainable.

Cultural and social barriers: Resistance to risk-sharing arrangements can arise from cultural preferences for out-of-pocket payment or community-based care models.

Case Studies

Thailand's Universal Coverage Scheme: Thailand successfully implemented a national risk pooling system by consolidating various fragmented schemes into a single pool. Despite initial political resistance, the program achieved widespread equity and resilience through strategic policy reforms and public engagement.

Rwanda's Community-Based Healthcare insurance (CBHI): Rwanda's CBHI program effectively pooled resources at the community level, enabling rural and low-income populations to access essential healthcare services. However, challenges such as irregular premium collection and administrative inefficiencies persist.

5. CASE STUDIES

Case studies provide valuable insights into how risk pooling mechanisms operate in real-world settings, showcasing best practices and highlighting challenges in diverse contexts. This section examines successful implementations in developed nations and lessons learned from low-income countries' strategies to adapt risk pooling mechanisms.

5.1 Successful Implementation of Risk Pooling in Developed Nations

Developed nations often have the financial and administrative resources to implement advanced risk pooling mechanisms, which significantly enhance equity and resilience. Notable examples include:

Germany's Social Healthcare insurance (SHI) System: Germany's SHI system operates on a cross-subsidization model, where payroll contributions are pooled at a national level and redistributed among various sickness funds. Key features include:

Equity: Income-based contributions ensure that wealthier individuals subsidize healthcare for low-income groups.

Resilience: Risk adjustment mechanisms between sickness funds ensure financial stability, even during crises such as the COVID-19 pandemic.

Efficiency: Administrative costs remain low due to streamlined processes and standardized benefits packages.

The Netherlands' Multi-Tier Risk Pooling Model: The Netherlands combines universal health coverage with a private insurance market regulated by the government.

Equity: Risk equalization ensures that insurers are compensated for enrolling high-risk individuals, preventing discrimination against those with pre-existing conditions.

Resilience: Robust funding mechanisms and reinsurance ensure continuity of care during economic downturns.

These examples demonstrate that advanced risk pooling mechanisms can effectively balance equity, efficiency, and resilience when supported by strong policy frameworks and regulatory oversight.

5.2 Lessons from Low-Income Countries' Adaptation Strategies

Low-income countries face unique challenges in implementing risk pooling mechanisms, including limited financial resources, fragmented health systems, and administrative capacity constraints. Despite these challenges, innovative strategies have emerged:

Rwanda's Community-Based Healthcare insurance (CBHI): Rwanda's CBHI pools resources at the community level to provide basic health coverage for rural and low-income populations.

Success factors:

Strong government support and subsidies for vulnerable groups.

Mandatory enrollment policies to expand the pool size.

Challenges:

Irregular premium collection due to seasonal incomes.

Limited financial capacity to cover high-cost medical services.

Ghana's National Healthcare insurance Scheme (NHIS): Ghana's NHIS combines payroll taxes, premiums, and donor funding to create a national-level risk pool.

Equity: The scheme subsidizes premiums for children, the elderly, and the indigent.

Challenges: Delays in claim reimbursements and reliance on donor funding for sustainability.

Metric	Germany (SHI)	Netherlands (Multi-Tier)	Rwanda (CBHI)	Ghana (NHIS)
Equity (Coverage)	High (Income-	High (Risk	Moderate	Moderate (Subsidized

of Poor)	based)	equalization)	(Government subsidies)	premiums)
Resilience (Crisis Response)	High (Stable reserves)	High (Reinsurance systems)	Moderate (Limited funds)	Moderate (Donor dependence)
Administrative Efficiency	High (Standardized processes)	High (Well-regulated market)	Moderate (Community-based)	Low (Delays in reimbursements)

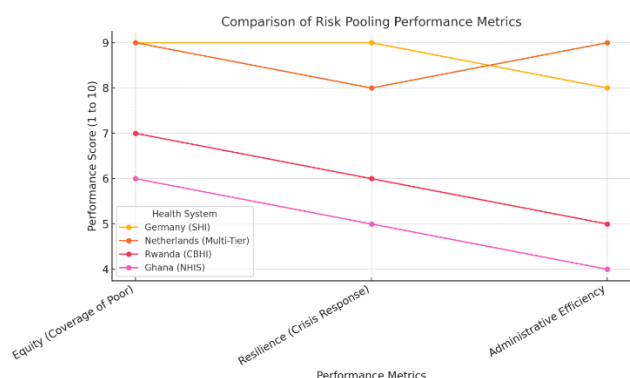


Figure 2: Comparison of Risk Pooling Performance Metrics

Figure 2, Compares the performance metrics of different risk pooling systems, focusing on equity, resilience, and administrative efficiency. Each system's performance is rated on a scale from 1 to 10, showcasing strengths and weaknesses across various contexts.

6. POLICY IMPLICATIONS

The findings of this study underscore the transformative potential of advanced risk pooling mechanisms to promote equity and resilience in Healthcare insurance systems. However, translating these insights into actionable policies requires strategic interventions tailored to the socio-economic and institutional contexts of different countries. This section outlines strategies for policymakers to foster equity through risk pooling and enhance system resilience through technological and structural reforms.

6.1 Strategies for Policymakers to Foster Equity Through Risk Pooling

1. Establishing National or Regional Risk Pools: Policymakers should prioritize the consolidation of fragmented risk pools into larger, unified national or regional pools. Larger pools enhance equity by redistributing financial resources across socio-economic and health-status divides. For instance, countries like Thailand have demonstrated the success of unified schemes in reducing financial barriers to healthcare.

Policy Recommendation: Governments can mandate contributions from employers, employees, and the self-employed while providing subsidies for low-income groups to ensure universal participation.

2. Implementing Cross-Subsidization Mechanisms: Income-based premium structures or progressive taxation can ensure that wealthier individuals subsidize healthcare costs for poorer populations. Cross-subsidization not only promotes fairness but also reduces out-of-pocket expenditures, which disproportionately affect vulnerable groups.

Policy Recommendation: Introduce income brackets for contributions, where higher earners pay a greater share, complemented by government subsidies for the poorest populations.

3. Encouraging Mandatory Enrollment: Voluntary insurance schemes often face adverse selection, where high-risk individuals dominate the pool, leading to higher costs and financial instability. Mandatory enrollment, as seen in Germany and the Netherlands, prevents this issue and ensures that all individuals contribute to the pool.

Policy Recommendation: Policymakers should implement mandatory Healthcare insurance enrollment laws, with penalties for non-compliance, to expand the risk pool and enhance equity.

4. Strengthening Subsidy Programs for Vulnerable Groups: Governments must ensure that marginalized populations, such as the elderly, disabled, and rural poor, are adequately covered through direct subsidies or voucher systems. Programs like Rwanda's CBHI demonstrate the impact of targeted subsidies in increasing healthcare access for the underserved.

Policy Recommendation: Allocate a portion of national health budgets to fund premium subsidies, particularly for groups below the poverty line or with limited earning capacity.

5. Promoting Public Awareness and Education: A lack of awareness about the benefits of risk pooling often hinders participation in insurance schemes, particularly in rural or low-literacy areas. Education campaigns can help bridge this gap and encourage enrollment.

Policy Recommendation: Governments should collaborate with community leaders, NGOs, and local media to disseminate information on the benefits of risk pooling and Healthcare insurance enrollment.

6.2 Enhancing Resilience via Technological and Structural Reforms

1. Leveraging Digital Health Technologies:

Technological advancements, such as blockchain, artificial intelligence (AI), and data analytics, can enhance the efficiency and resilience of risk pooling systems. These technologies enable accurate risk assessments, fraud detection, and real-time fund management. For example, AI-driven predictive models can optimize premium calculations and ensure financial stability.

Policy Recommendation: Invest in digital health infrastructure, including electronic health records and AI-based risk assessment tools, to enhance system responsiveness and resilience.

2. Establishing Catastrophic Risk Reserves:

Resilience can be bolstered by creating dedicated funds for catastrophic health events, such as pandemics or natural disasters. These reserves can be funded through a combination of government allocations, donor contributions, and surcharges on premiums during non-crisis periods.

Policy Recommendation: Policymakers should legislate the creation of catastrophic health reserves with clear guidelines on activation criteria and replenishment mechanisms.

3. Strengthening Institutional Capacity: A resilient health system requires strong institutional frameworks for fund management, claims processing, and service delivery. Weak governance often results in inefficiencies and mismanagement, undermining the effectiveness of risk pooling mechanisms.

Policy Recommendation: Train administrators and establish independent oversight bodies to monitor the financial health of risk pooling schemes and address inefficiencies.

4. Adopting Multi-Tier Risk Pooling Models: Multi-tier systems, which combine universal basic coverage with supplementary insurance for high-income groups, provide a balance between equity and financial sustainability. Countries like Japan and the Netherlands have successfully implemented this model, ensuring equitable access while preserving financial stability.

Policy Recommendation: Design Healthcare insurance systems with a basic tier funded through public means and

additional tiers offering enhanced services for those who can afford supplementary coverage.

5. Facilitating International Collaboration and Knowledge Sharing: Low- and middle-income countries can benefit from the experiences of nations with well-established risk pooling mechanisms. International collaboration can provide technical assistance, financial support, and policy guidance to countries aiming to enhance their resilience.

Policy Recommendation: Encourage partnerships with global health organizations, such as the WHO and World Bank, to develop best practices and provide funding for technological and structural reforms.

7. CONCLUSION

The transformative potential of advanced risk pooling mechanisms in enhancing equity and resilience in Healthcare insurance systems. By addressing health disparities and preparing systems to withstand crises, risk pooling serves as a cornerstone for sustainable and inclusive healthcare. This conclusion synthesizes the key findings and outlines future research and policy priorities to guide the evolution of risk pooling practices.

7.1 Summary of Key Findings

The analysis reveals the following critical insights:

Equity Enhancement: Advanced risk pooling mechanisms, such as cross-subsidization, national pooling, and income-based contributions, significantly reduce health disparities. Examples from countries like Germany and Rwanda demonstrate how targeted subsidies and mandatory enrollment expand access to care for vulnerable populations.

System Resilience: Robust pooling mechanisms enhance health system resilience by creating financial buffers and enabling efficient fund redistribution during crises. National-level pooling models and catastrophic risk reserves have proven effective in maintaining service continuity during emergencies like the COVID-19 pandemic.

Implementation Challenges: Low- and middle-income countries face barriers such as political resistance, administrative inefficiencies, and limited financial resources. While innovative adaptations like Rwanda's CBHI model illustrate progress, sustainability remains a challenge without adequate funding and institutional capacity.

Role of Technology and Policy Innovation: Technological advancements, such as AI-based risk assessments and digital health records, present opportunities

to improve efficiency and adaptability. Policy interventions that mandate enrollment, consolidate fragmented pools, and promote multi-tier systems strike a balance between equity and financial sustainability.

7.2 Future Directions for Research and Practice

1. Context-Specific Adaptations: Future research should focus on tailoring risk pooling mechanisms to diverse socio-economic and cultural contexts. Comparative studies across low-, middle-, and high-income countries can provide valuable insights into best practices and adaptation strategies.

2. Longitudinal Impact Assessments: While many studies highlight the short-term benefits of advanced risk pooling mechanisms, there is a need for longitudinal research to evaluate their long-term impact on health outcomes, financial stability, and equity.

3. Integration of Technological Innovations: Further exploration is needed to assess the feasibility and scalability of emerging technologies, such as blockchain and AI, in enhancing risk pooling efficiency. Studies on the cost-effectiveness of these technologies in low-resource settings would be particularly valuable.

4. Policy Experimentation and Evaluation: Governments and international organizations should invest in pilot programs to test innovative risk pooling models, such as community-based schemes or hybrid public-private models. Rigorous evaluation frameworks should accompany these pilots to generate evidence for scale-up.

5. Strengthening Global Collaboration: Future practice should focus on fostering international partnerships to share knowledge, technical expertise, and funding. Collaborative efforts can help address common challenges, such as financing catastrophic health risks or managing demographic shifts.

6. Addressing Political and Institutional Barriers: Research should also explore strategies to overcome political resistance and institutional constraints. This includes studying effective advocacy campaigns, governance reforms, and stakeholder engagement strategies.

In conclusion, advanced risk pooling mechanisms hold significant promise for creating equitable and resilient health systems. While challenges persist, a combination of evidence-based policy design, technological integration, and global collaboration can help unlock the full potential of these mechanisms. The insights from this study provide a roadmap for future research and practice, emphasizing the importance of adaptive and inclusive approaches to Healthcare insurance reform.

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