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Research Brief

Time-series study of cardiovascular rates in India: A systematic analysis between 1990 and 2017

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ABSTRACT

Cardiovascular disease represents a significant public health issue and places an immense burden on India's citizens, families, health systems, and the population. Predictive models provide structure and direction in anticipating future needs. This time-series study employed Box–Jenkins time series modeling to forecast 2030 prevalence and mortality rates of stroke, ischemic heart disease, and cardiovascular disease. The 2030 projected cardiovascular disease prevalence rate was predicted to increase to 5.26% (95% prediction interval, 5.19%–5.28%), with major contributors being stroke and ischemic heart disease. The authors propose increased investment across the continuum of care to efficaciously promote, prevent, and rehabilitate cardiovascular disease.

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1. Introduction

Cardiovascular disease (CVD) remains a leading cause of mortality globally that requires an integrated approach.[1] In India, the epidemiological transition from predominantly infectious disease conditions to noncommunicable diseases has occurred over a rather brief period.[2] Furthermore, the outright burden of CVD has intensified globally as now low and middle-income countries experience higher rates of CVD because of the growing and aging population.[3,4] For example, according to the Indian Council of Medical Research (ICMR), India's growth in the aging population almost entirely explains the rise in CVD mortality from 156 to 209 per 100,000 between the years of 1990 and 2017.[3,4] Likewise, CVD related premature mortality and disability in terms of disability-adjusted life years (DALY) has risen from 4.16% (1990) to 4.72% (2017).[3,5] Two of the top five leading causes of the increase in DALYs are attributed to ischemic heart disease and cerebrovascular disease.[3] The prevalence rate of CVD increased in India between 1990 and 2017,[4] yet this increased CVD prevalence has not been mitigated by efforts to provide additional treatments, or via increased economic expenditures.[6] It is believed that the increase in the incidence rate of CVD will continue.[7] Also, CVD impacts Indians at younger ages than other developed nations, and mortality occurs ten years earlier.[7] Thus, CVD represents an enormous burden for individuals and their families, as well as for the health system and society in general.[7] A more specific examination yields significant state to state variations in CVD burden with a nine-fold variability existing in the burden of ischemic heart disease DALYs between the highest (Punjab) and lowest (Mizoram) per 100,000 persons.[8] It has been suggested that the state to state differences in mortality and morbidity are most likely guided by differences in treatment, control, management of acute CVD conditions, risk factor burden, and baseline rates.[8] Future endeavors should include identifying population segments with increased risk for CVD, targeting these segments, and recommending cost-effective approaches for treating CVD.[6]

2. Methods

In this time-series study, we retrieved annualrate information from the database maintained collaboratively by theIndian Council of Medical Research, Public Health Foundation of India, and Institute for HealthMetrics and Evaluation between the years of 1990 and 2017.[3,4] We used the Box–Jenkins time series modeling estimation method to determine what the prevalence and mortality rate of stroke, ischemic heart disease, and CVD will be by 2030.[9] Autoregression and other statistical analyses were run using SAS v.9.4. Diagnostics for the 12 models were completed checking for autocorrelation.[9] Adequacy of the model was tested using chi-square test statistics for white-noise residuals.[9] Our autoregressive integrated moving average models are robust to time series biases, such as recurring periodicities.[9]

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3. Results

Over 65 million deaths were attributed to CVD in India. Nationally, rates of CVD have increased. From 1990, there was a steady initial decline in the rates of CVD, similar to high-income countries. However, during 2004, the DALY rate started to increase from 3.77% to 4.72% in 2017. According to Table 1 and Fig. 1, the projected prevalence rate in 2030 is expected to be 5.26% (95% prediction interval, 5.19%–5.28%). As can be seen, the major contributors to CVD are stroke and ischemic heart disease. While mortality rates are projected to decline by 2030, prevalence rates for stroke are expected to increase in 2030 to 894 per 100,000 (95% prediction interval, 802.4–986.4). In particular, Table 1 denotes that the male stroke prevalence rate for 2030 is projected to increase while female stroke prevalence rates decline. Likewise, Table 1 indicates ischemic heart disease lessening by 2030.

4. Discussion

Eminently, the age-standardized mortality rate for CVD did not decline in India, which is in sharp contrast to the dramatic declines that have been documented in other world regions, especially in high-income countries. The observed and forecasted epidemiological changes in the prevalence and mortality of CVD increase health services demand. Specifically, it is critical to note that to counteract higher prevalence rates of overall CVD, policymakers and stakeholders will need to increase investment across the continuum of care. Moreover, achieving declines in age-adjusted CVD mortality necessitates population-level policy interventions while reinforcing and supporting local, regional, and national health systems.[8] Sudden increases in infectious disease prevalence can strain the existing healthcare infrastructure severely and make it even more difficult to allocate resources to CVD-related healthcare.

The results from this study emphasize the need to address increasing costs of medical care, access issues, and forecasting future economic resources needed to meet the demands of health services, justify the development and implementation of indicators for the increasing changes in demand and the costs of future case management.

Concerning the implications for the health system and patients, we propose the following:

Table 1
Gender-specific and total prevalence and mortality for cardiovascular diseases in India.

	1990	2017	2030 projection
Cardiovascular Disease[a] (per 100,000)			
Mortality	317.7	282.3	278.3
Prevalence (Total)	5164.2	5214.2	5236.1
Males	5071.7	5086.7	5108.0
Females	5264.2	5337.8	5412.3
Stroke(per 100,000)			
Mortality	103.9	77.4	64.3
Prevalence (Total)	790.1	861.0	894.4
Males	781.1	874.4	887.7
Females	799.6	848.1	821.7
Ischemic Heart Disease(per 100,000)			
Mortality	168.7	164.7	163.0
Prevalence (Total)	1645.9	1529.3	1474.3
Males	1688.4	1555.9	1554.0
Females	1602.9	1505.4	1494.0

[a] The age-adjusted prevalence and mortality rate listed was for cardiovascular diseases, including stroke, ischemic heart disease, hypertension, peripheral arterial disease, and other related diseases. The rates are total and gender specific.

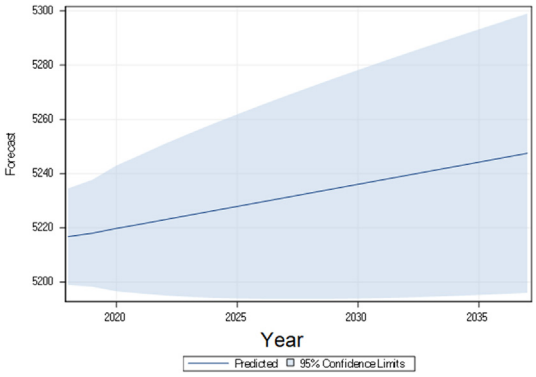

Fig. 1. Age-adjusted prevalence rate of cardiovascular disease (per 100,000).

1. The evidence for projected increases in the demand for healthcare for CVD patients can be used to effectively and efficiently direct resource allocation for the promotion, prevention, and rehabilitation of CVD. Since only around 37 percent of the population were covered by any form of health coverage in 2017–2018 including public health insurance schemes and commercial insurance, it is important to make resource reallocation and health access based on this context.
2. Our results elucidated a forecasted trend of continued male stroke prevalence growth, while overall mortality rates and female stroke prevalence rates are anticipated to decline. More focused efforts to understand the contrasting trends and their drivers are required. Accordingly, targeted promotion of technological innovations like tele-stroke can help to provide care to areas without sufficient healthcare providers.[6]
3 Targeted, cost-effective, evidence-based practices are needed that include preventive self-care and management of modifiable risk factors. Likewise, these approaches should be addressed at the state and local level and be gender-specific. This, in turn, will reduce economic hardship secondary to CVD related healthcare costs.

Authors' contributions

SB and JH equally conducted the literature review and contributed to the writing of the manuscript. SB conducted all statistical analyses and design of the study. SB and JH reviewed the final manuscript.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the Indian Council of Medical Research website (http://vizhub.healthdata.org/gbd-compare/india).

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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