Research Paper / Оригинальная статья
https://doi.org/10.51176/1997-9967-2026-2-136-150
МРНТИ 06.61.33
JEL: I14, I18, O15

Socio-Economic Inequality and Differences in Life Expectancy

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For citation: Choi, C. (2026). Socio-Economic Inequality and Differences in Life Expectancy. Economy: strategy and practice, 21(2), 136-150. https://doi.org/10.51176/1997-9967-2026-2-136-150

ABSTRACT

In the context of increasing global risks, pandemics, urbanization and socio-economic polarization, the problem of mortality inequality is becoming one of the key problems of modern distributive and social science. The purpose of this study is to analyze the long-term evolution of life expectancy inequality and assess the impact of modern socio-economic imbalances and global risks on changing trends towards equalization of mortality. The article uses a mixed approach combining historical and comparative interpretation, life table-based distribution analysis, and qualitative institutional analysis. The study uses data from WHO, the OECD, and the results of international research in the 19th, 20th, and early 21st centuries. The results of the study showed that during the 20th century, the coefficient of life expectancy inequality in developed countries decreased significantly: in the USA – from 0.476 in 1852 to 0.099 in 2002, in England and Wales – from 0.443 to 0.094, in France – from 0.446 to 0.083. At the same time, in the 21st century, there is a slowdown in the processes of equalization of life expectancy and an increase in socio-economic stratification of survival rates. During the COVID-19 pandemic, global life expectancy decreased by 1.8 years, while excess mortality reached about 14.9 million people. The study showed that mortality inequality is formed through the mechanisms of unequal exposure to risks, vulnerability, institutional protection and access to medical technologies. Furthermore, the study shows that the distribution of medical resources and access to them directly influence differences in survival outcomes between countries and social groups.

KEYWORDS: Social Stratification, Social Strategy, Inequality, Socioeconomic Inequality, Risk Society, Global Risk, Life Expectancy, Healthcare Allocation

CONFLICT OF INTEREST: the authors declare that there is no conflict of interest.

FINANCIAL SUPPORT: the study was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF- 2025S1A5A2A01005338)

Article history:
Received 13 March 2026
Accepted 26 May 2026
Published 30 June 2026

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Социально-экономическое неравенство и различия в продолжительности жизни

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Для цитирования: Чой С. (2026). Социально-экономическое неравенство и различия в продолжительности жизни. Экономика: стратегия и практика, 21(2), 136-150. https://doi.org/10.51176/1997-9967-2026-2-136-150

АННОТАЦИЯ

В условиях усиления глобальных рисков, пандемий, урбанизации и социально-экономической поляризации проблема неравенства смертности становится одной из ключевых проблем современной распределительной и социальной науки. Целью данного исследования является анализ долгосрочной эволюции неравенства в продолжительности жизни и оценка влияния современных социально-экономических диспропорций и глобальных рисков на изменение тенденций к выравниванию смертности. В статье используется смешанный подход, сочетающий историко-сравнительную интерпретацию, анализ распределения на основе таблицы жизни и качественный институциональный анализ. В исследовании использованы данные ВОЗ, ОЭСР и результаты международных исследований в XIX, XX и начале XXI века. Результаты исследования показали, что в течение XX века коэффициент неравенства продолжительности жизни в развитых странах существенно снизился: в США — с 0.476 в 1852 г. до 0.099 в 2002 г., в Англии и Уэльсе — с 0.443 до 0,094, во Франции — с 0.446 до 0.083. Вместе с тем в XXI веке наблюдаются замедление процессов выравнивания продолжительности жизни и усиление социально-экономической стратификации показателей выживаемости. В период пандемии COVID-19 глобальная ожидаемая продолжительность жизни сократилась на 1,8 года, тогда как объем избыточной смертности достиг около 14,9 млн человек. Исследование показало, что неравенство продолжительности жизни формируется под воздействием механизмов неравномерного распределения рисков, различий в уровне уязвимости, институциональной защиты и доступа к современным медицинским технологиям. Сделан вывод о том, что смертность должна рассматриваться не только как демографический или медицинский показатель, но и как итог распределительных процессов, связанных с институциональной организацией защиты, доступом к ресурсам и управлением глобальными рисками. Кроме того, исследование показывает, что распределение медицинских ресурсов и доступ к ним напрямую влияют на различия в показателях выживаемости между странами и социальными группами.

КЛЮЧЕВЫЕ СЛОВА: социальная стратификация, социальная стратегия, неравенство, социально-экономическое неравенство, общественный риск, глобальный риск, продолжительность жизни, распределение ресурсов здравоохранения

КОНФЛИКТ ИНТЕРЕСОВ: авторы заявляют об отсутствии конфликта интересов.

ФИНАНСИРОВАНИЕ: Исследование выполнено при поддержке Министерства образования Республики Корея и Национального исследовательского фонда Кореи (NRF-2025S1A5A2A01005338).

История статьи:
Получено 13 марта 2026
Принято 26 мая 2026
Опубликовано 30 июня 2026

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INTRODUCTION

In classical social and economic analysis, scholarly attention has been directed primarily toward inequalities in income, capital, healthcare, education, and social opportunity. Yet beneath these familiar domains lies a more fundamental dimension of inequality: unequal survival itself. Every society shapes not only access to material and social resources, but also the chances of living longer, healthier, and safer lives. From this perspective, mortality inequality is not merely a public health outcome; it reflects the translation of social asymmetries into unequal years of life and unequal exposure to premature death (Banks et al. 2021). As Peltzman's landmark formulation suggests, lifespan inequality represents a crucial but often underexamined dimension of welfare that has historically evolved alongside modernization and transformations in public health systems.

Over the long twentieth century, many industrial and postindustrial societies experienced a substantial reduction in mortality inequality. Similar long-term dynamics of mortality inequality evolution across OECD countries are discussed by Banks et al. (2021). Improvements in sanitation, vaccination, nutrition, maternal and child health, and later the expansion of social insurance and medical care contributed not only to rising life expectancy but also to a narrowing of lifespan disparities. Peltzman demonstrates that mortality inequality declined markedly during the modern era, particularly in high-income countries, as early-life mortality decreased and the age distribution of deaths became less dispersed. This historical trajectory suggests that longer and healthier lives gradually became more broadly accessible through advances in medical knowledge, institutional development, and public health protection (Sasson, 2025; Muszyńska-Spielauer et al., 2025).

However, the equalization of survival was never linear, natural, or complete. It was historically contingent, politically mediated, and unequally secured across class, race, gender, region, and nation. More importantly, the conditions of late modernity have altered the very architecture through which inequality becomes embodied. Beck's concept of the risk society remains especially powerful here because it shifts attention from the distribution of goods to the distribution of hazards generated by modern systems themselves. In risk society, technological progress and economic growth do not simply create prosperity; they also produce new forms of vulnerability, including ecological disruption, pandemic exposure, toxic environments, and socially stratified institutional failures. Beck's central insight was that contemporary societies are increasingly organized around conflicts over the production, management, and risks.

This paper argues that mortality inequality must therefore be reconceptualized as a distributional outcome of global risk. As Figure 1 illustrates, unequal death emerges through a cumulative chain of mechanisms. Macro-level shocks such as climate change, urbanization, and pandemics intersect with preexisting socioeconomic stratification and are metabolized into mortality through four linked channels: unequal exposure, unequal vulnerability, unequal protection, and unequal access to advanced technologies. The poor and socially marginalized are more likely to inhabit polluted environments, face occupational danger, carry a heavier burden of chronic disease, experience weaker institutional protection, and encounter delayed or inferior access to life-saving innovations. Mortality inequality is thus not an accidental by-product of crisis, but a patterned consequence of how risks and protections are distributed across populations. This approach extends the scope of distribution science beyond markets in goods toward the political economy of survival itself. In this context, social strategy becomes an important instrument for reducing inequalities in survival and health protection.

The COVID-19 pandemic made this mechanism globally visible. The pandemic exposed and intensified preexisting asymmetries in labor precarity, housing density, comorbidity burdens, healthcare access, and vaccine availability (Wang et al., 2023). Rather than functioning as a great equalizer, the pandemic exposed and intensified preexisting asymmetries in labor precarity, housing density, comorbidity burdens, healthcare access, and vaccine availability. The World Health Organization (hereinafter – WHO) estimated approximately 14.9 million excess deaths worldwide in 2020 and 2021, underscoring that the pandemic's mortality burden far exceeded officially reported COVID-19 deaths and was mediated through both direct infection and indirect system disruption. At the same time, Oxfam's Inequality Kills report argued that

inequality contributed to at least one death every four seconds, framing the pandemic not simply as a biomedical emergency but as a distributional crisis in which wealth concentration, policy asymmetry, and institutional neglect translated into avoidable deaths. These findings sharpen the central question of this study: whether the long historical decline in mortality inequality has entered a period of reversal since the early twenty-first century, especially after 2019.

Accordingly, the aim of this study is to analyze the long-term evolution of mortality inequality and to evaluate the impact of contemporary socioeconomic disparities and global risks on the reversal of mortality equalization trends. The study approaches mortality inequality through the lenses of socioeconomic inequality, social stratification, and risk governance, emphasizing how changes in lifespan dispersion reflect not only health outcomes but also broader institutional and structural conditions that shape protection, vulnerability, and life chances. Empirically, the analysis draws on the mortality Gini coefficient to interpret both historical and contemporary mortality patterns. Ultimately, the paper argues that one of the central socioeconomic challenges of the twenty-first century concerns unequal survival conditions and the widening disparities in opportunities to live longer, healthier, and safer lives.

LITERATURE REVIEW

The nineteenth century represents a foundational distributive frontier in the history of human survival, characterized by a mortality regime defined not merely by high death rates, but by profound levels of mortality inequality. Within the framework of social and economic science, survival during this era can be interpreted as a scarce social resource allocated through institutions that were fundamentally stratified and only weakly universalistic. Unlike the modern era, in which death is increasingly concentrated in older age cohorts, the nineteenth-century mortality landscape was characterized by a high dispersion of ages at death. This dispersion was driven by the prevalence of infant and early-childhood mortality, an uneven burden of infectious diseases, and the concentration of environmental and occupational hazards that disproportionately affected the working-class populations compared to the elite.

Empirical evidence for this high-inequality regime is found in cohort-based mortality Gini values, which reflect the period's unequal mortality structure. In the mid-nineteenth century, countries such as the United States, England and Wales, and France exhibited Gini coefficients for mortality exceeding 0.44. These figures indicate an exceptionally high degree of lifespan dispersion, consistent with a regime in which a significant portion of the population died far below the mean age at death. The historical equalization narrative begins with interpreting the life-table Gini as more than an epidemiological indicator; rather, it represents a mean-standardized measure of the absolute difference in ages at death across individuals. This makes it possible to connect demographic outcomes to broader patterns of social and economic inequality, framing mortality as a consequence of institutional and socioeconomic conditions. Socio-economic inequality and differences in life expectancy have become increasingly interconnected across both national and global contexts (Chetty et al., 2016; Banks et al., 2021).

From a socio-political perspective, this period may be viewed as the prehistory of modern risk governance. While lethal risks were widespread, they were not yet systematically managed through large-scale state intervention. Instead, exposure to hazards remained deeply embedded within the industrial and urban political economy. Crowding, sanitation deficits, and workplace exposures ensured that mortality was shaped not only by biological factors but also by class-based living conditions and unequal infrastructures. These conditions influenced age-at-death patterns, as reflected in the high Gini values for mortality at the time. The subsequent century witnessed a sharp decline in these indicators, illustrating that historical mortality equalization was characterized not only by rising life expectancy but also by a growing concentration of deaths at older ages.

Methodologically, understanding this transition requires a clear distinction between cohort life-table Gini values, which track the lifetime outcomes of specific birth cohorts, and period life tables, which offer a synthetic snapshot of mortality rates at a single point in time. While nineteenth-century analyses rely heavily on reconstructed cohort data for a limited set of nations, these anchors provide the necessary contrast for modern period-

based metrics. Although the lack of linked socio-economic microdata for the 1800s necessitates inferring stratification mechanisms from macro-distributional patterns, the correlation between industrial inequality and mortality dispersion remains a robust feature of the historical record. Ultimately, the transition from high dispersion to age-at-death compression marks the emergence of a modern survival regime where the state increasingly manages health risks as universal concerns, gradually eroding the stark distributive frontiers of the nineteenth century (see Table 1).

Table 1. Transition of the mortality inequality regime

Feature	19th Century (High Dispersion)	Post-Equalization (Compression)
Mortality Gini	High (> 0.44 for US, UK, FR)	Significantly Low (Modern standards)
Age-at-death distribution	High dispersion (infant/child deaths)	Concentration at older ages
Social resource	Survival as a scarce/stratified resource	Survival as a universal right
Primary drivers	Infectious diseases, industrial hazards	Chronic diseases, managed aging
Risk governance	Embedded in class infrastructure	Reflexive, scale-managed Risk Society

Note: compiled by authors

The twentieth-century trajectory of mortality equalization represents a profound shift in the distributive logic of human survival, theorized as the systematic expansion of risk pooling and universalizing infrastructures. During this period, the institutionalization of sanitation, mass vaccination programs, maternal and child health initiatives, and the broader implementation of welfare-state social protections functioned as primary mechanisms for shifting the burden of death away from infancy and early adulthood. In the terminology of distribution science, this equalization is characterized by the left tail of the age-at-death distribution shrinking. As fewer individuals perish at young ages, the overall dispersion of survival time decreases, pulling the mortality Lorenz curve significantly closer to the line of perfect equality. This historical compression of mortality, or rectangularization of the survival curve, fundamentally reduced length-of-life inequality across populations (Shkolnikov et al., 2003).

This shift constitutes an important conceptual bridge between socioeconomic inequality research and mortality studies, as it enables the analysis of mortality inequality using evaluative tools such as the Lorenz curve and the Gini coefficient, which are traditionally applied to income and wealth inequality. Peltzman (2009) situates this equalization as a massive welfare transformation; whereas unequal longevity once stood as a primary dimension of social stratification in the nineteenth century, it fell drastically across high-income countries throughout the 1900s. The formalization of these metrics further enables decomposition, allowing analysts to attribute changes in the Gini coefficient to specific age- and cause-related shifts in mortality. Methodologically, the dramatic reduction in mortality inequality was driven disproportionately by declines in early age-specific death rates. Because infant and child deaths occur far below the mean age at death, their reduction removes the most extreme disparities in lifespan, thereby exerting a stronger equalizing effect on the Gini index than mortality improvements at older ages (Shkolnikov et al., 2003).

From a sociological and mixed-methods perspective, this transition was not an inevitable by product of progress but rather the result of deliberate governance choices and the institutionalization of health services. These developments align with a biopolitical logic wherein populations are increasingly viewed as governable distributions of risk and survival (Mbembe, 2003; Foucault, 2003; 2008). The life-course became medicalized and surveilled through public health capacity and social insurance expansion, transforming the social meaning of death from a localized tragedy into a manageable statistical outcome. Empirical benchmarks reflect this transformation: cohort mortality Gini values in countries like the United States, England, and France plummeted from roughly 0.3 in the early 1900s to the low 0.1 range by mid-century (Peltzman, 2009).

However, this narrative of equalization must be approached with caution regarding its global applicability and data limitations. While high-income countries experienced rapid dispersion contraction, the historical narrative may overgeneralize patterns that are not yet universal. Furthermore, gains in average life expectancy do not automatically guarantee equalization; if improvements are

concentrated exclusively among the elderly, the reduction in dispersion may be weaker than expected. Consequently, equalization must be empirically tested rather than assumed, particularly in contexts where incomplete vital registration necessitates statistical modeling. Despite these caveats, the twentieth century stands as the era in which survival was transformed from a highly stratified privilege into a more equitably distributed social standard, mediated by the emergence of the modern administrative state.

The late twentieth century is best characterized as a period of continued improvement in average longevity coupled with a significant deceleration and, in some contexts, a cessation of declines in lifespan inequality. While the mid-twentieth century witnessed a rapid contraction of mortality dispersion, empirical evidence suggests that this equalizing trend has lost its momentum in recent decades. According to the research of Shkolnikov et al., the strong correlation between rising life expectancy and falling inequality weakened substantially after 1970. In many low-mortality nations, mortality inequality has reached a plateau even as mean ages at death continue to climb (Banks et al., 2021). This pattern is central to understanding that mortality equalization is a historically contingent process rather than an inevitable outcome of modernization, and it remains potentially reversible under shifting social and economic conditions.

The distributional logic explaining why dispersion might stop improving despite gains in the mean lies in the shifting age-structure of mortality. As infant and early-childhood deaths become increasingly rare, further longevity gains are driven primarily by mortality reductions at older ages. When survival improvements are concentrated in the upper tail of the age distribution (the elderly) while premature deaths among disadvantaged groups remain stagnant, the result is a distributional divergence. In this scenario, the floor of premature death remains fixed for vulnerable populations, while the ceiling of survivorship expands for the advantaged, effectively maintaining or even increasing the dispersion of lifetimes. This transition shifts the locus of inequality from early-life survival to midlife and older-age gradients, which are increasingly shaped by chronic diseases, occupational exposures, and stratified access to preventive care (Prior, 2021).

The long-run empirical trend of this equalization, and its subsequent plateau, is clearly illustrated by the cohort mortality Gini benchmarks. The data demonstrate a dramatic long-run compression of mortality across high-income countries, alongside a notable catch-up trajectory among emerging economies such as Brazil.

The benchmarks in Table 1 confirm that while high-income countries reached an exceptionally low level of dispersion (Gini < 0.10) by the early twenty-first century, the rate of improvement has visibly flattened compared to the massive gains made between the early and mid-twentieth centuries. For instance, the high-income mean Gini dropped by 0.22 points between 1902 and 1952, but only by 0.04 points in the subsequent half-century. Furthermore, the divergence between the high-income mean (0.092) and Brazil (0.156) in the 2002 cohort illustrates that while global convergence is occurring, significant distributive frontiers remain (see Table 2).

Table 2. Cohort mortality Gini benchmarks across eras

Country / Group	Mid-19th Century Cohort	Early-20th Century Cohort	Mid-20th Century Cohort	Early-21st Century Cohort
United States	0.476 (1852)	0.335 (1902)	0.133 (1952)	0.099(2002)
England and Wales	0.443 (1852)	0.353 (1902)	0.145 (1952)	0.094(2002)
France	0.446 (1852)	0.366 (1902)	0.118 (1952)	0.083(2002)
Brazil	0.566 (1892)	0.548 (1902)	0.410 (1952)	0.156(2002)
High-income Mean	0.455 (1852)	0.352 (1902)	0.132 (1952)	0.092(2002)

Note: compiled by the authors based on Peltzman (2009)

This plateau phase necessitates the adoption of mortality Gini and related indices as essential distributional complements to life expectancy. In an era of risk society, where systemic hazards are managed at scale, but vulnerability remains stratified, aggregate gains in longevity can mask deep-seated internal dispersion dynamics (Strozza et al., 2024). Future analysis must move beyond these historical cohort anchors to evaluate annual-period Gini fluctuations, thereby providing a baseline to distinguish between long-term structural plateaus and the acute shocks observed in the post-2020 era.

RESEARCH METHODS

The phenomenon of contemporary reversal in mortality trends is best understood not as an abrupt, singular event but as a complex, two-stage process that challenges the mid-twentieth-century narrative of linear equalization. The first stage consists of a pre-pandemic period characterized by a notable deceleration in longevity gains and an intensifying stratification of survival across socioeconomic strata. The second stage involves the acute pandemic shock, which functioned as a catalyst, amplifying pre-existing gradients and exposing the structural fragilities of modern health and social protection systems. This pre-pandemic phase provides crucial evidence that the distributional mechanism of survival has shifted; even when aggregate life expectancy continues to rise, the distribution of survival time can become more unequal if the benefits of medical and social progress accrue disproportionately to high-income or highly educated populations.

This study employs a mixed-methods approach that combines historical-comparative analysis, a mortality Gini assessment, and an institutional analysis of socioeconomic and health inequalities. The study utilizes cohort and period life-table indicators, WHO and OECD datasets, and comparative historical evidence to evaluate long-term changes in mortality inequality. Figure 1 presents the study's analytical framework, illustrating the long-term evolution of mortality inequality and the mechanisms linking socioeconomic disparities, global risks, and unequal mortality outcomes.

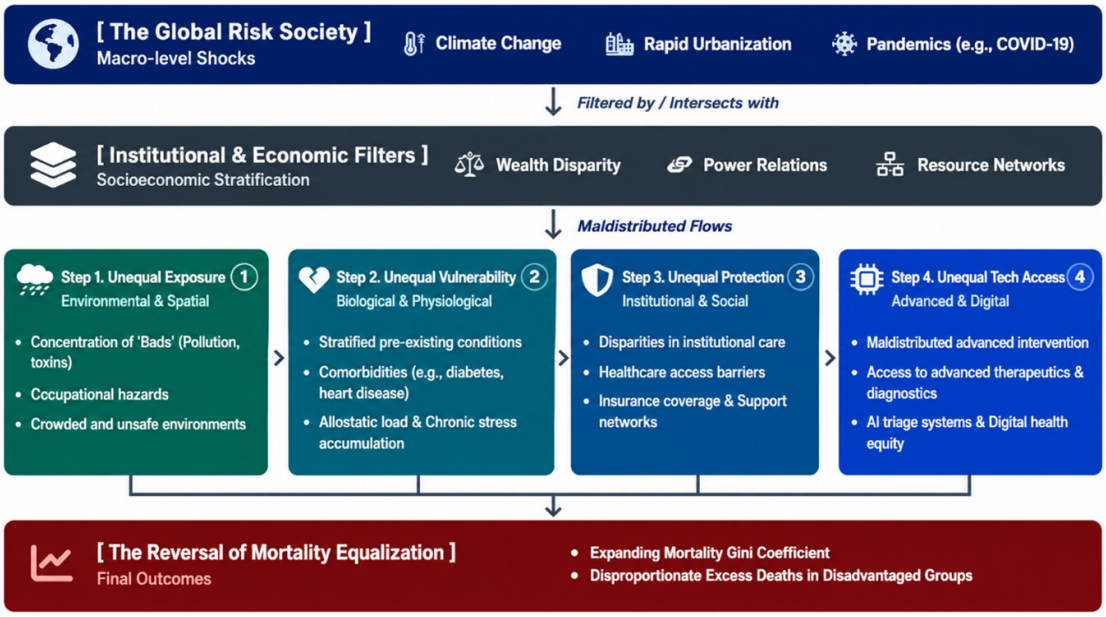

Figure 1. Conceptual framework on mortality inequality

Empirical data from the United States illustrate the magnitude of this socioeconomic divergence. Research by Chetty et al. (2016) reveals a staggering life expectancy gap between the richest and poorest 1% of the population, amounting to 14.6 years for men and 10.1 years for women. More importantly, the rate of progress has become fundamentally decoupled: between 2001 and 2014, life expectancy for the top 5% of the income distribution rose significantly by 2.34 years for men and 2.91 years for women, while the bottom 5% saw virtually no improvement, with gains as marginal as 0.32 years for men and a negligible 0.04 years for women. This divergence represents a paradigmatic shift in the ecology of survival, where the floor of premature death stagnates for the disadvantaged while the ceiling of survivorship continues to expand for the elite.

This stratification is not a uniquely American phenomenon; similar educational gradients are observed across high-income nations. OECD estimates suggest that the gap in life expectancy at age 25 between high- and low-education groups remains substantial, averaging approximately 8 years for men and 5 years for women. Even at age

65, where biological factors might be expected to attenuate social differences, gaps of 3.5 years for men and 2.5 years for women persist. These figures highlight that the adult segment of the age-at-death distribution remains heavily stratified even in societies that have successfully compressed early-life mortality. At the macro level, the OECD has documented a general slowing of life expectancy gains across its member countries, noting that 2015 was a pivotal year when life expectancy actually fell in 19 countries, signaling a potential exhaustion of the previous century's equalizing momentum.

From a distribution-science perspective, these stagnation episodes are critical because inequality indices—such as the Gini coefficient are sensitive to age- and group-specific mortality trends. When midlife mortality or deaths at disadvantaged ages fail to improve, the overall dispersion of lifetimes increases, even if the mean age of death stays constant or rises slightly. Methodologically, this sub-chapter argues that stratified gains can drive a distributional inequality in survival that aggregate metrics fail to capture. By using period life-table Gini computations and decomposing $\Delta Gini$ into contributions from changes in mortality above and below key age thresholds (such as age 60), researchers can isolate the resurgence of premature mortality. Ultimately, while life expectancy provides a measure of average progress, the analysis of dispersion reveals a more sobering reality: a survival regime that is increasingly polarized by the stratified allocation of risk and protection.

RESULTS

The COVID-19 pandemic introduced a rare and devastating natural experiment: a global mortality shock superimposed on pre-existing gradients of inequality. According to official WHO reporting, the total death toll directly or indirectly associated with the pandemic, measured as excess mortality, was approximately 14.9 million between January 2020 and December 2021. From the perspective of distribution science, excess mortality serves as a vital metric of systemic shock rather than a mere disease-specific count. It encompasses direct viral deaths, indirect fatalities resulting from health-system disruptions, and even deaths averted through reduced mobility and fewer accidents. This comprehensive measure underscores how the pandemic's impact was metabolized through the unequal capacities of national health infrastructures and social protection systems.

In parallel with excess mortality, global life expectancy trends reflect the severity of the crisis, effectively wiping out nearly a decade of progress. Between 2019 and 2021, global life expectancy fell by 1.8 years to 71.4 years, returning to 2012 levels. However, this decline was profoundly uneven across the globe. While the Americas and South-East Asia experienced life expectancy losses of approximately 3.0 years, the Western Pacific region saw a negligible decline of less than 0.1 years. These regional disparities directly influence mortality inequality, indicating that the shock altered the global distribution of deaths in a way that widened the gap between high-resilience and high-vulnerability populations.

A critical nuance for the analysis of mortality inequality is the dispersion ambiguity inherent in mortality shocks. Lifespan inequality indices, such as the Gini coefficient, can move in either direction depending on the age-pattern of excess deaths. For instance, data from England and Wales indicate that substantial declines in life expectancy occurred alongside a slight *decrease* in lifespan inequality. This paradox arises when excess mortality is heavily concentrated among the elderly; by removing individuals from the upper tail of the age distribution, the statistical dispersion of lifetimes may actually contract. This highlights that a reversal of the historical equalization trend may manifest as a collapse in mean life expectancy or a divergence between regions and socioeconomic strata, even if the internal dispersion indicator remains stable or declines in certain settings.

Methodologically, the analysis of the COVID-19 era requires computing period life-table Gini coefficients and decomposing changes into specific age contributions. This approach allows researchers to distinguish between the compression at old ages caused by elderly mortality and the resurgence of premature mortality among younger, disadvantaged groups. Ultimately, while life expectancy provides a measure of average loss, a distributional science lens reveals that the reversal of progress is fundamentally driven by the unequal metabolism of global risk across socioeconomic and geographic boundaries (Strozza et al., 2024).

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Table 3. COVID-era excess mortality and life expectancy change

Grouping	Excess Deaths (2020–2021)	Share of Global Excess Deaths	Life Expectancy Change (2019→2021)
Global	14.9 million (13.3–16.6)	100%	−1.8 years (to 71.4)
Lower-middle-income countries	≈7.9 million	53%	—
Upper-middle-income countries	≈4.2 million	28%	—
High-income countries	≈2.2 million	15%	—
Low-income countries	≈0.6 million	4%	—
WHO Region: Americas	—	—	≈−3.0 years
WHO Region: South-East Asia	—	—	≈−3.0 years
WHO Region: Western Pacific	—	—	<−0.1 years

Note: compiled by authors based on WHO (2022) and WHO (2024).

To establish a clearer link with distribution science, the political economy of unequal death must be specified in terms of distribution actors and channel mechanisms. Mortality inequality does not arise directly from macro-level shocks alone. It emerges through a layered chain in which different actors control distinct stages of sourcing, allocation, delivery, and access. In this framework, governments, hospitals, pharmaceutical firms, international organizations, wholesalers, logistics providers, pharmacies, and community health networks are not peripheral institutional contexts. They are the principal actors through which health-resource inequality is organized and translated into mortality outcomes.

At the upstream end of the chain stand pharmaceutical firms, manufacturers, and patent-holding innovators. These actors shape the initial supply of vaccines, therapeutics, and diagnostics through production capacity, licensing strategies, pricing, technology transfer, and contractual priority. Their decisions influence not only how much is produced, but also who receives timely access. International organizations, including the World Health Organization, multilateral procurement arrangements, and donor agencies, intervene at the transnational allocation stage. They attempt to reduce market concentration, coordinate procurement, standardize emergency guidance, and widen access across low-capacity settings. Yet their effectiveness depends on financing, political cooperation, and the willingness of states and firms to treat essential health resources as globally distributable goods rather than as instruments of national advantage (de Bengy Puyvallée & Storeng, 2022).

National governments occupy the pivotal middle position in the distribution chain. They decide procurement strategies, emergency stockpiling, import approvals, reimbursement rules, subsidy design, territorial allocation, and priority-group sequencing. They determine whether limited resources are distributed according to purchasing power, administrative convenience, or social vulnerability. Government choices, therefore, shape the entire domestic architecture of access. Hospitals, public health agencies, and clinical networks translate these decisions into operational allocation. They govern intensive care admission, referral systems, emergency triage, continuity of non-COVID treatment, and the distribution of institutional care across metropolitan and peripheral regions. Finally, pharmacies, local clinics, mobile outreach systems, and community-level delivery networks determine whether resources reach end users, especially older adults, low-income households, migrants, rural populations, and medically underserved groups.

The channel pathway linking these actors to mortality inequality can be clearly stated. Macro-level shocks increase the demand for health protection. Upstream supply actors determine the availability and timing of critical resources. National and international allocators determine volume, price, territorial distribution, and eligibility. Delivery institutions determine whether resources are converted into effective services. End-user access is then shaped by distance, insurance, digital literacy, waiting times, and local service capacity. When any part of this chain is socially stratified, institutional inequality emerges. When multiple points along the chain are stratified simultaneously, institutional inequality is metabolized into mortality inequality. In practical terms, delayed procurement can become delayed vaccination; delayed vaccination can become differential infection and hospitalization; weak referral networks can become treatment delay; treatment delay can become

disproportionate excess death.

This model also clarifies how institutional inequality and mortality inequality should be connected analytically. The relevant causal path is not linear in a simplistic sense, but cumulative. Institutional inequality first appears as unequal availability, affordability, territorial reach, or service continuity. These then become unequal protection. Unequal protection interacts with pre-existing vulnerability such as age, comorbidity, poor housing, and insecure work. Mortality inequality is thus expressed as differential survival across populations. It should be understood not merely as an aggregate demographic outcome but as the final manifestation of cumulative failures across a multi-actor system of health resource production, allocation, logistics, and delivery (Sung et al., 2021).

This formulation preserves the central theoretical contribution of the present study while rendering its causal mechanism more concrete and institutionally observable. More specifically, a macro-level shock generates a sudden rise in demand for health resources, including vaccines, medicines, diagnostics, and medical services. This surge in demand is mediated first by pharmaceutical production capacity and licensing arrangements, then by international procurement and allocation mechanisms, and subsequently by national decisions regarding stockpiling, priority setting, and territorial allocation. These upstream decisions are translated into outcomes through regional logistics, healthcare delivery systems, and local service networks, which in turn shape household-level access, uptake, and continuity of care. When these stages are unevenly organized across territories and social groups, the result is unequal protection, which ultimately contributes to unequal mortality outcomes (Yan et al., 2023).

This actor-centered model adds a concrete distributional layer to the manuscript's existing mechanism chain of unequal exposure, vulnerability, protection, and technological access. The contribution is significant because it shows that mortality inequality is not only socially produced in the abstract; it is channel-produced through the structure and performance of real distribution systems. In this form, the article can speak more directly to distribution science by showing that failures in supply chains, access regimes, and delivery systems are not secondary administrative issues. They are one of the principal pathways through which survival becomes unequally distributed.

To conceptualize mortality as a distributional outcome, it is necessary to adopt a theoretical framework that can connect sociology, political economy, and public health within a single explanatory logic. In contemporary society, life and death can no longer be understood as the simple products of biological chance or individual frailty. They are increasingly shaped by institutional arrangements, market hierarchies, technological infrastructures, and the unequal social allocation of risk. Unequal death, therefore, is not an incidental by-product of crisis but the cumulative result of historically structured disparities in exposure, vulnerability, protection, and access to survival-enhancing resources. To explain this process, the present study integrates three major theoretical perspectives Ulrich Beck's risk society, Michel Foucault's biopolitics, and Achille Mbembe's necropolitics — and brings them together through a chain of distributional mechanisms that links macro-level shocks to differentiated mortality outcomes.

Beck's theory of the risk society provides the macro-sociological point of departure. Beck argued that the central conflict of late modernity is no longer organized solely around the distribution of economic goods, such as income, property, and opportunity, but increasingly around the distribution of bads, including environmental hazards, systemic insecurity, toxic exposure, and pandemic disease (Beck, 1992). Scientific and technological development, far from eliminating insecurity, has generated new forms of manufactured risk whose scale exceeds national borders and whose consequences are often unpredictable. Climate change, rapid urbanization, and global pandemics exemplify this transformation. Yet while such risks are global in origin, they are never experienced evenly. They are filtered through preexisting structures of socioeconomic stratification. Wealth, power, and institutional capacity determine who is protected from risk, who is displaced into zones of exposure, and who bears the cost of uncertainty. In this sense, the distribution of risk is inseparable from the distribution of inequality itself.

This point is particularly important because inequality is not merely the passive setting in which mortality occurs; it is an active force that organizes the social metabolism of death. Oxfam (2022) estimated that inequality contributes to at

least 21,300 avoidable deaths each day, a figure that sharply illustrates how distributive injustice can become biologically consequential. The expansion of urban populations intensifies this dynamic. According to the United Nations, nearly 68% of the world's population is projected to live in urban areas by 2050 (United Nations, 2018). Urbanization, however, does not create uniform risk. Marginalized populations are disproportionately concentrated in overcrowded neighborhoods, polluted industrial zones, precarious housing, and environmentally degraded areas. As a result, the global risk society does not simply generate common threats; it localizes and stratifies them.

If Beck helps explain the structural distribution of hazards, Foucault clarifies how institutions manage the distribution of survival. Foucault's concept of biopolitics identifies a historical transformation in the exercise of power, from sovereign authority centered on the right to take life toward modern forms of governance concerned with fostering life, managing populations, and regulating biological processes (Foucault, 2003; Foucault, 2008). Mortality, from this perspective, is not merely observed and recorded by institutions; it is shaped by them. Public health systems, welfare arrangements, urban planning, risk communication, and emergency triage protocols all function as mechanisms through which states and institutions decide how life is to be protected, optimized, and differentially sustained.

The COVID-19 pandemic made this biopolitical dimension especially visible. Decisions about who could work remotely and who had to remain in frontline labor, who had access to timely testing and treatment, who could isolate safely, and who received scarce hospital resources were not simply technical responses to the crisis. They were political decisions embedded in institutional allocation structures. The state's capacity to make live was distributed unevenly. Affluent populations were better able to convert income into distance, safety, and medical access, while disadvantaged communities were often exposed to greater risk and weaker institutional protection. In this way, biopolitics reveals that survival is not distributed according to vulnerability alone, but according to the social organization of care, infrastructure, and state capacity.

Taken together, these theoretical perspectives can be operationalized through a distributional mechanism chain of unequal death. Taken together, these theoretical perspectives can be operationalized through a chain of mechanisms linking global risks, unequal protection, and mortality inequality (Figure 2).

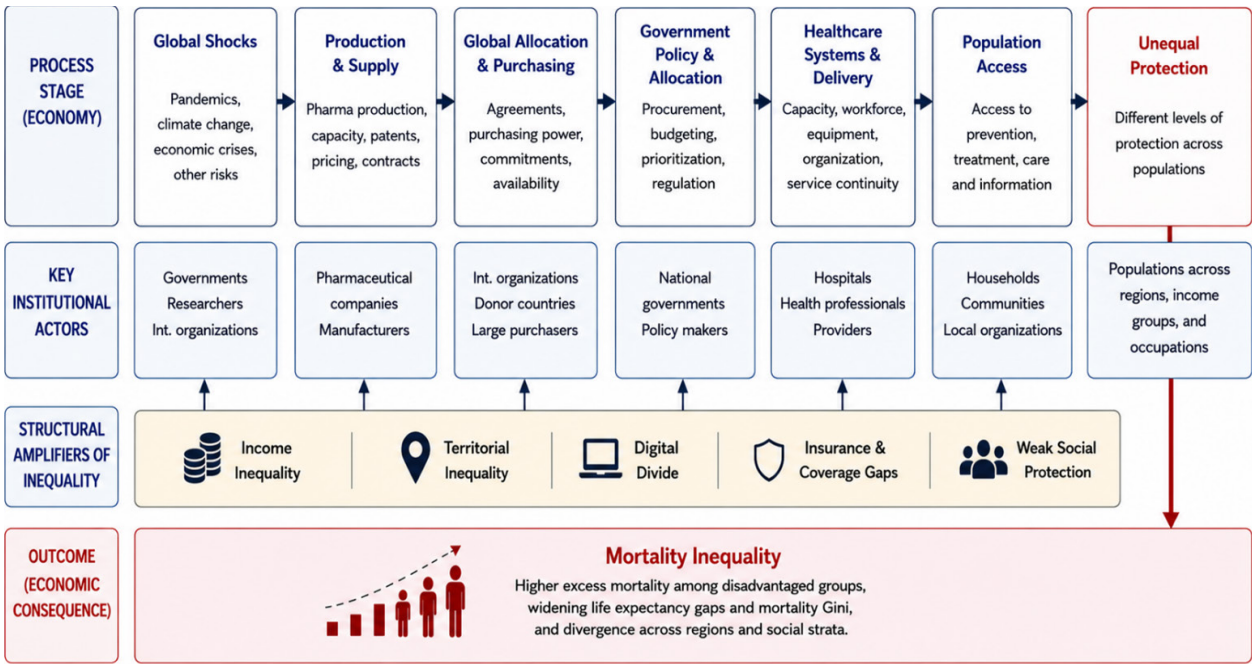

Figure 2. Mechanisms linking health-resource allocation and mortality inequality

This chain begins with macro-level shocks generated within the global risk society, including climate change, rapid urbanization, and pandemics. These shocks do not operate in a social vacuum. They are filtered through institutional and economic structures characterized by wealth disparities, power asymmetries, and unequal access to resource networks. The result is a sequence of cumulative disadvantages that progressively convert socioeconomic inequality into mortality inequality.

The first step in this chain is unequal exposure. In risk society, disadvantaged populations are more likely to be situated in environments characterized by pollution, occupational hazards, toxic infrastructure, and overcrowded living conditions (Beck, 1992). They are more likely to work in frontline or physically exposed occupations and less able to insulate themselves from hazards through mobility, property, or market purchasing power. The second step is unequal vulnerability. Exposure is not only spatial; it is embodied over time. Chronic deprivation, insecure housing, nutritional deficits, and cumulative stress contribute to higher levels of comorbidity and allostatic load, leaving socially disadvantaged groups biologically more susceptible to crisis shocks (Bambra, 2022; Bambra, 2024; Prior, 2021). What enters the body as chronic inequality reappears as differential frailty in moments of acute emergency.

The third step is unequal protection. Once hazards materialize, access to institutional care, social safety nets, emergency treatment, and reliable healthcare infrastructure becomes decisive. Yet these protective capacities are not distributed according to need alone. Insurance status, territorial inequality, welfare provision, and institutional responsiveness all shape who receives timely and effective protection and who remains exposed to preventable mortality (WHO, 2022). The fourth step is unequal access to technology. Advanced therapeutics, mRNA vaccines, precision diagnostics, digital health systems, and AI-assisted clinical tools all hold out the promise of extending survival. But these innovations do not diffuse equally. Their availability is often governed by intellectual property, profit-centered logistics, weak international solidarity, and digital exclusion. As a result, technologies that could reduce mortality gaps may instead widen them.

The cumulative effect of these mechanisms appears in final mortality outcomes. Unequal death becomes visible not only in excess deaths and differential loss of life expectancy, but also in the widening dispersion of ages at death, which can be measured using indicators such as the mortality Gini coefficient (Peltzman, 2009). From this perspective, the recent reversal of mortality equalization is not simply a public health setback. It is a crisis of distributive justice. The concentration of excess mortality among already burdened populations demonstrates that survival itself has become one of the most unequally allocated resources of the contemporary world.

The political economy of unequal death, therefore, demands a fundamental shift in social and economic science. Death should no longer be treated as a purely biological endpoint detached from institutions, infrastructures, and systems of allocation. It must be understood as the final output of a wider distributive order in which risks and protections are unevenly organized. Addressing mortality inequality requires more than medical progress in the narrow sense. It requires equitable governance, universal social protection, and the ethical distribution of life-saving technologies. These priorities should become part of a long-term social strategy aimed at reducing inequalities in survival and access to protection. In this sense, the struggle against unequal death is not only a matter of public health. It is one of the central questions of distributive justice in the twenty-first century.

CONCLUSIONS

This study began with a simple but far-reaching proposition: survival is not merely a biological fact but a socially distributed resource. Once mortality is approached in that way, the history of life expectancy ceases to look like a neutral record of medical progress and instead becomes legible as a history of distributive struggle. The long movement from the nineteenth century to the present shows that the unequal allocation of death has never been fixed, natural, or immune to institutional change. It has been shaped by sanitation, vaccination, welfare provision, public health capacity, labor conditions, urban form, and the political terms on which protection is granted or withheld. The central contribution of this article has been to trace that history not only as a rise in average longevity, but as a changing distribution of

survival itself. In doing so, the paper has argued that the twentieth century should be understood as an era of mortality equalization, while the early twenty-first century increasingly appears as a period in which that equalizing trajectory has slowed, plateaued, and, under the pressure of systemic shocks, begun to reverse.

The historical record matters because it demonstrates that mortality inequality can be reduced. The dramatic fall in mortality Gini coefficients across the twentieth century, especially in high-income societies, was not a statistical accident. It reflected the broad diffusion of collective protections that shifted death away from infancy, childhood, and preventable early adulthood, compressing it toward later life. In that sense, the equalization of mortality was one of the most profound achievements of modern social organization. It signified more than longer lives. It signified that survival itself had become less unevenly developed. Yet the paper has also shown that this equalization was never unconditional. It was historically contingent, uneven across regions and classes, and deeply dependent on institutions capable of socializing risk and extending protection beyond privileged groups. Once those institutions weaken, fragment, or become selectively distributive, the equalizing trajectory becomes vulnerable to interruption. The slowing of gains in life expectancy, the persistence of large educational and income gradients, and the increasing concentration of survival benefits among the socially advantaged all point to a structural exhaustion of the earlier model of convergence.

It is precisely here that the concept of the risk society becomes indispensable. The contemporary world is marked not simply by persistent inequality, but by a new configuration in which manufactured risks are global while the capacities to absorb, avoid, or survive them remain sharply stratified. Climate change, rapid urbanization, pandemics, and technologically mediated crises do not replace older inequalities; they pass through them and intensify them. The paper has therefore argued that mortality inequality in the present era is best understood as the outcome of a chain of distributional mechanisms. Macro-level shocks do not translate automatically into deaths. They are filtered through wealth disparities, power asymmetries, institutional capacities, and resource networks, which in turn generate unequal exposure, vulnerability, protection, and access to advanced technologies. By the time mortality appears in the form of excess deaths, declining life expectancy, or widening dispersion in ages at death, it is already the endpoint of a long social process. Death, in this framework, is not simply an event. It is a terminal distributional outcome.

The COVID-19 pandemic made this structure unusually visible. Rather than functioning as a universal human equalizer, the pandemic exposed the extent to which survival remained structured by labor precarity, housing conditions, chronic illness, institutional neglect, and geopolitical hierarchy. The striking unevenness of excess mortality across regions and income groups demonstrated that the burden of crisis was not borne symmetrically. At the same time, the pandemic underscored a crucial analytical point developed in this paper: the reversal of mortality equalization cannot be reduced to a single statistical indicator. In some contexts, extreme mortality shocks may compress certain dispersion measures if deaths are concentrated at older ages, even while welfare collapses and life expectancy falls. For that reason, this article has insisted that reversal must be understood in a broader sense: as the breakdown of long-term equalizing convergence, the reappearance of durable stratification in survival, and the concentration of mortality loss among populations already positioned at the margins of protection. What reverses is not only a trend line in a graph, but the political and institutional capacity to make survival more equally shareable across society.

The theoretical synthesis developed here helps explain why this reversal is not merely epidemiological. Beck clarifies the structural distribution of hazards, Foucault illuminates how institutions govern life through uneven protective capacities, and Mbembe reveals the darker threshold at which some populations are rendered more exposed, less protected, and ultimately more disposable. Together, these perspectives make clear that mortality inequality is not exhausted by the language of health disparity. It is also a question of valuation. Whose deaths are anticipated, normalized, and politically backgrounded? Whose vulnerability is recognized as a public problem, and whose is treated as an unfortunate but tolerable residue of crisis? Once framed this way, the

unequal distribution of vaccines, intensive care, emergency care, safe working conditions, and digital health technologies becomes inseparable from the larger political economy of life and death. The mixed-methods orientation proposed in this paper is important precisely because it allows these questions to be analyzed not only through demographic indicators, but also through the institutional and discursive logics that justify unequal protection.

The implications for distribution science are substantial. If the field continues to confine itself to the allocation of goods, services, and market opportunities, it risks leaving untouched the most consequential distributional problem of all: who gets to survive, for how long, and under what conditions. Mortality inequality forces a broader understanding of distribution, one that includes not only wealth and welfare but the infrastructures of protection that mediate life chances under conditions of systemic risk. This means that public health systems, social insurance, urban planning, environmental regulation, labor protection, and technology governance should not be treated as separate policy domains. They are all part of the distributive architecture of survival. The lesson of the twentieth century is that mortality equalization becomes possible when risk is collectivized and protection is widened. This requires the implementation of effective social strategies focused on equitable healthcare access and institutional resilience.

At this point, we can state the article's contribution more concretely in terms of health resource systems. Mortality inequality is shaped not only by who is socially exposed to danger, but also by how vaccines, medicines, diagnostics, and medical services are sourced, allocated, transported, and delivered across institutional and territorial channels. In this sense, unequal survival is mediated by supply chain performance, the inclusiveness of access regimes, and the effectiveness of delivery systems. Governments, pharmaceutical firms, hospitals, international organizations, and local care networks function as key actors whose decisions influence procurement, stockpiling, priority setting, regional allocation, and household-level uptake. Where these channels operate unevenly, institutional inequality is converted into unequal protection and, ultimately, into unequal mortality outcomes. The study, therefore, suggests that mortality inequality should be analyzed not only as a problem of risk governance or health disparity, but also as a problem of healthcare allocation and institutional access systems through which life-saving resources are materially circulated.

For that reason, the normative conclusion of this paper is unavoidable. The reversal of mortality equalization is not simply a technical challenge for demographers or a temporary disturbance in global health indicators. It is a socioeconomic and institutional justice crisis. A world in which advanced medicine, public health knowledge, and digital technologies coexist with preventable excess death on such a scale is not suffering from a shortage of scientific capability alone. It is suffering from a failure to organize protection on equitable terms. The task ahead is therefore not just to restore average gains in life expectancy, but to rebuild the institutional and moral foundations of equal survival. That requires treating healthcare access, social protection, environmental security, and life-saving technology not as residual benefits to be distributed after markets have spoken, but as constitutive elements of a just social order. If mortality is the final register of distributional failure, then the struggle against unequal death must become one of the central intellectual and political projects of our time.

AUTHOR CONTRIBUTIONS

Conceptualization and theory: CC; research design: CC; data collection: CC; analysis and interpretation: CC; writing draft preparation: CC; supervision: CC; correction of article: CC; proofread and final approval of article: CC. All authors have read and agreed to the published version of the manuscript.

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