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The Asymmetric Impact of Health Expenditure, Bottom Decile Income, and Trade Openness on BRICS Health Indicators[1]

Abstract. Amid growing concerns about widening health inequities and the complex interaction of socioeconomic determinants, the problem of improving health outcomes in emerging economies—particularly within BRICS nations—has become ever more significant. This research delves into the impact of health expenditure, trade openness, and income distribution on health indicators such as infant mortality rate (IMR), life expectancy (LE), and crude death rate (CDR) in BRICS, including Brazil, Russia, India, China and South Africa. The study uses annual time series panel data from 2000 to 2023 and applies the cross-sectional asymmetric autoregressive distributed lag (CS-NARDL) model to examine these relationships. The findings reveal that an increase in health spending leads to reductions in mortality and death rates, while reduced spending has a more pronounced (negative) effect on health indicators. Moreover, the study highlights the organic improvement in health indicators observed in open economies, as they benefit from the exchange of advanced health technology and services. The results indicate that an increase in income among the poorest households in the lowest quartile of income distribution enhances their access to health services, thereby leading to improved health indicators. This study contributes to the existing literature on the impact of health expenditure and income distribution on health indicators. Governments should establish mechanisms to evaluate the effectiveness of healthcare spending on health outcomes, enabling them to improve their healthcare policies and programs.

Keywords: health indicators, health expenditure, IMR, life expectancy, crude death rate, trade openness

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ИССЛЕДОВАТЕЛЬСКАЯ СТАТЬЯ

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АСИММЕТРИЧНОЕ ВЛИЯНИЕ РАСХОДОВ НА ЗДРАВООХРАНЕНИЕ, ДОХОДОВ НИЖНЕГО ДЕЦИЛЯ И ОТКРЫТОСТИ ЭКОНОМИКИ НА ПОКАЗАТЕЛИ ЗДРАВООХРАНЕНИЯ В СТРАНАХ БРИКС

Аннотация. В условиях неравномерного доступа к медицинским услугам и воздействия различных социально-экономических факторов проблема повышения эффективности систем здравоохранения в странах с развивающейся экономикой, в частности в странах БРИКС, приобретает особую значимость. Настоящее исследование посвящено анализу того, как государственные расходы на здравоохранение, открытость экономики и распределение доходов влияют на ключевые показатели здоровья населения — уровень младенческой смертности (IMR), ожидаемую продолжительность жизни (LE) и общий коэффициент смертности (CDR) в Бразилии, России, Индии, Китае и Южной Африке. В качестве эмпирической базы использованы панельные данные за 2000–2023 гг. Для оценки асимметричных эффектов применяется модель кросс-секционного асимметричного авторегрессионного распределённого лага (CS-NARDL). Показано, что увеличение расходов на здравоохранение способствует снижению показателей смертности, тогда как их сокращение оказывает более выраженное негативное влияние на состояние здоровья населения. Кроме того, выявлено, что в более открытых экономиках наблюдается естественное улучшение показателей здравоохранения, обусловленное доступом к передовым медицинским технологиям и услугам. Повышение доходов среди наименее обеспеченных групп населения (нижний дециль) также способствует улучшению доступа к медицинской помощи и, соответственно, улучшению здоровья. Таким образом, данное исследование расширяет наши представления о влиянии расходов на здравоохранение и распределении доходов на здоровье населения в странах БРИКС. Подчеркивается необходимость внедрения механизмов мониторинга и оценки эффективности государственных расходов в данной сфере, что позволит повысить эффективность политики здравоохранения и приблизиться к целям устойчивого развития.

Ключевые слова: показатели здравоохранения, государственные расходы на здравоохранение, уровень младенческой смертности, ожидаемая продолжительность жизни, общий коэффициент смертности, открытость торговли

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Introduction

Healthcare is a complex and multifaceted system that plays a vital role in the overall well-being of society. Economic development remains a central objective for any nation, as it drives both the production of goods and services and enhances population well-being (Acemoglu & Restrepo, 2017; Barro, 1991). Given that health is a fundamental aspect of human life, investments in healthcare directly contribute to improving quality of life and overall well-being (Grigoli & Kapsoli, 2018). A well-functioning healthcare system is therefore essential to sustaining public health and supporting economic and social development.

There is strong empirical evidence demonstrating a positive correlation between rising incomes from economic growth and increased healthcare expenditures (Grigoli & Kapsoli, 2018). Research has demonstrated a robust correlation between increased earnings stemming from economic expansion and a considerable surge in healthcare costs (Baltagi & Moscone, 2010; Hartwig & Sturm, 2014; Hosoya, 2014; Rana et al., 2021). While some studies suggest that higher healthcare spending can further stimulate economic growth (Naidu & Chand, 2013; Piabuo & Tieguhong, 2017), others contend that the relationship is less straightforward and that increased spending does not necessarily lead to economic expansion (Khoshnevis Yazdi & Khanalizadeh, 2017; Wang & Lee, 2018). Nonetheless, investment in healthcare infrastructure is widely recognized as a critical factor in achieving sustainable development and enhancing societal well-being (Grigoli & Kapsoli, 2018).

Research has shown that the Sustainable Development Goals (SDGs) and healthcare are closely linked and addressing health challenges is crucial for achieving sustainable development (Aziz et al., 2021; Rebolledo & Giatti, 2022). The SDGs adopted by the United Nations in 2015, include specific targets for improving health and well-being for all, under Goal 3. Research has shown that inclusive, accessible, and affordable healthcare systems can contribute significantly to reducing poverty and promoting long-term economic growth (Rebolledo & Giatti, 2022). Access to quality healthcare is associated with improved health outcomes, increased life expectancy, and reduced mortality rates.

Furthermore, studies underscore the importance of investing in healthcare infrastructure and workforce, expanding access to essential medicines and vaccines, and addressing the social determinants of health that drive disparities (Ahmed, 2022; Hone et al., 2018). Building resilient healthcare systems capable of responding to crises—such as pandemics and natural disasters—is also critical for sustainable development. Moreover, equitable healthcare systems that address structural inequalities and social determinants of health have been shown to produce more equitable health outcomes and reduce disparities across populations (Odagiri et al., 2018).

The relationship between individual income and health is well established. As income rises, its marginal impact on health tends to diminish, reflecting a concave relationship with important implications for the connection between income distribution and overall health outcomes (Rodgers, 2002; Subramanian & Kawachi, 2004). This can help to ensure that all members of a society have an equal opportunity to lead healthy and fulfilling lives, regardless of their socio-economic status. More broadly, healthcare systems play a vital role in advancing the Sustainable Development Goals (SDGs). Ongoing research and systematic evaluation are essential for enhancing the performance and effectiveness of these systems, and for ensuring that they remain aligned with the principles of sustainable development (Ahmed, 2022).

Gross National Income (GNI) per capita is an important factor that affects health expenditure. It reflects a country's overall economic stability and prosperity. Countries with higher GNI per capita tend to have more resources to spend on healthcare, as higher incomes may drive demand for healthcare services (see, (Baltagi & Moscone, 2010; Hartwig & Sturm, 2014; Hosoya, 2014; Rana et al., 2021). Furthermore, higher GNI per capita enables greater allocation of resources to healthcare, leading to increased current health expenditure. Over the past two decades, global health spending has risen significantly, reaching US$ 8.5 trillion in 2019, or 9.8 % of global GDP (up from 8.5 %) (WHO, 2021) (see, Figure 1). High-income nations accounted for nearly 80 % of this expenditure, with the United States alone contributing over 40 %. On average, per capita health expenditure in these nations was more than four times the average GDP per capita of low-income countries (Baltagi & Moscone, 2010; Hartwig & Sturm, 2014; Hosoya, 2014; WHO, 2021).

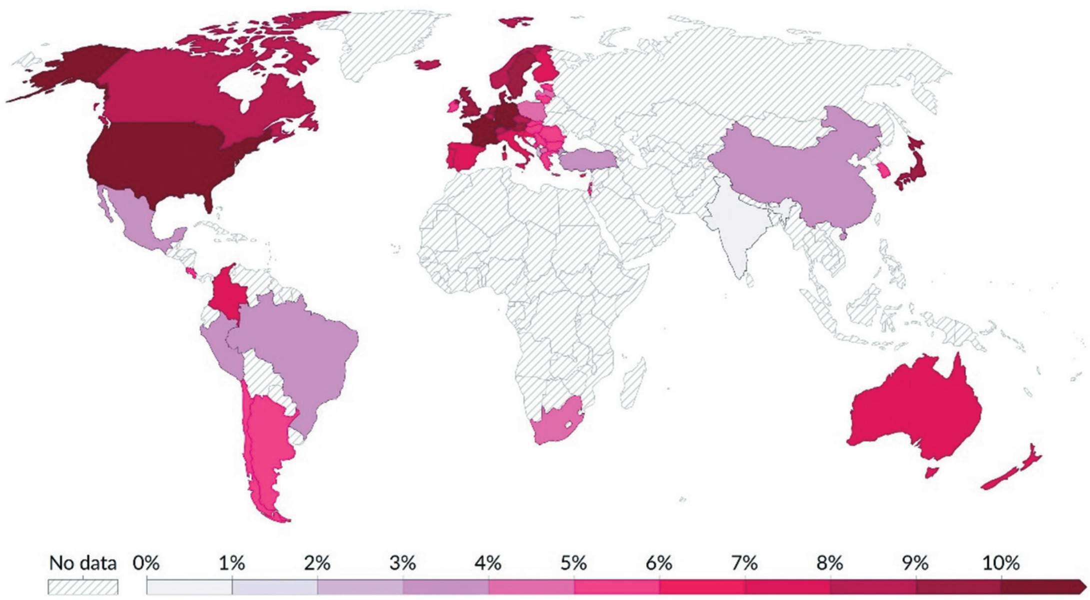

Fig. 1. *Government Health Expenditure as Share of GDP from 1980 to 2021*
Data Source: Our World in Data based on Lindert (1994), OECD (1993), OECD Stat (2021). https://ourworldindata.org/financing-healthcare (Date of access: 01.06.2024)

The substantial increase in health expenditure has prompted academicians and policymakers to examine its effects and underlying determinants (Cutler et al., 2006; Hall & Jones, 2007; Kleiman, 1974; Murphy & Topel, 2006; Newhouse, 1977; Nordhaus, 2002).

Studying health indicators in BRICS nations (Brazil, Russia, India, China, and South Africa) is crucial, as they have surpassed the G7 countries in their share of global GDP based on purchasing power parity (PPP). By 2023, this gap had widened further, with BRICS accounting for 32 % of global GDP compared to the G7's 30 %. Government spending in BRICS countries also shows an upward trend, rising from an average of 33.9 % of GDP in 2018 to 35.85 % in 2023 (see Figure 1), with total expenditure peaking at 38 % of GDP during the COVID-19 pandemic in 2019–20[1].

It is essential to study the determinants of healthcare expenditure as the level of spending carries significant policy implications for the financing and allocation of healthcare resources (Baltagi et al., 2017; Baltagi & Moscone, 2010). No economy can remain closed. Throughout human history, trade has been a key driver of economic development. It functions like the bloodstream of today's globalized economy. Trade openness, a key indicator of globalization, is known to boost productivity, foster human capital accumulation, and promote human development. Moreover, trade can influence both the pace and structure of economic growth. Higher growth rates can increase the use of labour and capital—two essential inputs in production that contribute to rising per capita income (Farooq et al., 2019).

From a theoretical perspective, a country's trade openness can directly influence its economic growth by impacting income, consumption, and investment (Frankel & Romer, 1999; Harrison, 1996; Jawadi et al., 2018). Additionally, it can indirectly shape wealth distribution, inequality, poverty levels, and overall health outcomes. The link between trade openness and health operates through two primary mechanisms. First, trade with more developed nations can create knowledge spillovers that enhance disease treatment by improving access to high-quality pharmaceuticals and medical technologies (Coe & Helpman, 1995). These spillovers can also strengthen local institutions by introducing new ideas, policies, and regulatory frameworks (Sandholtz & Gray, 2003), fostering an environment conducive to better health outcomes (Rodrik et al., 2004). Second, international trade can enhance product quality, promote competition, lower prices, and strengthen public sector capacity (Rodrik et al., 2004).

Some studies suggest that trade liberalization positively impacts public health by facilitating the exchange of medical goods and services, improving healthcare practices, and optimizing disease management. Furthermore, trade can drive institutional improvements, as open economies often import not just goods and capital but also ideas, regulations, and governance norms (Jawadi et al., 2018; Rodrik et al., 2004; Sandholtz & Gray, 2003). (Owen & Wu, 2007) examined this relationship using panel data on 219 countries, including both developed and developing economies, to analyse how trade openness influences child mortality and life expectancy and found positive relationship between them (also see, (Bergh & Nilsson, 2010; Bussmann, 2009; Jawadi et al., 2018).

Figures 2 and 3 highlight declining trends in the infant mortality rate (IMR) and improving trends in life expectancy across BRICS countries. This raises an important question: are these shifts in health indicators primarily driven by strategic health expenditure and government spending, or are they the result of open economic policies? This study seeks to examine the influence of health expenditure, trade openness, and income distribution on key health indicators, including IMR, life expectancy (LE), and the crude death rate (CDR), within the context of BRICS countries.

Literature Review

Since the pioneering work by Kleiman (1974) and Newhouse (1977), income has been the primary variable in determining how health care spending varies from one country to the next. Earlier studies have tried to measure the income elasticity of health spending and its policy implications for funding and allocating resources for health care. Healthcare is a matter of divergent opinions; according to some research, health services and their distribution should be market driven. Alternatively, some argue that healthcare is a fundamental service and support government funding and participation in providing healthcare (Culyer, 1988; Di Matteo, 2003).

Several non-income determinants of health expenditure have been identified in the literature, including factors such as population size, life expectancy, and income inequality (Baltagi et al., 2017; Culyer, 1988). Research has found a strong correlation between rising incomes due to economic growth and significantly greater health

[1] International Monetary Fund (IMF). (2023). World Economic Outlook. https://www.imf.org/en/Publications/WEO/Issues/2023/10/10/world-economic-outlook-october-2023 (Date of access: 02.07.2024)

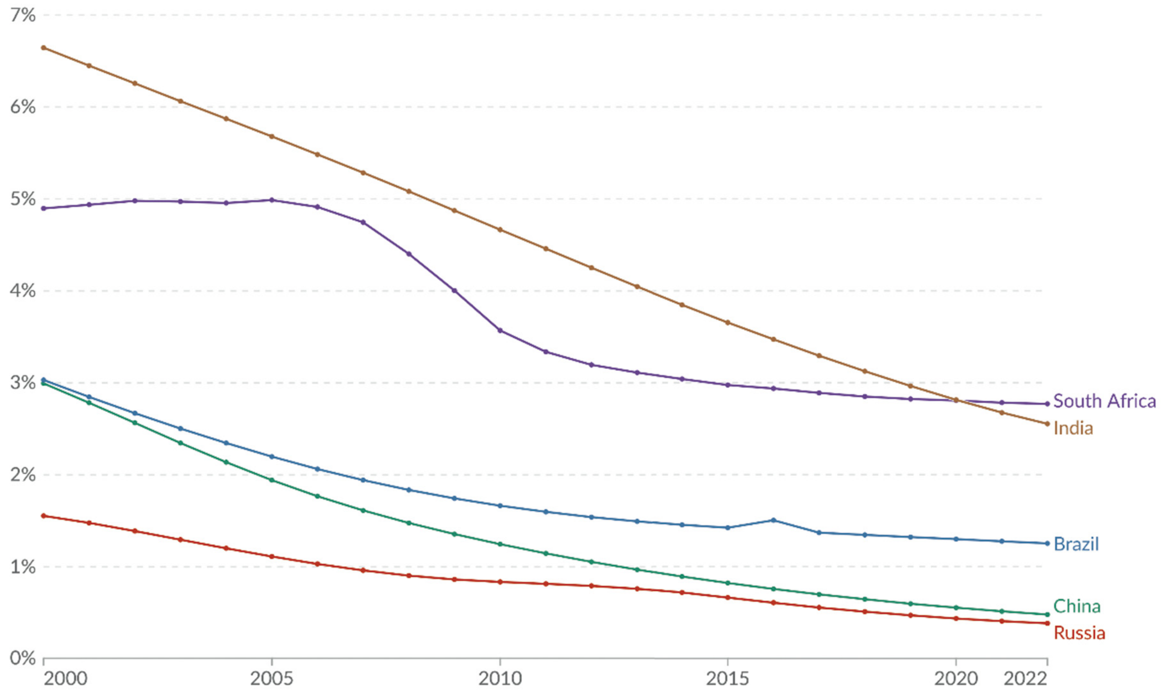

Fig. 2. *Infant Mortality Rate of BRICS Nation from 2000 to 2022*
Data Source: World Bank (2023) and complied by Our World in Data. https://ourworldindata.org/grapher/infant-mortality?tab=chart&country=BRA~RUS~IND~CHN~ZAF (Date of access: 10.07.2024)

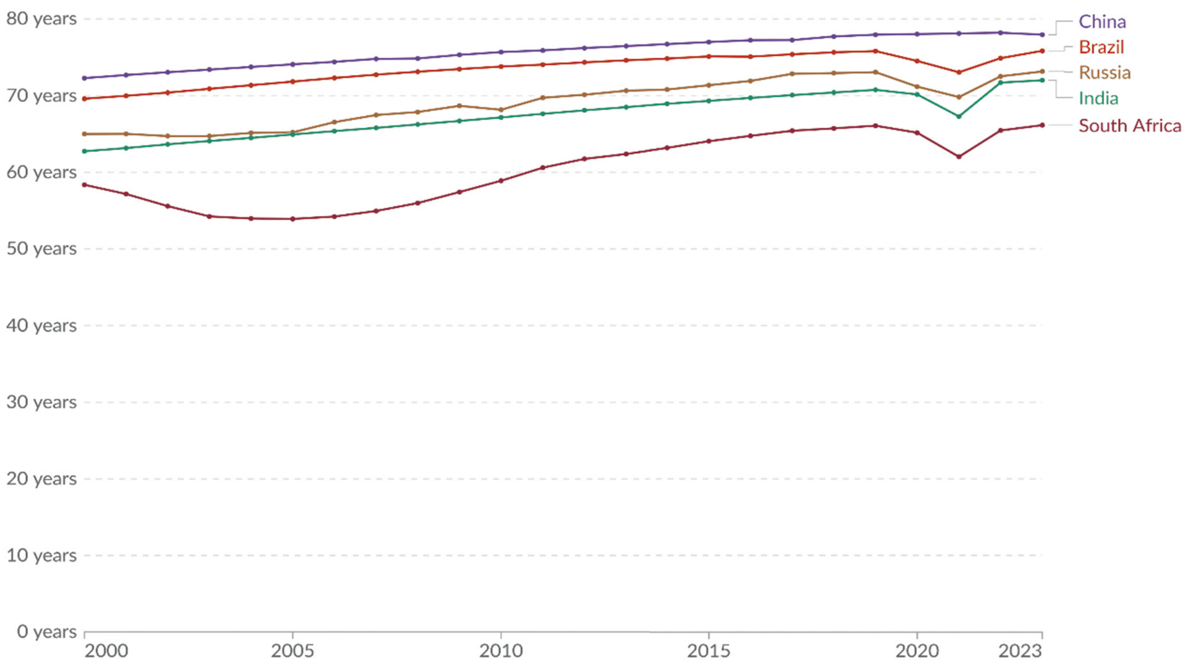

Fig. 3. *Life Expectancy Rate of BRICS Nation from 2000 to 2023*
Data Source: World Bank (2023) and complied by Our World in Data. https://ourworldindata.org/life-expectancy (Date of access: 20.07.2024)

spending (Baltagi & Moscone, 2010; Hartwig & Sturm, 2014; Hosoya, 2014; Rana et al., 2021). On the one hand, some research suggests that health spending boosts economic growth (Naidu & Chand, 2013; Piabuo & Tieguhong, 2017), while other studies contend that this is not the case (Khoshnevis Yazdi & Khanalizadeh, 2017; Wang & Lee, 2018). Hence, investing in healthcare infrastructure is a crucial aspect of achieving sustainable development and improving the well-being of society (Grigoli & Kapsoli, 2018).

Asian economies have experienced rapid growth over the past two to three decades, driven largely by the economic engines of countries like China

Table 1

Summary of Methodologies and Limitations in Previous Studies

Literature	Methodology used	Key Findings	Limitation of Methodology
(Baltagi & Moscone, 2010; Rana et al., 2021)	Fixed effect Panel Regression	A strong association was identified between increased incomes driven by economic growth and substantially higher health expenditures.	The limitation of fixed effect panel regression is its inability to estimate the effects of time-invariant variables, as these are absorbed by the individual fixed effects.
(Hartwig & Sturm, 2014)	Extreme Bounds Analysis		The limitation of Extreme Bounds Analysis is its reliance on arbitrary model specifications, which may lead to over-sensitivity or dismissal of valid relationships.
(Khoshnevis Yazdi & Khanalizadeh, 2017)	Autoregressive Distributed Lag (ARDL)	No association was observed between increased incomes resulting from economic growth and significantly higher health expenditures.	The limitation of the Autoregressive Distributed Lag (ARDL) model is its reliance on a large sample size to ensure reliable estimates, especially for long-run relationships.
(Wang & Lee, 2018)	dynamic panel threshold model (D.P.T.M.)		The limitation of DPTM is its complexity in estimation and interpretation, requiring strong assumptions about threshold effects and potential endogeneity.
(Babones, 2008; Kawachi & Kennedy, 1999; Pickett & Wilkinson, 2015)	Causality Models	In developed and developing nations, income inequality affects both life expectancy and infant mortality rates.	The limitation of causality models is their dependence on strong assumptions, such as no omitted variable bias or the validity of instruments, which are challenging to verify in practice.
(Jakovljevic et al., 2022)	Bayesian hierarchical models	An increase in health expenditure results in a reduction in mortality rates within BRICS countries.	The limitation of Bayesian hierarchical models is their computational intensity, especially for large datasets, which may require advanced techniques like Markov Chain Monte Carlo (MCMC) and substantial computing resources.
(Jani et al., 2019)	Panel Regression	Globalization activities, such as trade openness, have a positive impact on health indicators.	The limitation of panel regression is its susceptibility to endogeneity issues, which can bring biased results if not addressed through techniques like instrumental variables or dynamic modelling.

Source: Compiled by the authors

and India (Wolf et al., 2011). This unprecedented income growth is helping Asia narrow the income gap with developed countries, particularly those in the OECD. However, the literature on income and health remains divided on whether the health disparities between countries can be attributed mainly to income differences. In developed nations, life expectancy and infant mortality rates are influenced by income inequality (Pampel Jr. & Pillai, 1986; Wilkinson, 1992) Subsequent studies have established a link between income distribution within societies and health indicators (Babones, 2008; Kawachi & Kennedy, 1999) An extensive review of this topic (Pickett & Wilkinson, 2015) found that income inequality, both within and between countries, can negatively affect health outcomes.

Amimo et al. (2021) argue that the "Rise of Emerging Markets" will be driven by the BRICS countries, shaping social and economic transformations over the next 30 years. As leading economies among emerging markets, the BRICS nations have experienced significant increases in health spending and now contribute a larger share to global health expenditures (Bai et al., 2021; Gu et al., 2022). Healthcare costs per capita in the BRICS countries have steadily risen, and it is projected that by 2035 their health expenditures will reach the highest absolute levels globally (Gupta & Bhatia, 2022; Sahoo et al., 2023).

Sahoo et al. (2023) predict that the BRICS nations have the capacity to lead in social policy. In order to achieve universal health care, the BRICS nations are reworking their health systems. Not all the BRICS member nations are able to increase their health spending and coverage compared to other fellow members, (M. G. Sharma & Popli, 2023) found that India is not as close to reaching the Universal Health Coverage (UHC) objective as its peer nations in the BRICS and ASEAN-5, despite notable advancements in a number of health metrics. They highlights the reason to hamper healthcare due to lack of infrastructure and a skilled health personnel, which is made worse by the unequal distribution of these resources (Ansmann et al., 2021; Yan et al., 2023).

Contrary to the findings of Sharma & Popli (2023), Lamnisos et al. (2021) predict a long-term increase in per capita health spending across the BRICS nations. It is expected that Russia's total health expenditure as a share of GDP will remain stable until 2030 (see Canbay & Kırca, 2022), while China is projected to significantly boost its investment in the health sector. Brazil's health spending as a proportion of GDP is anticipated to decline notably. India is forecasted to experience the highest growth rate in per capita health expenditure through 2030 (Jakovljevic et al., 2022; Wang et al., 2023).

The literature on the impact of trade openness on health shows mixed results (Cornia, 2001; Hitiris & Posnett, 1992; Jani et al., 2019; Levine & Rothman, 2006). A key concern is that trade openness may primarily benefit developed countries, due to the less mature economic and governance systems in developing and underdeveloped nations (Cornia, 2001; Deaton, 2004).

The primary focus of the study was to examine how trade openness, income inequality, and health expenditure influence key health indicators, such as the Infant Mortality Rate (IMR), Life Expectancy (LE), and Crude Death Rate (CDR), specifically within the context of BRICS countries. Additionally, a brief literature review highlighted that prior studies examining the relationships among these factors and health indicators—either individually or collectively—show mixed results. This variability can be attributed to issues such as sample size and methodological differences. Table 1 summarizes the common methods employed in previous studies along with their limitations.

This study employs the cross-sectional panel non-linear autoregressive distributed lag model (CS-NARDL), which is more effective than methods like panel regression and linear ARDL (Patel & Mehta, 2023; R. Sharma et al., 2024). This model captures asymmetric relationships between variables, allowing it to distinguish how positive and negative shocks impact the dependent variable differently. It offers greater flexibility in modelling non-linear dynamics, making it more suitable for real-world scenarios (Aydin & Bozatli, 2023; Mehta & Derbeneva, 2023). The CS-NARDL model enhances the model fit by accommodating varying effects in both the short and long run. Unlike more complex models, it remains relatively straightforward while still capturing intricate relationships, resulting in more robust findings (Aydin & Bozatli, 2023).

Data and Methodology

This paper aims to examine the impact of health expenditure, trade openness, and income distribution among the poor on the health indicators of BRICS nations. The analysis uses infant mortality rate (IMR), life expectancy (LE), and crude death rate (CDR) as dependent variables. The key independent variables include current health expenditure, trade openness (as a proxy for globalization), and income distribution, while income and urbanization are included as control variables. Table 2 provides a detailed description of the variables, along with their representation and data sources. The study employs panel data for BRICS countries, covering the period from 2000 to 2023. All nominal values have been converted into real terms using the 2005 GDP deflator.

Econometric Model

The study proposes cross sectional panel non-linear autoregressive distributed lag models (CS-NARDL) (Shin et al., 2014) to capture the asymmetric relationship of health indicators (IMR, LE and CDR), current health expenditure, trade openness and income inequality. The study estimates three models to assess the impact of explanatory variables on three distinct health indicators (see Equations (3.1), (3.2) and (3.3)).

$$\aleph_{ij} = f(\tau_{ij}, \gamma_{ij}, \omega_{ij}, \delta_{ij}, \sigma_{ij}) \quad (3.1)$$

$$\varphi_{ij} = f(\tau_{ij}, \gamma_{ij}, \omega_{ij}, \delta_{ij}, \sigma_{ij}) \quad (3.2)$$

$$\vartheta_{ij} = f(\tau_{ij}, \gamma_{ij}, \omega_{ij}, \delta_{ij}, \sigma_{ij}) \quad (3.3)$$

Equation (3.1) represents the infant mortality rate (IMR, $\aleph_{ij}$ for BRICS as a function of the explanatory variables under consideration. Similarly, Equations (3.2) and (3.3) represent life expectancy (φ_{ij}) and crude death rate (ϑ_{ij} respectively, as functions of the same set of explanatory variables. To determine the existence of a long-run relationship among the variables in Equations (3.1)–(3.3), cointegration tests are conducted. These tests assess the stationarity of the residuals under the assumption that the independent variables have cross-section-specific intercepts and homogeneous slope coefficients (Esily et al., 2022; Mehta & Prajapati, 2024; Pedroni, 1999, 2004). After establishing the presence of a cointegration relationship, a causality test is performed to examine the direction of causality between the variables. Equation (3.4) is used to test the null hypothesis of no causal relationship between y (the dependent variable) and x (the independent variable).

$$y_{it} = \eta_i + \sum_{k=1}^{K} \tilde{n}_i^{(l)} y_{it-k} + \sum_{k=1}^{K} \varsigma_i^{(l)} x_{it-k} + \varepsilon_{it} \quad (3.4)$$

Table 2

Data Description and Measure of Dependent Variables

Variable	Variable Representation	Description
Dependent Variables		
Infant Mortality Rate	$\aleph$	Description: The number of infants dying before reaching one year of age, per 1,000 live births in a given year.
Life Expectancy	φ	Description: Life expectancy at birth indicates the number of years a new-born infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.
Crude Death Rate	ϑ	Description: The number of deaths during the year, per 1,000 population estimated at midyear.
Independent Variables		
Current Health Expenditure	τ	Description: Expressed as a percentage of GDP. Estimates of current health expenditures include healthcare goods and services consumed each year.
Trade Openness	γ	Description: Trade is the sum of exports and imports of goods and services measured as a share of GDP.
Income share held by lowest 10 %*	ω	Description: Percentage share of income or consumption that accrues to the first (poorest) decile.
Control Variable		
National Income	δ	Description: Annual percentage growth rate of GDP at market prices based on constant local currency.
Urban Population	σ	Description: Calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects.

Source: Compiled by the authors by using the data from World Development Indicators Data from World Bank Database 2023. https://databank.worldbank.org/source/world-development-indicators (Date of access: 21.08.2023)

* Income inequality is reflected in the uneven distribution of income or consumption, with the lowest income groups receiving the smallest shares. These data are typically sourced from nationally representative household surveys. Source: World Bank, Poverty and Inequality Platform. https://databank.worldbank.org/metadataglossary/world-development-indicators/series/SI.DST.FRST.10 (Date of access: 26.11.2024)

where η_i denotes the constant term, $\tilde{n}_i^{(l)}$ means the lag parameter, and $\varsigma_i^{(l)}$ indicates the slope coefficient at lag length l.

The cross sectional asymmetric distributed lag model (CS-NARDL) is presented in long-run equations (3.5), (3.6) and (3.7) for health indicators (IMR, LE and CDR) as a measure of health expenditure, trade openness, income inequality, national income and urban population.

$$\aleph_{tj} = \alpha_0 + \alpha_1\tau_{tj}^{+} + \alpha_2\tau_{tj}^{-} + \alpha_3\gamma_{tj}^{+} + \alpha_4\gamma_{tj}^{-} + \alpha_5\omega_{tj}^{+} + \alpha_6\omega_{tj}^{-} + \alpha_7\delta_{tj} + \alpha_8\sigma_{tj} + \varepsilon_t \quad (3.5)$$

$$\varphi_{tj} = \psi_0 + \psi_1\tau_{tj}^{+} + \psi_2\tau_{tj}^{-} + \psi_3\gamma_{tj}^{+} + \psi_4\gamma_{tj}^{-} + \psi_5\omega_{tj}^{+} + \psi_6\omega_{tj}^{-} + \psi_7\delta_{tj} + \psi_8\sigma_{tj} + \varepsilon_t \quad (3.6)$$

$$\vartheta_{tj} = \phi_0 + \phi_1\tau_{tj}^{+} + \phi_2\tau_{tj}^{-} + \phi_3\gamma_{tj}^{+} + \phi_4\gamma_{tj}^{-} + \phi_5\omega_{tj}^{+} + \phi_6\omega_{tj}^{-} + \phi_7\delta_{tj} + \phi_8\sigma_{tj} + \varepsilon_t \quad (3.7)$$

Where τ, γ and ω measure the asymmetric impact of current health expenditure, trade openness and income inequality on $\aleph$ (Infant Mortality Rate), φ (Life Expectancy) and ϑ (Crude Death Rate) in Equations (3.5), (3.6) and (3.7).

$$\begin{cases} \tau_i^{+} = \sum_{j=1}^{t}\Delta\tau_{ij}^{+} = \sum_{j=1}^{T} Max\left(\Delta\tau_{ij}, 0\right) \\ \tau_i^{-} = \sum_{j=1}^{t}\Delta\tau_{ij}^{-} = \sum_{j=1}^{T} Min\left(\Delta\tau_{ij}, 0\right) \end{cases} \quad (3.8)$$

$$\begin{cases} \gamma_i^{+} = \sum_{j=1}^{t}\Delta\gamma_{ij}^{+} = \sum_{j=1}^{T} \mathrm{Max}\left(\Delta\gamma_{ij}, 0\right) \\ \gamma_i^{-} = \sum_{j=1}^{t}\Delta\gamma_{ij}^{-} = \sum_{j=1}^{T} \mathrm{Min}\left(\Delta\gamma_{ij}, 0\right) \end{cases} \quad (3.9)$$

$$\begin{cases} \omega_i^{+} = \sum_{j=1}^{t}\Delta\omega_{ij}^{+} = \sum_{j=1}^{T} \mathrm{Max}\left(\Delta\omega_{ij}, 0\right) \\ \omega_i^{-} = \sum_{j=1}^{t}\Delta\omega_{ij}^{-} = \sum_{j=1}^{T} \mathrm{Min}\left(\Delta\omega_{ij}, 0\right) \end{cases} \quad (3.10)$$

The positive and negative partial sum decomposition for τ, γ and ω is presented in Equations (3.8), (3.9) and (3.10).

$$\Delta\aleph_{it} = \sum_{J=1}^{M-1}\theta_{ij}\Delta\aleph_{it-J} + \sum_{J=0}^{N-1}\left(\theta_{ij}^{+}\Delta\tau_{ij}^{+} + \theta_{ij}^{-}\Delta\tau_{ij}^{-}\right) + \\ +\sum_{J=0}^{O-1}\left(\theta_{ij}^{+}\Delta\gamma_{ij}^{+} + \theta_{ij}^{-}\Delta\gamma_{ij}^{-}\right) + \sum_{J=0}^{O-1}\left(\theta_{ij}^{+}\Delta\omega_{ij}^{+} + \theta_{ij}^{-}\Delta\omega_{ij}^{-}\right) + \\ +\sum_{J=1}^{Q-1}\theta_{ij}\Delta\delta_{it-J} + \sum_{J=1}^{R-1}\theta_{ij}\Delta\sigma_{it-J} + \theta_{ij}ECT_{t-1} + \varepsilon_{it} \quad (3.11)$$

$$\Delta\varphi_{it} = \sum_{J=1}^{M-1}\theta_{ij}\Delta\varphi_{it-J} + \sum_{J=0}^{N-1}\left(\theta_{ij}^{+}\Delta\tau_{ij}^{+} + \theta_{ij}^{-}\Delta\tau_{ij}^{-}\right) + \\ +\sum_{J=0}^{O-1}\left(\theta_{ij}^{+}\Delta\gamma_{ij}^{+} + \theta_{ij}^{-}\Delta\gamma_{ij}^{-}\right) + \sum_{J=0}^{O-1}\left(\theta_{ij}^{+}\Delta\omega_{ij}^{+} + \theta_{ij}^{-}\Delta\omega_{ij}^{-}\right) + \\ +\sum_{J=1}^{Q-1}\theta_{ij}\Delta\delta_{it-J} + \sum_{J=1}^{R-1}\theta_{ij}\Delta\sigma_{it-J} + \theta_{ij}ECT_{t-1} + \varepsilon_{it} \quad (3.12)$$

$$\Delta\vartheta_{it} = \sum_{J=1}^{M-1}\theta_{ij}\Delta\vartheta_{it-J} + \sum_{J=0}^{N-1}\left(\theta_{ij}^{+}\Delta\tau_{ij}^{+} + \theta_{ij}^{-}\Delta\tau_{ij}^{-}\right) + \\ +\sum_{J=0}^{O-1}\left(\theta_{ij}^{+}\Delta\gamma_{ij}^{+} + \theta_{ij}^{-}\Delta\gamma_{ij}^{-}\right) + \sum_{J=0}^{O-1}\left(\theta_{ij}^{+}\Delta\omega_{ij}^{+} + \theta_{ij}^{-}\Delta\omega_{ij}^{-}\right) + \\ +\sum_{J=1}^{Q-1}\theta_{ij}\Delta\delta_{it-J} + \sum_{J=1}^{R-1}\theta_{ij}\Delta\sigma_{it-J} + \theta_{ij}ECT_{t-1} + \varepsilon_{it} \quad (3.13)$$

The error correction term (ECT) in the short-run CS-NARDL Equations (3.11), (3.12), and (3.13) measures the speed at which the system returns to long-term equilibrium following a short-term disturbance.

Results and Discussion

Each variable's standard deviation is less than its mean value, showing constant variation (see Table 3). The normal distribution of all the variables was corroborated by the insignificant Jarque-Bera test statistic (Mehta & Derbeneva, 2024). Table 3 shows the pairwise correlation among the variables for BRICS countries panel data along with a summary of the descriptive statistics.

The pairwise correlation estimates strongly suggest that current health expenditure health expenditure (τ), trade openness (γ, decrease of income inequality (ω) have a negative impact on health indicators (see Table 4). To test the hypothesis that all panels are non-stationary, the study utilizes unit root tests to determine the long-term and short-term integration of the BRICS panel data (see, Breitung, 2000; Im et al., 2003; Levin et al., 2002; Mehta & Derbeneva, 2024).

Table 3

Descriptive Statistics

	ℵ	φ	ϑ	τ	γ	ω	δ	σ
Mean	18.167	70.662	9.441	6.022	42.588	2.105	4.306	1.435
Median	14.100	71.261	7.125	5.266	46.094	2.350	4.600	1.373
Maximum	57.800	77.968	16.400	10.313	68.094	3.700	11.395	4.198
Minimum	4.400	53.980	6.106	2.858	22.106	0.800	–7.800	–0.467
Std. Dev.	12.674	5.109	3.621	1.967	12.247	0.896	3.833	1.218
Skewness	1.315	–1.145	0.659	0.390	–0.051	–0.070	–0.650	0.134
Kurtosis	1.015	1.418	1.736	1.946	1.985	1.727	2.392	2.046
Jarque-Bera	21.840	19.953	9.175	4.725	2.862	4.513	5.069	2.701
Probability	0.1830	0.2543	0.1050	0.9480	0.2390	0.1055	0.8709	0.2591
Observations	66	66	66	66	66	66	66	66

Source: Authors' calculations from Eviews

Table 4

Pairwise Correlation Matrix

	ℵ	φ	ϑ	τ	γ	ω	δ	σ
ℵ	1.000	—	—	—	—	—	—	—
φ	—	1.000	—	—	—	—	—	—
ϑ	—	—	1.000	—	—	—	—	—
τ	-0.033^{*}	-0.050^{**}	-0.257^{**}	1.000	—	—	—	—
γ	-0.007^{*}	-0.485^{**}	0.706^{*}	–0.622	1.000	—	—	—
ω	-0.062^{***}	-0.052^{*}	-0.287^{*}	-0.865^{*}	0.484	1.000	—	—
δ	-0.179^{**}	-0.011^{*}	-0.070^{**}	0.614^{*}	0.373^{*}	0.319	1.000	—
σ	-0.406^{*}	-0.286^{*}	-0.749^{*}	0.208^{*}	–0.155	0.0249	0.436	1.000

*, **, *** indicates significant at 1 %, 5 % and 10 % level of significance, respectively.
Source: Authors' calculations from Eviews

The CS-NARDL model can be estimated even when variables are integrated at different levels, specifically, when some are stationary at I(0) and others at I(1) (Sheikh et al., 2020; Shin et al., 2014). As shown in Table 5, all variables in the current study are stationary at the I(1) level. Despite demographic diversity among BRICS nations, the results of cross-sectional dependence tests (Table 5) indicate significant interdependence, empirically supporting their treatment as a single panel.

The rejection of the null hypothesis of cross-sectional independence at the 1 % significance level suggests the presence of common structural patterns across these countries, indicating that economic and policy-related factors influence health outcomes in a broadly similar way. Furthermore, the CS-NARDL model accommodates country-specific asymmetries by capturing both short- and long-run dynamics. This allows for demographic differences, such as stages of demographic transition, levels of urbanization, and population behaviour, without distorting the overall results. This methodological framework enhances the robustness of the findings by addressing heterogeneity while preserving the validity of cross-country comparisons.

Table 6 presents the results of the panel cointegration tests. The findings from the Pedroni tests indicate that the test statistics are significant at the 1 % level, confirming the existence of a long-run cointegration relationship among the variables (Mehta & Derbeneva, 2024; Yuelan et al., 2022).

Table 7 presents the results of the Dumitrescu-Hurlin panel causality test for the BRICS countries. The findings reveal a robust one-way relationship between health indicators (IMR-ℵ; Life Expectancy- φ; Crude Death Rate-ϑ) and health expenditure, trade openness, lower income share, national income as well as urbanization.

Table 5

Stationarity and Cross-Section Dependency Tests

Stationarity Test								
	ℵ	φ	ϑ	τ	γ	ω	δ	σ
Fisher-ADF	44.2966	19.3090*	9.2456	1.9458	13.6948	2.1360	18.1562*	9.6943
Fisher-PP	32.5925	24.7967*	3.6311	0.7518	14.9067	12.8326	38.3397*	11.8928
	Δℵ	Δφ	Δϑ	Δτ	Δγ	Δω	Δδ	Δσ
Fisher-ADF	10.8266*	6.5097*	3.1158*	24.0558*	36.3832*	7.8939*	63.2601*	56.7876**
Fisher-PP	6.4572*	16.4465*	5.3707**	33.9154*	70.1432*	41.6992*	49.1365*	83.9489*
Cross-section Dependency Test								
Cross-section	ℵ	φ	ϑ	τ	γ	ω	δ	σ
LM Breusch-Pagan	202.093*	187.017*	70.353*	88.190*	36.779*	25.123*	84.682*	88.737*
LM Pesaran scaled	42.9534*	39.5823*	13.4954*	17.4838*	5.9889*	4.5358*	16.7003*	17.6062*
CD Pesaran	14.2073*	13.6531*	1.5552*	2.9443*	-0.6525*	1.5637*	8.7349*	1.2551*

*, **, *** indicates significant at 1 %, 5 % and 10 % level of significance, respectively.
Source: Authors' calculations from Eviews

Table 6

Panel Cointegration Test

Pedroni Cointegration: Common AR coefficients (within-dimension)						
	Panel: ℵ τ γ ω δ σ		**Panel: φ τ γ ω δ σ**		**Panel: ϑ τ γ ω δ σ**	
	Statistic	Weighted Statistic	Statistic	Weighted Statistic	Statistic	Weighted Statistic
Panel v-Statistic	–1.1514*	–1.9346*	0.2783*	–1.3491*	–0.1027*	–1.7651*
Panel rho-Statistic	2.0363*	2.5277*	0.8278*	1.2929*	1.5667*	1.8283*
Panel PP-Statistic	2.9840*	4.5769*	–0.6773*	1.3483*	0.5146*	1.9870*
Panel ADF-Statistic	1.1131*	1.4498*	0.6026*	–5.9173*	1.5388*	1.4380*
Pedroni Cointegration: Individual AR coefficients (between-dimension)						
	Statistic		Statistic		Statistic	
Group rho-Statistic	1.5796*		1.6452*		2.3669*	
Group PP-Statistic	–0.2310*		0.5037*		1.6526*	
Group ADF-Statistic	–7.3729*		–17.4859*		2.2089*	

*, **, *** indicates significant at 1 %, 5 % and 10 % level of significance, respectively.
Source: Authors' calculations from Eviews

Table 7

Results of the Dumitrescu-Hurlin Causality Test

Null Hypothesis:	W-Stat.	Z-Stat.	Conclusion
$\aleph \nRightarrow \tau$	10.3895	6.5249	$\tau \Rightarrow \aleph$
$\tau \nRightarrow \aleph$	3.5416**	0.9786**	
$\varphi \nRightarrow \tau$	6.7648	3.5819	$\tau \Rightarrow \varphi$
$\tau \nRightarrow \varphi$	3.0183*	0.55477*	
$\vartheta \nRightarrow \tau$	6.3896	3.2853	$\tau \Rightarrow \vartheta$
$\tau \nRightarrow \vartheta$	2.1614*	–0.1392*	
$\aleph \nRightarrow \gamma$	6.0023	3.0656	$\gamma \Rightarrow \aleph$
$\gamma \nRightarrow \aleph$	4.0602*	1.4542*	
$\varphi \nRightarrow \gamma$	5.0440**	2.2705**	$\gamma \Leftrightarrow \varphi$
$\gamma \nRightarrow \varphi$	5.3000**	2.4829**	
$\vartheta \nRightarrow \gamma$	7.9928	4.7173	$\gamma \Rightarrow \vartheta$
$\gamma \nRightarrow \vartheta$	3.2410*	0.7744*	
$\aleph \nRightarrow \omega$	13.9935	9.6965	$\omega \Rightarrow \aleph$
$\omega \nRightarrow \aleph$	11.2447*	7.4156*	
$\varphi \nRightarrow \omega$	8.5038	5.1413	***ù*** $\Rightarrow \varphi$
$\omega \nRightarrow \varphi$	3.4852*	0.9770*	
$\vartheta \nRightarrow \omega$	7.2942	4.1376	$\omega \Rightarrow \vartheta$
$\omega \nRightarrow \vartheta$	6.6745*	3.6234*	

*, **, *** indicates significant at 1 %, 5 % and 10 % level of significance, respectively.
Source: Authors Calculation using EViews

The Dumitrescu-Hurlin causality estimates show unidirectional causality between health spending (τ), and lower income share (ω) with health indicators (IMR-$\aleph$; Life Expectancy- φ; Crude Death Rate-ϑ), whereas trade openness (γ) shows bi-direction relationship with life expectancy (φ, and uni-directional relationship with IMR ($\aleph$) and Crude Death Rate (ϑ). The causality gives the primal evidence of causal relation between health indicators and health expenditure, trade openness, and lower income share.

Impact of Health Expenditure on Health Indicators

The long-run asymmetric CS-NARDL estimates (see Table 8) reveal a significant negative relationship between health expenditure (τ) and IMR ($\aleph$. A 1 % increase in τ^{+} will decrease ($\aleph$ by 0.533 %, while a 1 % decrease in τ^{-} will increase ($\aleph$ by 1.50 %. Similarly, a 1 % increase in health spending leads to a reduction in the crude death rate (ϑ) by 1.24 %, while a decrease in health spending increases (ϑ) by 1.02 %. Additionally, the positive and significant coefficient of health spending indicates that a 1 % increase in τ^{+} will increase the life expectancy (φ) by 0.41 % whereas a reduction in τ^{-} will decrease the life expectancy (φ) by 0.64 %. It is noteworthy that the negative impact of health expenditure τ^{-}on infant mortality rate (IMR) is greater than the positive impact of increased health spending τ^{+}. This suggests that if health spending is reduced, the IMR will increase more significantly than it would decrease with higher health spending. Fluctuations in health spending directly affect life expectancy. Increased health expenditure promotes longevity, while cuts in health spending will jeopardize life expectancy.

In contrast, both increases and decreases in health spending have a positive impact on life expectancy. The short-run estimates (see Table 9) also indicate that a positive change in health expenditure $\Delta\tau^{+}$ leads to a reduction in the infant mortality rate ($\aleph$ and crude death rate (ϑ) by 2.23 and 0.28 %, respectively. Conversely, a 1 % increase in health spending $\Delta\tau^{+}$ will boost life expectancy by 0.43 %. Furthermore, the significant coefficient of a negative shock in health spending $\Delta\tau^{-}$ will increase ($\aleph$, (ϑ) and (φ) by 0.50, 0.82 and 0.55 %, respectively, in the short run.

These long-run and short-run results align with previous studies, emphasizing the importance of health expenditure (see Amimo et al., 2021; Bai et al., 2021; Gupta & Bhatia, 2022; Wang et al., 2023). The estimates indicate that health expenditure is associated with a reduction in the crude death rate and infant mortality rate, as well as improvements in life expectancy. However, the magnitudes of the effects on infant mortality and life expectancy are relatively smaller compared to the impact of negative shocks. While it is difficult to draw definitive conclusions or offer strong policy recommendations, the findings are consistent with theoretical expectations and are statistically significant.

Impact of Trade Openness on Health Indicators

It is surprising that the positive shock of trade openness (γ^{+}) increases the infant mortality rate ($\aleph$)by 0.03 % and the crude death rate (ϑ) by 0.54 %. This suggests that while trade openness may stimulate economic activity and globalization, it could also expose vulnerable populations to health risks, possibly due to unequal resource distribution or environmental challenges associated with increased trade. However, the findings also indicate that trade openness contributes to an improvement in life expectancy (φ) in the long run, likely due to better access to healthcare technologies, improved standards of living, and enhanced availability of medical resources facilitated by open trade policies (see Table 8).

In contrast, the negative shock coefficient of trade openness (γ^{-}) indicates that a reduction

Table 8

Long-run CS-NARDL Estimates

Dependent Variables	IMR ($\aleph$)	Life Expectancy (φ)	Crude Death Rate (ϑ)
Independent Variables	**Coefficient**	**Coefficient**	**Coefficient**
τ^{+}	-0.5330**	0.4125*	-1.2403**
τ^{-}	1.50110*	0.6494*	1.0243*
γ^{+}	0.0301***	0.5498*	-1.3275*
γ^{-}	0.0864**	0.1889*	0.2506
ω^{+}	-1.3178*	0.7550**	-0.6396**
ω^{-}	0.2403*	0.6621***	0.2048**
δ	-0.5102*	0.4079*	-0.8753*
σ	-0.1983*	0.2353*	-0.6419*

*, **, *** indicates significant at 1 %, 5 % and 10 % level of significance, respectively.
Source: Authors' calculations from EViews

Table 9

Short-run CS-NARDL Estimates

Dependent Variables	IMR ($\aleph$)	Life Expectancy (φ)	Crude Death Rate (ϑ)
Independent Variables	**Coefficient**	**Coefficient**	**Coefficient**
$\Delta\tau^{+}$	–2.2317**	0.4377*	–0.2879*
$\Delta\tau^{-}$	0.5038**	0.5511**	0.8201*
$\Delta\gamma^{+}$	–0.03972***	0.1328**	–0.0915*
$\Delta\gamma^{-}$	0.03446***	0.0057**	0.0106*
$\Delta\omega^{+}$	–0.16022*	0.2257*	–0.1416*
$\Delta\omega^{-}$	0.0830*	0.0876***	0.0466**
$\Delta\delta$	–0.0134*	0.1234***	0.0820**
$\Delta\sigma$	–1.0125**	0.2168*	–0.5457*
ECT	–0.0431*	–0.0112*	–0.0895*
Constant	0.1499**	0.3844***	0.0282**

*, **, *** indicates significant at 1 %, 5 % and 10 % level of significance, respectively.
Source: Authors' calculations from EViews

Table 10

CS-NARDL Model Diagnostics

Dependent Variables	IMR ($\aleph$)	Life Expectancy (φ)	Crude Death Rate (ϑ)
WaldLR Asymmetry (τ)	44.5217**	35.8289*	48.1781*
WaldSR Asymmetry (τ)	2.9953**	2.3365*	3.5102**
WaldLR Asymmetry (γ)	37.9736*	21.3735**	29.1023*
WaldSR Asymmetry (γ)	4.7977*	5.4960**	3.3379*
WaldLR Asymmetry (ω)	42.0246*	24.7807**	35.6451*
WaldSR Asymmetry (ω)	4.9352**	3.8573**	4.8147*
Hausman test	388.3309 (0.6267)	395.2579 (0.2621)	163.4015 (0.9670)
Observations	105	105	105
Log likelihood	84.28361	18.14756	66.48055
Number of Cross Sections	5	5	5

*, **, *** indicates significant at 1 %, 5 % and 10 % level of significance, respectively.
Source: Authors' calculations from EViews

in trade openness will lead to a decline in the infant mortality rate ($\aleph$ by 0.08 % and the crude death rate (ϑ) by 0.25 %, while improving life expectancy (φ) by 0.18 % in the long run. In the short run (see Table 9), an increase in $\Delta\tau^{+}$ will lower ($\aleph$) and (ϑ) by 0.03 and 0.09 %, respectively. Additionally, a decrease in trade openness ($\Delta\tau^{-}$ will result in a slight improvement in (φ) by 0.005 %, while it further worsens infant mortality ($\aleph$) and crude death rate (ϑ), increasing them by 0.03 % and 0.01 %, respectively (see Deaton, 2004; Jakovljevic et al., 2022; Jani et al., 2019; Levine & Rothman, 2006). The estimates indicate that the impact of trade openness is much smaller in the short run compared to the long run; however, direct conclusions require further investigation since the long-run negative shock is statistically insignificant. These results align with studies by Frankel & Romer (1999), Harrison (1996), and Jawadi et al. (2018), which emphasize the theoretical view that a country's trade openness indirectly influences health outcomes—reflected in the small coefficient values—alongside other economic factors.

Impact of Income Distribution on Health Indicators

Tables 8 and 9 display the estimates of the asymmetric impact of income distribution on health indicators. To measure income distribution within the lowest quartile, the study utilized the percentage share of income or consumption accruing to the first (poorest) decile. From the estimates, it can be deduced that a 1 % increase in γ^{+} (income share held by the lowest 10 %) will lead to a reduction in the infant mortality rate ($\aleph$ and crude death rate (ϑ) by 1.31 and 0.63 %, respectively, while increasing life expectancy (φ) by 0.75 % in the long run. Similarly, in the short-run $\Delta\gamma^{+}$, it will decrease ($\aleph$) and (ϑ) by 0.16 and 0.14 %, respectively, and increase (ϑ) by 0.22 %.

The significant coefficient of the negative shock in income share, γ^{-} , indicates that a 1 % reduction will result in an increase in ($\aleph$) by 0.24 %, (φ) by 0.66 % and (ϑ) by 0.20 % in the long run. The short-run estimates of $\Delta\gamma^{-}$ align with the long-run negative shock of income share, as a 1 % reduction in income share will increase ($\aleph$), (φ) and (ϑ) by 0.08, 0.087, and 0.04 %, respectively. It is evident that an increase in household income within the last quartile of the income group will improve these people's access to health services and lead to improvements in health indicators. These results are consistent with studies showing that lower income inequality improves health outcomes (see, Ansmann et al., 2021; Sahoo et al., 2023; Yan et al., 2023).

The national income (δ) control variables demonstrate that a 1 % change in national income will result in a decrease in the infant mortality rate ($\aleph$ and crude death rate (ϑ) by 0.51 and 0.87 %, respectively, in the long run, as well as 0.03 and 0.08 %, respectively, in the short run. Additionally, the coefficient of urbanization indicates an impact on ($\aleph$ (reduction of 0.19 %), (ϑ) (reduction of 0.54 %), and (φ) (increase of 0.21 %) in the long-run. In the short term, urbanization will increase the infant mortality rate and crude death rate. The error correction term (ECT) in the CS-NARDL models suggests that any short-run imbalances tend to correct themselves towards long-run equilibrium, with a speed of 4.3 % (for the IMR model), 1.12 % (for the LE model) and 8.95 % (for the CDR Model). The significant Wald test affirms the presence of a long-run and short-run asymmetric connection between health indicators and the independent variables (see Table 10). To evaluate the short-run and long-run asymmetric impacts of health expenditure, trade openness and income distribution on health

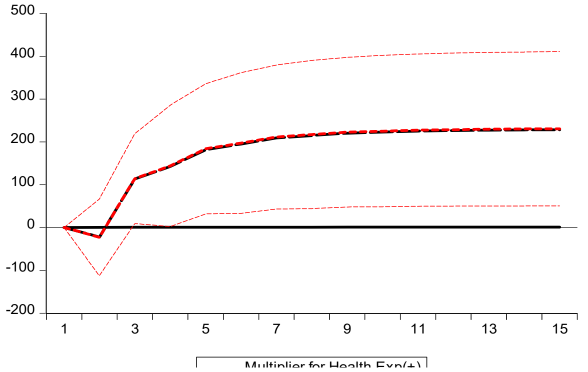

Figure 5: *CS-NARDL Dynamic Asymmetric Multiplier for Health Expenditure*
Source: Authors' calculations from Eviews

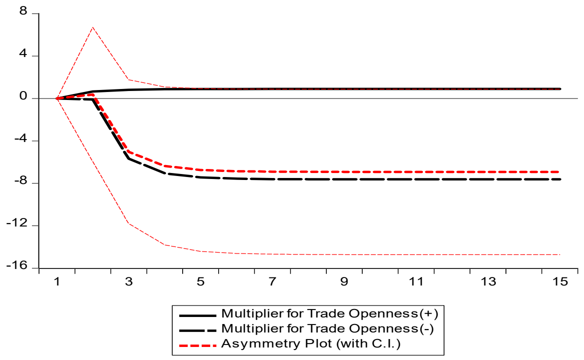

Figure 6: *CS-NARDL Dynamic Asymmetric Multiplier for Trade Openness*
Source: Authors' calculations from Eviews

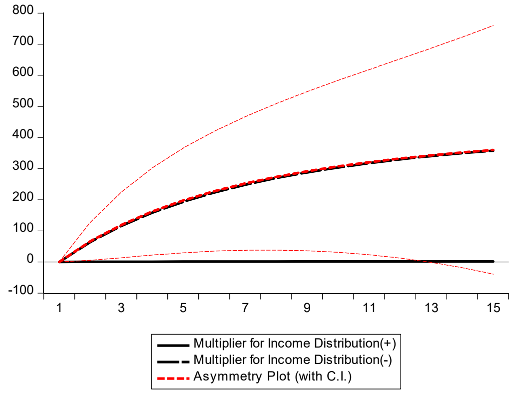

Figure 7: *CS-NARDL Dynamic Asymmetric Multiplier for Income Distribution*
Source: Authors' calculations from Eviews
Conclusion & Policy Takeaways

indicators, the cumulative dynamic multiplier is utilized (see Figure 5, 6 and 7).

The research delves into the asymmetric short-term and long-term effects of health expenditure, trade openness, and the income share of the poor on health indicators in BRICS nations (Brazil, Russia, India, China, and South Africa). It also specifically examines the impact on the infant mortality rate, life expectancy rate, and crude death rate by using panel data spanning from 2000 to 2023.

The CS-NARDL model results highlight the vital role of health spending in BRICS countries. Both short- and long-run estimates show that increased health expenditure significantly reduces infant mortality and crude death rates. Although the estimated coefficients are small, the relationship aligns with theory and warrants further study.

Health spending improves indicators like life expectancy and infant mortality, with even minor gains compounding over time for substantial long-term benefits. Conversely, reduced health expenditure increases mortality rates, showing how vulnerable health outcomes are to funding cuts. Higher health spending is also linked to longer life expectancy, while cuts have negative long-term effects. These findings underscore the need for BRICS policymakers to prioritize sustained health investment to improve health outcomes and advance human development.

The short-run analysis shows that increasing trade openness reduces the infant mortality and crude death rates, suggesting that stronger trade links improve health outcomes. Conversely, a decrease in trade openness tends to raise mortality rates, underscoring the importance of maintaining robust trade relationships. Trade openness also positively affects life expectancy, while reductions have adverse effects.

In the long run, trade openness appears to lower crude death rates and increase life expectancy, though the effect size is small and statistically insignificant, so conclusions should be drawn cautiously. This supports the theoretical view that trade benefits health, though the relationship may be indirect, explaining the small coefficients.

Unexpectedly, long-run estimates suggest trade openness increases infant mortality in BRICS countries. Possible reasons include unequal distribution of trade gains, environmental harm, neglected healthcare investments, urbanization pressures, and the import of low-quality products. This finding requires further investigation and should be viewed as a basis for future research, not a definitive conclusion.

The study also posits that improving income distribution among the poorest households significantly enhances access to healthcare and health outcomes. Overall, it deepens understanding of how health spending and income inequality affect health and emphasizes trade openness as a potential tool to improve health by facilitating the exchange of health technologies and services for disadvantaged groups.

Policy Takeaways

The study highlights the crucial role of government health expenditure in improving key health indicators such as crude death rate, life expectancy, and infant mortality rate. Allocating sufficient resources to enhance healthcare infrastructure and services should be a top priority for policymakers. The following are some key policy implications:

1. The study indicates that income distribution among the poorest segments influences health outcomes. Governments should consider policies that reduce income inequality—such as social welfare programs and progressive taxation—to improve health indicators for the most vulnerable populations.

2. BRICS countries are encouraged to adopt a "health-sensitive trade policy" that channels a portion of economic gains from increased trade into strengthening maternal and child healthcare services, especially in underserved areas. This policy should focus on enhancing prenatal care, immunization programs, and healthcare infrastructure to ensure that the benefits of trade contribute positively to infant health and help reduce infant mortality rates.

Regular and systematic monitoring and assessment of healthcare expenditure initiatives are essential. Governments need to create systems to assess how effective healthcare spending is on health outcomes, enabling them to make necessary adjustments and enhancements to healthcare policies and programs. Further investigation into the connections among health spending, trade openness, and income distribution with health indicators could benefit from examining panels of other similar economies. Additionally, incorporating other socio-economic and socio-cultural variables into the analysis could provide deeper insights into this research.

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Использование средств ИИ

Авторы заявляют о том, что при написании этой статьи не применялись средства генеративного искусственного интеллекта.

Use of AI tools declaration

All authors declare that they have not used Artificial Intelligence (AI) tools for the creation of this article.

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