

Epidemiological trends and future projections of vertebral fracture in BRICS countries: a GBD 2023 study

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Vertebral fracture is a major cause of morbidity and non-fatal health loss worldwide, yet its population burden varies substantially across countries owing to differences in demographic structure, epidemiological transition and healthcare capacity [1, 2]. BRICS countries (Brazil, Russia, India, China and South Africa) together account for over 40% of the global population but differ markedly in age structure, development trajectory and healthcare systems [3], making them a relevant setting for comparative assessment. Although previous studies have examined vertebral fracture burden at the global level or within individual countries [4, 5], comparative evidence across BRICS countries that integrates current burden, long-term trends and future projections within a single analytical framework remains limited. The present study aimed to address this gap by systematically characterizing the burden of vertebral fracture across all five BRICS countries from 1990 to 2023 and projecting future trends to 2050.

We extracted publicly available data on vertebral fracture incidence, prevalence and years lived with disability (YLDs) from the GBD 2023 database for the period 1990–2023 [6, 7]. Age-standardized rates (ASRs) per 100,000 population were used for cross-country comparisons to eliminate confounding by differences in population age structure. Long-term trends were quantified using estimated annual percentage change (EAPC), calculated from a log-linear regression model of the form $\ln(\text{ASR}) = \alpha + \beta \times \text{year}$, where $\text{EAPC} = 100 \times (e^{\beta} - 1)$ [8]. Positive EAPC values indicate an increasing trend, whereas negative values indicate a decreasing trend. Future trajectories to 2050 were projected using autoregressive integrated moving average (ARIMA) and exponential smoothing state space (ETS) models as complementary time-series forecasting approaches [9, 10]. Data processing and visualization were performed using Python. This study used publicly available, de-identified aggregate data from the GHDx query tool; ethical approval was not required.

In 2023, substantial between-country heterogeneity was observed across all three burden measures (Figure 1 A). The Russian Federation had the highest age-standardized incidence rate (341.68 per 100,000, 95% UI: 222.88–545.09), followed by China (236.00 per 100,000, 95% UI: 165.40–323.55), whereas South Africa had the lowest rate (66.28 per 100,000, 95% UI: 52.85–82.49). A consistent cross-country ranking was observed for age-standardized prevalence and YLD rates: Russia > China > Brazil > India > South Africa. China and India carried the largest abso-

lute numbers of cases and YLDs, reflecting their large population sizes. Across most countries, prevalence and YLD rates increased progressively with age and peaked in the oldest age groups, whereas the age pattern of incidence was less consistent across countries.

Temporal trends from 1990 to 2023 revealed marked heterogeneity in the direction and magnitude of change (Figure 1 B). China was the only BRICS country in which age-standardized incidence (EAPC = 1.26, 95% CI: 0.85–1.68), prevalence (EAPC = 1.27, 95% CI: 0.90–1.63) and YLD

A

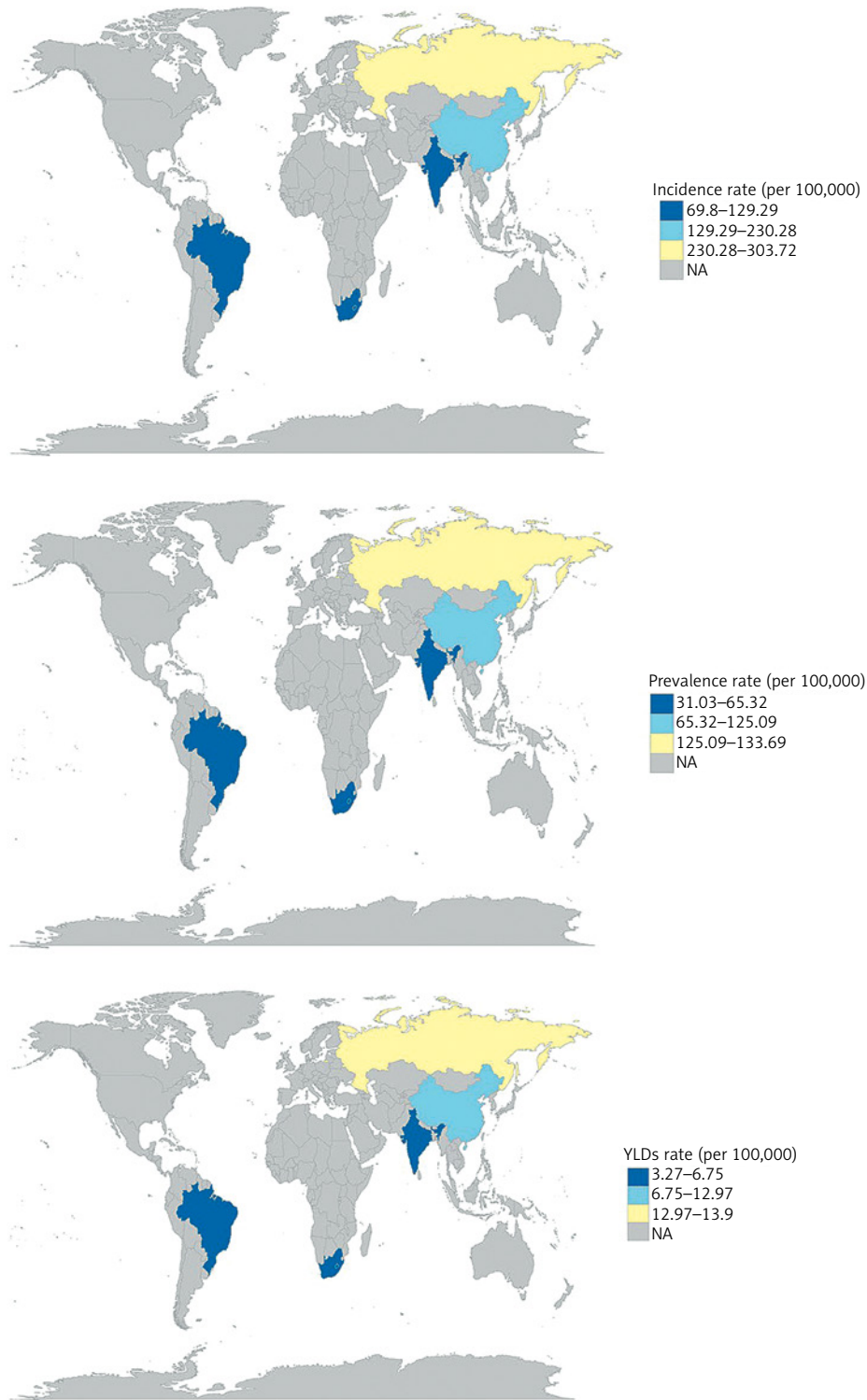


Figure 1. Temporal trends in vertebral fracture burden across BRICS countries, 1990–2023, and forecasts to 2050. **A** – Age-standardized incidence, prevalence and YLD rates in 2023

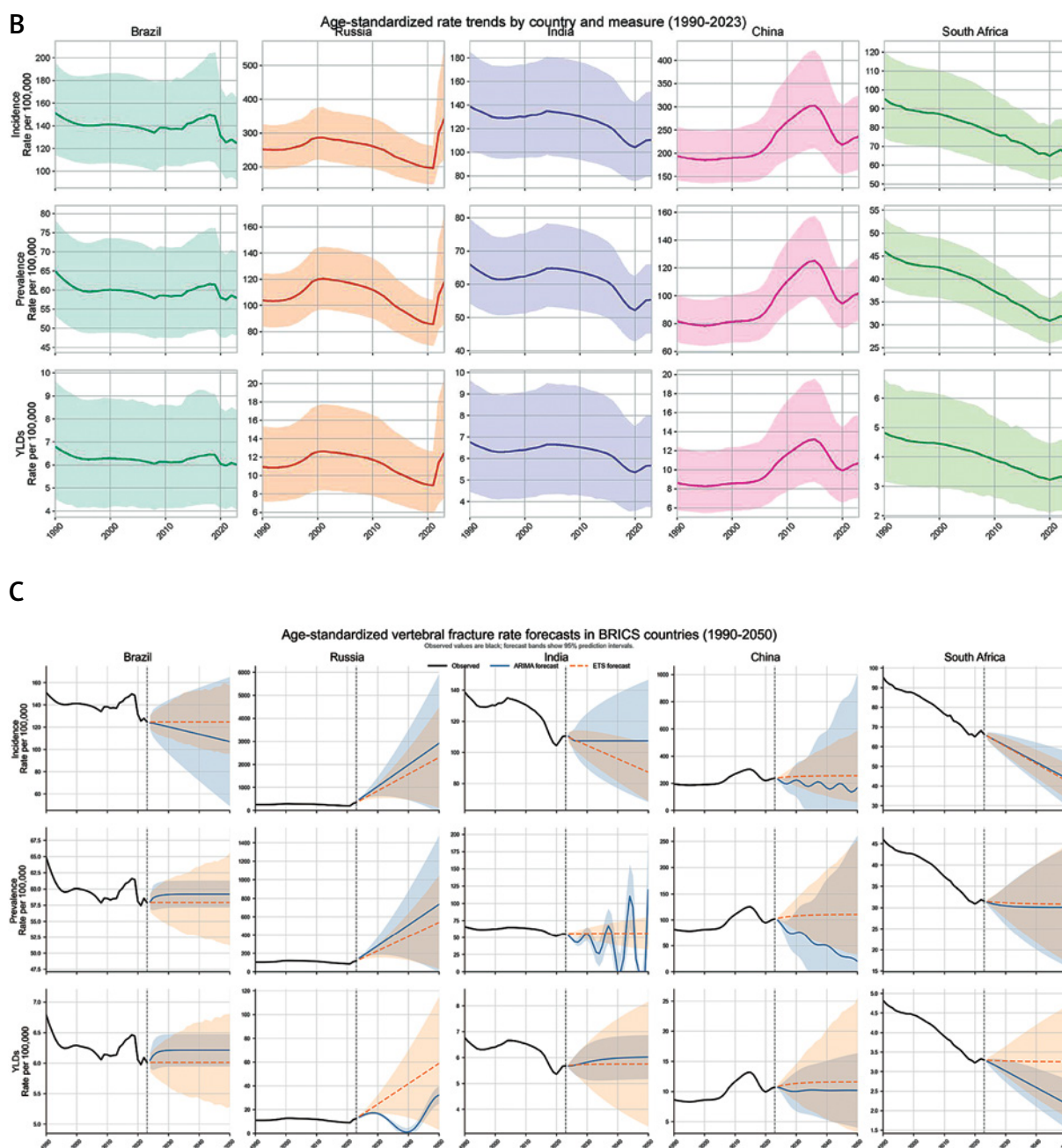


Figure 1. Cont. **B** – Age-standardized incidence, prevalence and YLD rates from 1990 to 2023. **C** – ARIMA and ETS model-based forecasts to 2050. Shaded bands indicate 95% uncertainty intervals

rates (EAPC = 1.26, 95% CI: 0.89–1.62) all increased significantly over the study period. In contrast, South Africa showed the most pronounced declines across all three measures, with EAPC values of -1.17 (95% CI: -1.24 to -1.09) for incidence, -1.25 (95% CI: -1.35 to -1.16) for prevalence and -1.26 (95% CI: -1.35 to -1.17) for YLDs. Brazil, Russia and India exhibited relatively stable or modestly declining age-standardized rates, with EAPC values close to or slightly below zero. Despite these divergent trends in age-standardized measures, all-age case numbers increased in all five countries over the study period, reflecting

ongoing demographic pressure from population growth and structural ageing.

Forecasts from both ARIMA and ETS models suggested that existing between-country disparities are likely to persist through 2050 (Figure 1 C). China and Russia were projected to maintain relatively high age-standardized burden trajectories, whereas South Africa was projected to remain on a consistently lower trajectory. The projections for Brazil and India fell between these extremes, with relatively moderate future burden levels.

These findings indicate that vertebral fracture burden across BRICS countries follows distinct na-

tional trajectories rather than a single shared pattern. The Russian Federation's persistently high age-standardized burden, despite its negative EAPC values, may reflect a legacy of high osteoporosis prevalence and an ageing population structure, which may maintain a high baseline level of disease even without continued increases over time [11]. The declining trends observed in South Africa may relate to competing health priorities, lower rates of clinical diagnosis and ascertainment, and a relatively younger population structure [12]. China's consistent increases across all three metrics are particularly noteworthy and may reflect the combined effects of rapid population ageing, lifestyle changes and improved diagnostic capacity [13]. Importantly, even countries with stable or declining age-standardized rates may face increasing healthcare demand as their populations age and absolute case numbers continue to rise. The projected persistence of between-country differences highlights the need for country-specific strategies that account for each nation's current burden level, temporal trajectory and demographic outlook. China's rising trend and large absolute burden warrant particular attention in terms of surveillance infrastructure and prevention planning, whereas Russia's high baseline burden calls for continued healthcare resource allocation despite its stable rates.

Several limitations should be acknowledged. This study relied on modelled GBD estimates rather than primary clinical registry data, and the results therefore depend on the quality and completeness of the underlying input data sources [6, 7]. The ecological and descriptive design precludes causal inference regarding the specific drivers of cross-country differences. Forecasts based on ARIMA and ETS models extend historical patterns and cannot capture future policy changes, healthcare reforms or unexpected demographic shocks [9, 10]. Additionally, the analysis was restricted to BRICS countries, which limits the generalizability of the findings beyond these settings.

In conclusion, vertebral fracture burden in BRICS countries is characterized by substantial and persistent heterogeneity across all measures examined. China's rising trajectory and Russia's persistently high burden warrant particular attention, whereas all five countries face increasing absolute case numbers driven by demographic changes. These findings support the development of country-specific surveillance, prevention and healthcare planning strategies tailored to each nation's evolving epidemiological profile.

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Ethical approval

Not applicable.

Conflict of interest

The author declares no conflict of interest.

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