Original Article

Associations Between the Macroeconomic Indicators and Suicide Rates in India: Two Ecological Studies

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ABSTRACT

Background: While western studies have focused on the importance of psychiatric illnesses in the complex pathways leading to suicides, several Indian studies have highlighted the important contributions by economic, social, and cultural factors. Hence, we tested the hypothesis that annual national suicide rates and suicide rates of the different states in India were associated with macroeconomic indices. **Materials and Methods:** Data from the National crime records bureau, Ministry of finance, labour bureau, Government of India, population commission, and planning commission official portals, World Bank and the United Nations were accessed. We assessed the correlations of annual national and state-wise suicide rates with macroeconomic, health, and other indices using ecological study design for India, and for its different states and union territories. **Results:** We documented statistically significant associations between the suicide rates and per capita gross domestic product, consumer price index, foreign exchange, trade balance, total health expenditure as well as literacy rates. **Conclusions:** As recent economic growth in India is associated with increasing suicide rates, macroeconomic policies emphasizing equitable distribution of resources may help curtailing the population suicide rates in India.

Key words: *Economics, inequality, suicide*

INTRODUCTION

Suicide continues to be a major public health problem in many countries.[1] Recent studies from India, using verbal autopsies in populations under comprehensive community programmes, have documented high suicide rates (95/100,000),[2,3] compared to the official national average (10/100,000).[4] These studies have also identified very high suicide rates in young women[5], and among the elderly.[6] While western

data and psychiatrists argue for mental illnesses as causal, those from India suggest economic, social and cultural factors.[3,7,8] Moreover, 17,060 Indian farmers committed suicide in 2006 and more than 26% of them were from a specific Indian state, Maharashtra.[9] Nevertheless, studies from India on suicide remain sparse, and are often limited to hospital-based samples. In addition, community studies have focused mostly on the individual risk factors. There is a dearth of ecological studies in which the units of analysis are populations or groups of people, rather than individuals. Such investigations involve direct observations of individuals, which are then aggregated or summarized, or rely on global population measures. A previous ecological study involving 22 Indian states has reported that state-wise suicide rates in 1979 were correlated with the population density, percentage of urban population, and per capita income.[10] Hence, we aimed to study the relationships between suicide rates and more

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macroeconomic as well as other indices in India using ecological study design.

MATERIALS AND METHODS

Data sources
The data was compiled into two datasets:
1. National data for India from 1980 to 2005.
2. Data for states and union territories in 2005 or their closest available year.

The first dataset was compiled to investigate the longitudinal associations between the annual national suicide rates and macroeconomic indicators in India. The second dataset was formed to assess the cross-sectional associations between state-wise suicide rates and macroeconomic indicators of Indian states and union territories. Available data for India on the following indicators were collected from national or international databases and sources: Suicide rates,[11] population,[12] population density,[12] urban population,[13] literacy rate,[13-15] unemployment rate,[16-18] per capita income,[13] consumer price index,[13] inflation,[13] gross domestic product,[19] gross domestic product per capita,[13] trade balance,[20] economic inequality index (Gini),[14,21-27] gross savings,[13] crop production index,[13] food grain availability,[28] total health expenditure[13], and doctors per 100,000 population.[13]

Available data on the following state-wise indicators were collected from national databases and sources: Suicide rate,[29] population,[30] per capita income,[31] economic inequality index (Gini coefficient),[21] population below poverty line,[32] consumer price index,[33] literacy rates,[34] access to safe drinking water,[35] infant mortality rate[36] and production of food grains.[37] We included these indicators due to their hypothetical relevance, and public availability.

Data analyses
We initially checked whether all continuous variables followed Gaussian distribution by one sample Kolmogorov-Smirnov tests. As the national and state-wise suicide rates did not follow Gaussian distribution, the bivariate correlations between the suicide rates and various indicators were assessed by Spearman's rank order correlation. As the regression diagnostics proved that linear regression models, employing Ordinary Least Squares (OLS) regression, were not valid, we studied the associations between the suicide rates and various hypothesized explanatory variables with non-parametric robust regression models, using STATA *rreg* command. Robust regression models are valid, despite the presence of influential outliers and the non-normality of residuals. They initially perform OLS regression to compute absolute residuals, which

are scaled by the median residual value. After estimating Huber weights and Tukey biweights, iteratively reweighted least squares regression is performed to estimate the regression coefficients. All statistical analyses were performed using statistical software Statistical Package for Social Sciences Version 21.0 (SPSS 21.0) and STATA 12.1.

RESULTS

Table 1 shows the results of the bivariate correlations, and multivariate statistics for the relationships between annual national suicide rates and the different macroeconomic and other indices for India. Population, consumer price index, per capita gross domestic product, foreign exchange, trade balance, gross savings, crop production index, total health expenditure and the number of doctors per 100,000 people were significantly associated with national suicide rates of India after adjusting for the effects of potential confounders.

Table 2 shows the results of the bivariate correlations, and multivariate statistics for the relationships between the suicide rates and the different macroeconomic as well as other indices for the different states and union territories in India. Per capita income was significantly correlated with state-wise suicide rates (Spearman $\rho = 0.388$; $P = 0.03$). After adjusting for the effects of per capita income, literacy rates were significantly associated with state-wise suicide rates. States and union territories with better literacy rates, such as Kerala and Pondicherry, had higher suicidal rates. As Gini coefficient was available only for 15 Indian states,[21] our analysis was underpowered to detect any association between the Gini coefficient and suicide rates. States with high economic inequality, such as Tamil Nadu and Maharashtra, showed a trend towards higher suicidal rates, which was not statistically significant.

DISCUSSION

This study investigated the relationships between the macroeconomic indicators and other variables, which impact on suicide in India. It found the correlations between annual national as well as state wise suicide rates and indicators of economic development. Increasing gross domestic product and consumer prices were associated with higher national suicide rates. Although the summative nature of this study would prevent speculation on the causal relationships between these variables and suicide, it documented that recent economic growth in India was associated with increasing suicide rates. Rapid economic growth in

Table 1: Correlation between annual national suicide rates and macroeconomic as well as other indicators in India

Indicator	Bivariate correlation		Multivariate statistics[a]	
	Spearman's rho	*P*-value	β (95% CI)	*P*-value
Population density (per square km)	0.849	<0.001	0.07 (0.04 to 0.09)	<0.001
Urban population (%)	0.805	<0.001	0.23 (−0.79 to 1.25)	0.64
Literacy rate (%)	0.744	<0.001	0.11 (−0.01 to 0.23)	0.06
Unemployment rate (%)	0.296	0.33	−0.15 (−0.62 to 0.33)	0.49
Consumer price index	0.849	<0.001	0.07 (0.04 to 0.09)	<0.001
Inflation (%)	−0.490	0.03	0.04 (−0.10 to 0.18)	0.55
Gross domestic product per capita (in US$)	0.848	<0.001	0.01 (0.01 to 0.01)[b]	<0.001
Foreign exchange (INR per US$)	0.887	<0.001	0.07 (0.03 to 0.11)	0.001
Trade balance (in million US$)	−0.676	0.006	6.54 (1.43 to 11.66) e^{-05}	0.02
Economic inequality index (Gini coefficient)	0.136	0.58	−0.10 (−0.27 to 0.07)[c]	0.22
Gross savings (Billion US$)	0.801	<0.001	−0.02 (−0.04 to −0.01)	0.01
Crop production index (%)	0.903	<0.001	0.13 (0.08 to 0.18)	<0.001
Food grain availability (million tons)	0.772	<0.001	0.00 (−0.04 to 0.04)	0.94
Total health expenditure (in US$)	0.879	0.001	1.81 (0.78 to 2.83) e^{-05}	0.008
Doctors per 100,000 population	0.910	<0.001	0.43 (0.13 to 0.72)	0.009

[a]Each row represents a multiple robust regression model with annual suicide rates as the dependent variable and gross domestic product per capita (in US$) as well as Gini coefficient as the co-variates; [b]a multiple robust regression model with annual suicide rates as the dependent variable and Gini coefficient as the co-variate; [c]a multiple robust regression model with annual suicide rates as the dependent variable and gross domestic product per capita (in US$) as the co-variate

Table 2: Correlation between state-wise suicide rates and macroeconomic as well as other indicators in India

Characteristic	Bivariate correlation		Multivariate statistics[a]	
	Spearman's rho	*P*-value	β (95% CI)	*P*-value
Population	−0.105	0.548	0.27 (−0.68 to 1.22) e^{-04}	0.57
Economic inequality index (Gini coefficient)	0.454	0.089	1.07 (−0.45 to 2.59)	0.15
People below poverty line (in lakhs)	−0.078	0.654	0.11 (−2.74 to 2.96)	0.94
Consumer price index (base 1982 = 100)	−0.200	0.398	−0.20 (−0.47 to 0.06)	0.12
Literacy rate (%)	0.287	0.095	0.47 (0.05 to 0.89)	0.03
Safe access to drinking water (%)	0.207	0.232	0.01 (−0.16 to 0.19)	0.87
Infant mortality rate (for 1,000 births)	−0.181	0.367	0.02 (−0.19 to 0.23)	0.85
Food grain production (thousand tonnes)	−0.014	0.959	0.13 (−0.53 to 0.27)	0.51

[a]Each row represents a multiple robust regression model with state-wise suicide rates as the dependent variable and per capita annual income (in INR) as the co-variate. As Gini coefficient was available only for 15 Indian states, it was not included as a covariate in the multiple robust regression models

India has worsened the prevailing economic and social inequalities that impact physical and mental health of vulnerable sections of the population.[38] Rising income and literacy, when associated with increasing economic inequality, may provide a milieu for disillusionment.

Kuznets hypothesized that the relationship between economic development and income inequality takes the form of an inverted U-curve.[39] The income inequality may exacerbate relative poverty which may, in turn, adversely affect the quality of health, education and nutrition resulting in poor quality of life. However, rising inequality will eventually put pressure on the governments to rectify the situation using the high incomes attained in the late stages of development. The current situation in India may suggest that while by the poverty based on head-counts has reduced, it has remained constant or even increased when mean consumption and inequality are taken into account.[40] Inconsistent and incomplete public availability of data on economic inequality index in India hampers studies that investigate the association between the suicide rates and economic inequality in India. As in all ecological studies, the aggregate nature of the findings presented cannot evaluate the relationship of observed co-variates to the suicide at the level of individuals. Bias, called the ecological fallacy, may occur because an association observed between variables on an aggregate level may not necessarily represent the association that exists at an individual level.

Suicide is a complex behaviour resulting from a many factors in the individual, and the interaction with his/her immediate and broader environment. Case controls studies from rural India have documented that psychosocial stress and social isolation increase the risk of completed suicides.[8] Macro-economic factors, as has been discussed in the suicides documented in farmers,[9] play a major role. There is a need to examine macroeconomic policies and their implications in more detail to develop effective policies to curtail national suicide rates in India. A detailed discussion

on the potential pathways connecting macroeconomic indicators with suicide and on the pertinent national policies for the prevention of suicide in India has been published elsewhere.[41]

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