# Health impact of hypertension control in four countries: an individual-based simulation model calibrated to Global Burden of Disease Study estimates

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# Research Objective

Globally, 218 million disability adjusted life years (DALYs) were lost due to systolic blood pressure (SBP) ≥140 mmHg in 2017. The effectiveness of low-cost antihypertensive medications is established, but hypertension screening and medication coverage varies widely among countries. We projected the potential impact of an opportunistic hypertension screening program coupled with treatment with fixed dose combination (FDC) antihypertensive medications in four countries using a computer simulation model of hypertension treatment based on country-level estimates from the Global Burden of Disease (GBD) Study .

# Study Design

We developed an individual-based, discrete-time Markov model of disease and risk factor prevalence, incidence, and mortality. In each cycle, we exposed individuals to risk of nonfatal or fatal ischemic heart disease, ischemic stroke, or hemorrhagic stroke, or mortality from other causes. We calibrated model output to match country-level GBD incidence, cause-specific mortality, and all-cause mortality. We assigned each individual a sex and a time-varying age, systolic blood pressure, fasting plasma glucose, kidney function status, and hypertension treatment status. In the treatment scenario, we simulated a program consisting of an opportunistic hypertension screening (using age-/sex-/location-specific outpatient visit rates to simulate screening opportunities) and treatment with FDC for individuals age 40+ with measured SBP ≥140 mmHg, including untreated hypertension as well as treated, but uncontrolled hypertension. We compared population health under this intervention with the current standard of care. To capture real-world challenges to quality hypertension screening and treatment, we included SBP measurement error, risk of medication-related adverse events leading treatment discontinuation, and therapeutic inertia (failure to intensify antihypertensive treatment given uncontrolled SBP).

# Population Studied

We generated 1,000 replicates of cohorts of 1,000,000 adults representing the population aged ≥35 years in each of four middle-income countries (Brazil, Russia, India, and China).

# Principal Findings

Age-standardized change in SBP with FDC treatment varied among countries, from a mean reduction of 6.23 mmHg in India to 8.21 mmHg in Russia; this corresponded to a change in the percent controlled of 14.2 percentage points (pp) in India to 18.4 pp in Russia. Reduction in average number of days lived with uncontrolled hypertension varied from a mean of 41 days uncontrolled per patient-year in China to 58 in Russia. DALYs averted with FDC treatment varied from 991 per 100,000 person-years in Brazil to 2,960 in Russia.

|  | **DALYs Averted (per 100,000 PY)** | **Shift in SBP (mmHg)** | **Change in %**  **Controlled (pp)** |  | **Change in Time Uncontrolled (days)** |
| --- | --- | --- | --- | --- | --- |
| **Brazil** | 991.0 | 7.4 | 17.8 |  | 55.2 |
| **India** | 1524.2 | 6.2 | 14.2 |  | 44.7 |
| **China** | 1604.7 | 6.3 | 14.3 |  | 40.8 |
| **Russia** | 2963.8 | 8.2 | 18.4 |  | 58.0 |

# Conclusions

An individual-based computer simulation leveraged GBD standard country-level demographic, epidemiologic, and treatment coverage data, thus allowing valid between-country treatment program simulation comparisons. The analysis revealed substantial variation among countries in the potential impact of a screening and FDC treatment program. Countries’ SBP reductions and DALYs averted per 100,000 increased with higher mean SBP among hypertensive individuals and lower proportion of controlled hypertension at baseline.

# Implications for Policy or Practice

Scale up of a screening and FDC treatment program would lead to substantial health gains in four middle income countries; program health impact varies according to the country context.