Journal of Biosocial Science (2021), 53: 3, 379–395
doi:10.1017/S0021932020000255

CAMBRIDGE UNIVERSITY PRESS

RESEARCH ARTICLE

Testing the regional Convergence Hypothesis for the progress in health status in India during 1980–2015

Mohammad Zahid Siddiqui[1*], Srinivas Goli[1,2] and Anu Rammohan[3]

[1]Centre for the Study of Regional Development (CSRD), Jawaharlal Nehru University, Delhi, India, [2]UWA Public Policy Institute, University of Western Australia, Perth, Australia and [3]Department of Economics, University of Western Australia (M251), Crawley, Australia
*Corresponding author. Email: say2zahid.s@gmail.com

(Received 20 December 2018; revised 09 April 2020; accepted 14 April 2020; first published online 10 June 2020)

Abstract

The key challenges of global health policy are not limited to improving average health status, with a need for greater focus on reducing regional inequalities in health outcomes. This study aimed to assess health inequalities across the major Indian states used data from the Sample Registration System (SRS, 1981–2015), National Family Health Survey (NFHS, 1992–2015) and other Indian government official statistics. Catching-up plots, absolute and conditional β-convergence models, sigma (σ) plots and Kernel Density plots were used to test the Convergence Hypothesis, Dispersion Measure of Mortality (DMM) and the Gini index to measure progress in absolute and relative health inequalities across the major Indian states. The findings from the absolute β-convergence measure showed convergence in life expectancy at birth among the states. The results from the β- and σ-convergences showed convergence replacing divergence post-2000 for child and maternal mortality indicators. Furthermore, the estimates suggested a continued divergence for child underweight, but slow improvements in child full immunization. The trends in inter-state inequality suggest a decline in absolute inequality, but a significant increase or stationary trend in relative health inequality during 1981–2015. The application of different convergence metrics worked as robustness checks in the assessment of the convergence process in the selected health indicators for India over the study period.

Keywords: Health status; Regional inequalities; Convergence Hypothesis

Introduction

Improvements in human health have historically been categorized into two distinct phases. The first is characterized by high mortality and low life expectancy, with minimal health differentials in the population. The second phase begins with the accumulation of wealth throughout industrialization, and the development of trade and technological and health innovations that reduce major disease outbreaks. Deaton (2013) described this period as the path of 'great escape' for industrialized societies from the destitution and misery of mass killers. The Industrial Revolution resulted in a disproportionate increase in wealth and enabled the wealthier segments of the population to take advantage of health care developments and substantially improve their life expectancy relative to others (Deaton, 2013; Marmot, 2015a, b; Milanovic, 2016).

Despite considerable progress on average health indicators across the world, there is evidence of the persistence of preventable mortality and morbidity in many developing countries (Vallin & Mesle, 2001, 2004; Whitehead *et al.*, 2001; Vallin *et al.*, 2005; Bloom & Canning, 2007; WHO, 2015). A 'great divide' in health and well-being, a socioeconomic gradient in health status and rising health costs of socioeconomic inequality are gradually becoming apparent

(Marmot, 2015a, b; Piketty, 2014; Stiglitz, 2015; WHO, 2015; Milanovic, 2016; Oxfam, 2017). A report by the United Nations (2019a) suggested that sub-Saharan Africa had the lowest average life expectancy (61 years) and the highest mortality of children below the age of five (79 deaths/1000 live births) in 2019. This contrasted with average life expectancies of above 80 years and under-5 mortality rates of below 5 deaths/1000 live births in developed countries. Furthermore, a recent UN report on the progress of Sustainable Development Goal (SDG) 10 suggested that 'inequality within and among nations continues to be a significant concern despite progress in and efforts at narrowing disparities of opportunity, income, and power' (United Nations, 2019b).

Despite the presence of stark health differentials, the most optimistic report from the Commission on Investing in Health anticipated the onset of the third stage of health transition in the near future, where the burden of communicable diseases in poor countries would converge towards the level of rich countries (Jamison *et al.*, 2013). It has also been suggested that innovations and the strengthening of health interventions could lead to the realization of a 'grand convergence' of health within the current generation (Jamison *et al.*, 2013; Lim *et al.*, 2016).

Although there is growing interest in assessing the convergence in health status across populations, much research has focused on inter-country differences and has rarely been in the context of developing countries, where growth trajectories remain hidden (Neumayer, 2003; McMichael *et al.*, 2004; Moser *et al.*, 2005; Taylor, 2009; Dorius & Firebaugh, 2010; Wilson, 2011; Goli *et al.*, 2019). The dissimilar rates of progress in health status across different countries make it difficult to achieve SDG-3 and -10. Tracking progress in intra-country inequalities in health will help in designing better policies to accelerate progress in developing countries to catchup with developed countries (Nayyar, 2013; Goli, 2014; Atkinson, 2015).

India's health transition is critical for achieving the grand convergence of global health status, given its sizeable population, poverty, disease burden and mortality (UNICEF, 2011; Drèze & Sen, 2012, 2013; Goli & Arokiasamy, 2013, 2014; Goli, 2014; James & Goli, 2016). The country has made significant improvements in life expectancy and health status in the last two decades (Office of Registrar General of India, 2009, 2017; Ram *et al.*, 2013; Saikia *et al.*, 2013; Goli & Arokiasamy, 2013; Goli & Siddiqui, 2015). However, there is substantial variation in the speed and timing of economic, health, and demographic transition across Indian states and geographical regions (Saikia *et al.*, 2011; Goli, 2014; Goli & Arokiasamy, 2013; Drèze & Sen, 2013). India's demographic and epidemiological transition has resulted in disproportionate progress in health status and survival outcomes (Visaria, 2004a, b; James, 2011; Singh *et al.*, 2011; James *et al.*, 2016). The states in southern India are comparable to the most developed countries of Europe, whereas northern states are showing characteristics similar to the least-developed regions of Africa. A recent report from the Reserve Bank of India (RBI) found that in India, the poorest nine states account for 48% of the total population, but bear 70%, 75% and 62% of the burden of infant deaths, under-five deaths and maternal deaths, respectively (RBI, 2017).

Therefore, the challenges facing policy makers currently include the reduction of health inequities, and not merely a focus on average health status or improvements in life expectancies (Blas & Kurup, 2010; Goli & Arokiasamy, 2013; Goli, 2014). Most previous literature on health inequalities has focused on most recent information. However, estimates based on recent health data have serious limitations in terms of understanding the true trajectories of between-state inequalities (Rivas & Villarroya, 2016). The present study assessed whether improvements in national average health status over the three decades from 1981 to 2015 had been equitably distributed across the different states of India. Understanding health transition and convergence over time will indicate where the country is heading. Furthermore, an assessment of the progress in health status and health inequality is critical for designing future health policy and suggesting pathways for achieving the SDGs in India. Against this backdrop, the primary objective of this paper was to address the question: is progress in health status across Indian states converging or diverging?

Methods

Data sources

Secondary data were obtained from the Sample Registration System (SRS) for 1981 to 2015 (Office of Registrar General of India (2007, 2009, 2014, 2015, 2017), all four rounds of the National Family Health Survey (NFHS) from 1992–93 to 2015–16 (IIPS & Macro International, 1995, 2000, 2007, 2017) and other official statistics. Convergence metrics were used to examine convergence and divergence in health and health inequality in Indian states over the period 1981–2015. The health status and health inequality indicators examined included: Life Expectancy at Birth (LEB), i.e. average number of years that a newborn is expected to live if current mortality rates continue; Infant Mortality Rate (IMR), i.e. number of children who die before reaching to their first birthday per 1000 live births; Neonatal Mortality Rate (NNMR), i.e. number of children who die before 28 days of life per 1000 live births; Maternal Mortality Ratio (MMR), i.e. number of women who die due to pregnancy-related causes per 100,000 live births; Child Underweight, i.e. number of children aged 0–59 months, whose weight is less than −2 standard deviations below the median weight for the age group in the international reference population; and Child Full Immunization, i.e. number of children aged 12–23 months who have received the recommended vaccines for the major states of India.

Statistical analysis: the convergence models

The concept of ‘convergence’ is widely used to study growth and income inequality transition (Goesling & Firebaugh, 2004). In economics, the Convergence Hypothesis suggests that the gap in income between countries will close over time. Similar to inequality transition, the demographic and health transition process has also been described as going through the process of equilibrium and disequilibrium in terms of health and mortality convergence, divergence and re-convergence across different regions (McMichael *et al.*, 2004; Moser *et al.*, 2005; Dorius, 2008; Dorius & Firebaugh, 2010). The concept of convergence lies at the heart of demographic and health transition theory. In the post-1990 period there was growing interest in convergence methodologies in demography and public health (Goli, 2014).

Global studies on economic, demographic and health convergence have used models ranging from simple graphical tools to sophisticated econometric models, including catching-up plots, absolute β-convergence, σ-convergence, conditional β-convergence and non-parametric methods of convergence (Young *et al.*, 2008; Goli, 2014). There has not been harmonization among researchers on the process and measures of convergence. O’Connell (1981) and Wilson (2001) used simple graphical methods; Dorius (2008) used three indices (population-weighted σ-and β-convergence and inequality measures); Tryggvi *et al.* (2000) focused on the conditional β-convergence model; Franklin (2002, 2003) used σ-convergence; and Bloom and Canning (2007) used non-parametric tools. As there appears to be no agreement on a single standard measure of health convergence, this study used all available important convergence models, as described below.

Catching-up process

In the neoclassical growth model, the catching-up mechanism is necessary for convergence across regions. In this model, advanced states experience lower growth rates as they are already at higher values in the initial period. In contrast, laggard states experience higher growth rates given their lower values in the initial period. In this study, the catching-up process was identified by plotting a scatter diagram for change in an indicator at two points in time against values in the initial period.

Convergence metrics

Absolute β-convergence happens when health status in laggard regions progresses faster than in advanced regions. Thus, convergence in a given health indicator between $t=0$ and $t=1$ can be estimated by assessing the presence of a negative relationship between its base year values and change from $t=0$ to $t=1$ (Barro, 1991; Barro & Sala-I-Martin, 1991). Rey and Montouri (1999) used the following linear regression model for estimation of β-convergence:

$$\text{In}\left[\frac{Y_{i,\ t+k}}{Y_{i,t}}\right] = \alpha + \beta.\ \ln(Y_{i.t}) + \varepsilon_{it}$$

where $\text{In}\left[\frac{Y_{i,\ t+k}}{Y_{i,t}}\right]$ is the average annual growth rate of the selected indicator Y in a country or state i in period $(t, t+k)$, $Y_{i.t}$ is the value of selected indicators in the initial period t and ε_{it} are the corresponding residuals.

The calculation of the *speed of convergence* for a particular indicator is as follows:

$$s = -1/\text{T}\ (\ln\ (1+T\beta)$$

where s is the pace of convergence or divergence and $T\beta$ is the β-convergence in time period T (Barro & Sala-I-Martin, 1991, 1992).

Sigma convergence estimates show the status of variations present among different countries or regions over time. If the standard deviation across the states in the selected indicator is decreasing or increasing over time, it is referred to as convergence or divergence, respectively. The estimates are not concerned with whether the laggard states are catching-up with advanced states, but only focus on the decline or increase in variations over time. Therefore, it is possible for convergence in the case of growth rate decreasing in advanced states and stagnant in laggard states.

The mathematical notation of the σ-convergence model is:

$$\sigma_t > \sigma_{t+T}$$

where σ_t is the standard deviation of the indicator at time t. If the parameter σ_{t+T} declines over time, it implies convergence, and divergence otherwise (Barro & Sala-I-Martin, 1991, 1992, 1995).

The pace and timing of health transitions vary across Indian states. Therefore, in analysing the presence of convergence or divergence in any indicators of health status over time, the persistence of differences in the social and economic status of different states needs to be taken into consideration (Tryggvi *et al.*, 2000). Dorius (2008) estimated the *conditional β-convergence* to account for socioeconomic variability by including some explanatory indicators in the formal β-regression model. This study accounted for significant differentials in the proportion of the illiterate population and Net State Domestic Product (NSDP) of states as probable covariates in the Barro regression analysis. The mathematical equation for this model is:

$$\text{In}\left[\frac{Y_{i,\ t+k}}{Y_{i,t}}\right] = \alpha + \beta.\ln\left(Y_{,i.t}Y_{1,i.t}Y_{2,i.t}\right) + \varepsilon_{it}$$

where $\text{In}\left[\frac{Y_{i,\ t+k}}{Y_{i,t}}\right]$ is the average annual growth of selected indicator Y in state i for the period $(t, t+k)$, $Y_{i.t}$ is the value of the selected indicator in the initial period t and ε_{it} are the corresponding residuals. Likewise, Y_1 is the proportion of the illiterate population in state i in period $(t, t+k)$ and Y_2 is the log of NSDP in state i in period $(t, t+k)$.

Non-parametric model

The non-parametric estimates do not have any inherent assumption about the normality of the data under investigation (Quah, 1993; Wang, 2004). The theoretical explanation of the non-parametric estimation suggests that different countries or states are typically characterized by dual regimes, i.e. high and low mortality in the case of mortality transition (Moser *et al.*, 2005; Strulik &

Vollmer, 2015). As convergence takes place, the second peak disappears because at this time all the countries or states successfully achieve high levels of life expectancy and low mortality. Kernel Density estimations identify the short-term divergent paths, which may occur in the long-term convergence process and are usually not detected in β- or σ-convergence models.

Kernel Density estimates are widely used in non-parametric estimation for convergence analysis. More formally, let $f=f(x)$ denote the continuous density function of a random variable X at a point x, and let $x_1, \ldots, x_n$ be the observations from f. The Kernel function k may be expressed as:

$$\int_{-\infty}^{\infty} k(y)dy = 1$$

where $k(y) \geq 0$. The general Kernel estimator $\hat{f}(x)$ is defined by:

$$\widehat{f(x)} = \frac{1}{hn}\sum_{i=1}^{n} k\left(\frac{X_i - x}{h}\right) = \frac{1}{nh}\sum_{i=1}^{n} k(Y_i)$$

where $Y_i = h^{-1}(x_i - x)$, n refers to the number of observations in the sample, h is the window width (bandwidth), which is a function of the sample size, and K (.) is the smooth and symmetric Kernel function integrated to unity (Quah,1993).

Inequality measures

Dispersion Measure of Mortality (DMM)

The DMM quantifies the prevailing dispersion of mortality experiences at any point in time in a certain region or state. This is equal to the weighted average of the absolute differences in mortality patterns among each pair of regions or states. The estimate of the average difference in mortality of the regions is weighted by its respective population size. Changes in DMM in selected regions or countries over time suggest that there are changes in patterns of mortality, whereas a decrease shows convergence and a corresponding increase is a divergence. The DMM of LEB, IMR, NNMR and MMR was estimated using the following formula (Shkolnikov *et al.*, 2003; Moser *et al.*, 2005):

$$\text{DMM} = \frac{1}{2(W_Z)^2}\sum_{\text{i}}\sum_{\text{J}}\left(|M_i - M_j| W_I W_J\right)$$

where I and j are the state, and $1 \leq i, j \leq 193$, Z is equal to 1, M is the existing mortality rate, W is the population weight and $\sum_i W_i = \sum_j W_j = W_z$.

When this is applied to life expectancy at birth, M = life expectancy at birth for the state, $W_Z = 1$ and W_I represents the relative population size of state i.

Average Interstate Differences (AID)

Similarly, average interstate differences (AID) measure absolute inequality in health status or mortality among selected regions or states. It shows dispersion in the selected indicators of health status. The formula to estimate the AID for LEB and IMR (Shkolnikov *et al.*, 2012) is:

$$\text{AID} = \frac{1}{2u^2}\sum_{x}\sum_{y} d_x d_y |\hat{x} - \hat{y}|$$

where u is the mean of the selected health indicator and d_x and d_y are the population proportions of states x and y. Similarly, $\hat{x} - \hat{y}$ is the difference in selected health indicator of states x and y.

Table 1. Health status statistics for major Indian states

Variable	*N*	Mean	SD	Min	Max
LEB (1981–2015)	60	63.1	6.0	50	75
IMR (1981–2015)	60	66.8	33.0	11	150
MMR (201–2013)	30	227.3	128.4	61	539
NMR (1981–2015)	60	44.0	20.2	6	96
Child Underweight (1992–2015)	60	38.5	10.1	16	59
Child Full Immunization (1992–2015)	60	51.5	20.9	11	90
Illiteracy (1981–2011)	60	39.9	16.2	6	72
NSDP (1981–2014)	60	134,909.6	268,919.5	917	1,329,308

LEB: Life Expectancy at Birth; IMR: Infant Mortality Rate; MMR: Maternal Mortality Ratio; NMR: Neonatal Mortality Rate; NSDP, Net State Domestic Product.

Gini Index

Furthermore, to examine relative inequality in selected health indicators across states, the Gini index was estimated. The Gini of LEB is estimated by dividing the corresponding dispersion measure of mortality (DMM) by mean LEB among the selected states (Shkolnikov *et al.*, 2003). Thus, the formula for the Gini index (G) of LEB is:

$$G = \frac{\mathrm{DMM}}{\overline{e_0^0}}$$

where the mean life expectancy at birth adjusted by the population proportion of the country $i \ldots i_n$, $\overline{e_0^0}$, is given by:

$$\overline{e_0^0} = \left[\sum_i Pie_0^i\right]$$

Results

Descriptive statistics

Table 1 shows the values of the variables for the period 1981–2015. Data on LEB and IMR were available for sixteen major states. On average, LEB at the state level rose from a minimum of 50 years in 1981–85 to a maximum of 75 years in 2011–15, while IMR ranged from a maximum of 150 deaths per 1000 live births in 1981 to a minimum of 11 deaths per 1000 live births in 2015. Considerable improvements in average LEB, IMR, NNMR, MMR, Child Underweight and Child Full Immunization were observed over the study period.

Testing the hypothesis of convergence in health

Catching-up process

Differential changes in health outcomes across the Indian states were observed over the study period 1981–2015. Ideally, in the case of convergence, states with poor health status should experience a greater change than those with better health outcomes over the period under observation. Catching-up plots showed a weaker catching-up process in laggard states relative to leading states in the case of LEB, while there was evidence of a modest catching-up process in the case of IMR and MMR. There was also evidence of more unequal progress among states in the case of Child

https://doi.org/10.1017/S0021932020000255 Published online by Cambridge University Press

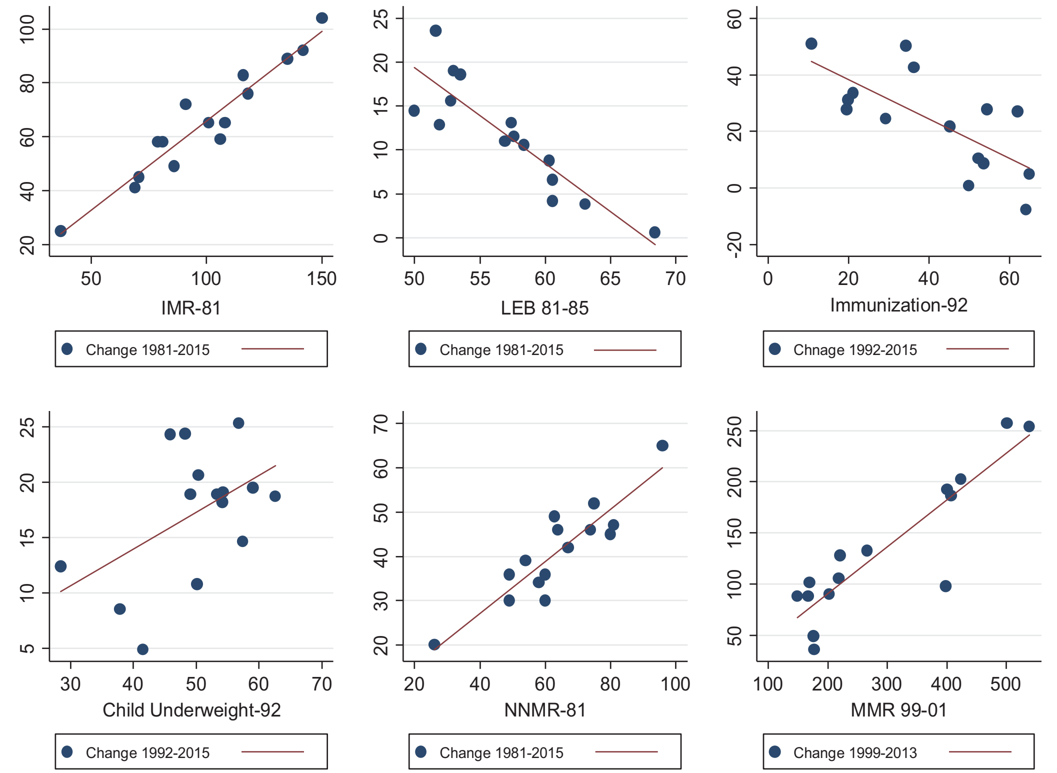

Figure 1. Catching-up process in health indicators across the major states of India, 1981–2015.

Underweight and Child Full Immunization. There was no evidence of a strong pattern of catching-up in any of the health indicators included in the study (Fig. 1).

Absolute β- and σ-convergence

Table 2 showed the results of the absolute β-convergence model for the selected health indicators for the major Indian states. In the period 1981–85 to 2011–15, progress in LEB resulted in significant convergence across states (β=−0.0543, p<0.001). The piecewise β-convergence models showed that there was convergence in LEB for the sub-periods as well. Moreover, estimates for the speed of convergence revealed that the progress in LEB across states was converging at the rate of 7.8 years per year from1981–85 to 2011–2015. However, in more recent decades, from 2001–05 to 2011–15, the speed of convergence declined at a slower pace (2.8 units per year).

Similarly, despite considerable catching-up during the period 1981–2015, absolute β-convergence for IMR showed divergence (β = 0.0005, p<0.929) for the years 1981–2015. Similarly, the divergence pattern continued for the sub-periods, except for the most recent one. The results of divergence during the sub-periods were, however, statistically insignificant. Moreover, the results from the most recent periods (2001–15) showed convergence in IMR (β=−0.0381, p<0.078).

A similar process was adapted to assess absolute β-convergence in NNMR, MMR, Child Underweight and Child Full Immunization for the overall period and sub-periods. Divergence and convergence were found in Child Underweight (β=0.0055, p<0.821) and Child Full Immunization (β=−0.1071, p<0.001), respectively, for the whole period. However, for the most recent period β-convergence in both indicators occurred. The results for NNMR and MMR

https://doi.org/10.1017/S0021932020000255 Published online by Cambridge University Press

Table 2. Absolute β-convergence estimates for selected health indicators across the major states of India, 1981–2015

	β-coefficient	p-value	R^2	Speed[a]
LEB				
1981–85 to 2015	−0.0543	<0.001	0.8280	7.8
1981–85 to 1991	−0.02745	ns	0.2682	3.2
1991–95 to 2001	−0.03924	0.001	0.7068	4.9
2001–05 to 2015	−0.11964	<0.001	0.6967	2.8
IMR				
1981 to 2015	0.0005	ns	0.0006	0.4
1981 to 1991	0.0156	ns	0.0464	1.5
1991 to 2001	0.0022	ns	0.0019	0.2
2001 to 2015	−0.0381	ns	0.2128	5.4
NNMR				
1981 to 2015	0.0165	ns	0.1451	1.3
1981 to 1991	0.036	ns	0.0548	3.0
1991 to 2001	−0.0294	ns	0.1974	3.5
2001 to 2015	−0.00177	ns	0.0002	0.2
MMR				
1999 to 2013	0.0011	ns	0.0086	0.12
1999 to 2006	0.0036	ns	0.0168	0.36
2006 to 2013	−0.0012	ns	0.0102	0.12
Child Full Immunization				
1992–93 to 2015–16	−0.1071	0.001	0.8063	4.9
1992–93 to 1998–99	0.121	0.007	0.4391	9.1
1998–99 to 2005–06	−0.1772	0.001	0.6824	20.3
2005–06 to 2015–16	−0.1502	0.001	0.6935	11.6
Child Underweight				
1992–93 to 2015–16	0.0055	ns	0.0041	0.52
1992–93 to 1998–99	−0.0370	ns	0.0155	4.1
1998–99 to 2005–06	−0.0258	ns	0.0159	2.8
2005–06 to 2015–16	−0.0168	ns	0.0213	1.8

Number of states: 15; degree of freedom: 14.
[a]Speed of convergence in units per annum; ns: not significant.

indicated that the divergence process was underway for the overall period, but hinted at a re-emergence of convergence for the most recent period.

The faster growth rate of the laggard states suggested that there was β-convergence but there was insufficient evidence for the presence of σ-convergence, which is more important because it provides information on the increase or decrease in disparity across states over time. Thus, σ-convergence needs to be examined alongside β-convergence to find conclusive evidence of

Table 3. Sigma convergence estimates for selected health indicators for different years across the major states of India, 1981–2015

	Standard Deviation (SD)
LEB	
1981	5.0
1991	4.8
2001	3.9
2015	3.2
IMR	
1981	30.5
1991	26.5
2001	21.4
2015	12.9
NNMR	
1981	16.7
1991	16.5
2001	12.0
2015	8.8
MMR	
1999	135
2006	124
2015	79
Child Full Immunization	
1992–92	18.0
1998–99	26.7
2005–06	17.5
2015–16	13.4
Child Underweight	
1992–92	9.6
1998–99	9.8
2005–06	10.2
2015–16	7.8

convergence or divergence. Therefore, σ-convergence was estimated by analysing the progress in the standard deviation of the selected indicators across the major states. The results indicated the presence of convergence for LEB, IMR, NNMR and MMR. For Child Underweight and Child Full Immunization there was divergence followed by the re-emergence of convergence (Table 3). However, the results from the most recent period showed that the convergence process was underway in almost all indicators examined.

Conditional β-convergence

Previous research has shown that large gaps in socioeconomic conditions, sectoral distribution and policy environments are drivers of differential economic and health outcomes among states (Janssen *et al.*, 2016). Thus, a mere examination of absolute β- or σ-convergence, by assuming that all states have the same socioeconomic environment and policy conditions, generates incomplete evidence for future health policy design. Conditional β-convergence provides clues about the factors that need to be targeted to accelerate the regional convergence process. Therefore, the existing socioeconomic differentials among states were accounted for by considering two more explanatory factors in the β-regression model, as additional independent variables along with the annual growth rate. The first explanatory variable was the proportion of the illiterate population in the state (Proportion Illiterate), and the second variable the log of NSDP. The negative β-coefficient for LEB suggested a convergence while controlling for differences in literacy and NSDP across states for the overall period and the sub-period as well.

The conditional β-convergence estimates for IMR showed convergence with negative β-coefficients for the overall period, 1981–2015 and for sub-periods as well. However, the results for absolute β-convergence showed divergence for the overall period. Thus, to assess the convergence process, the existing differentials in the socioeconomic status of the population needs to be accounted for. The results also showed the greater speed of convergence in IMR across states while estimating the conditional β-convergence as compared to the absolute β-convergence. Moreover, both overall and piece-wise conditional β-convergence estimates for NNMR showed convergence for the overall period (1981–2015). However, the piece-wise conditional β-regression estimates for Child Full Immunization compared with the absolute β-regression estimates showed a greater speed of convergence for the most recent period (Table 4). Furthermore, the results for conditional β-convergence showed convergence in the case of Child Underweight and MMR for the most recent period. Although results from both absolute and conditional β-convergence models showed convergence in a majority of the indicators across the states for the whole period, the speed of convergence in the conditional β-convergence model differed significantly from absolute β-convergence estimates.

Testing the hypothesis of convergence 'clubs'

The non-parametric analysis provided evidence of the presence of convergence 'clubs', where some states are clustered with higher levels of health outcomes and some with lower levels. There was evidence of a bimodal distribution in LEB over the period 2011–15 across states. However, the distribution was widely spread in the initial period (1981–85) compared with the most recent period (2011–15). In 2015, the majority of the states were concentrated at a higher level of LEB, which suggests an emerging convergence process. In the case of IMR, the presence of convergence clubs was evident in 1981 with a wider spread, but in 2015 there was evidence of a larger peak at higher IMR values and a smaller secondary peak at lower IMR values. This suggests that some states were converging at a lower level of IMR and that most of the states were still at a higher level of IMR.

Similarly, NNMR and MMR showed two peaks, with a greater clustering of states at lower values with comparatively fewer states clustering at the higher end for the recent period (2011–15). However, in the case of Child Underweight and Child Full Immunization the results showed a wider spread instead of a bimodal distribution, even for the recent period (Fig. 2). However, across different models, there was no evidence of continued convergence in Child Full Immunization coverage.

Table 4. Conditional β-convergence estimates for selected health indicators across the major states of India, 1981–2015

	β-coefficient	Proportion of Illiterate Population	Log NSDP	R^2	Speed[a]
LEB					
1981–85 to 2015	−0.0456 (0.006)	0.0022 (ns)	−0.1220 (ns)	0.8389	1.70
1981–85 to 1991	−0.0270 (ns)	−0.0041 (ns)	−0.2408 (ns)	0.3331	3.14
1991–95 to 2001	−0.0321 (ns)	0.0029 (ns)	−0.0169 (ns)	0.7165	3.88
2001–05 to 2015	−0.1049 (0.017)	0.0029 (ns)	−0.1552 (ns)	0.7051	5.43
IMR					
1981 to 2015	−0.0122 (ns)	0.0333 (ns)	−0.6781 (ns)	0.4076	1.53
1981 to 1991	−0.0215 (ns)	0.1359 (ns)	1.2126 (ns)	0.3246	2.42
1991 to 2001	−0.0220 (ns)	0.0876 (ns)	1.4186 (ns)	0.3724	2.49
2001 to 2015	−0.0485 (ns)	−0.1047 (ns)	−3.1111 (0.013)	0.5720	8.12
NNMR					
1981 to 2015	−0.0143 (ns)	0.0521 (0.005)	−0.3636 (ns)	0.6376	2.04
1981 to 1991	−0.0244 (ns)	0.1346 (ns)	1.8123 (ns)	0.2818	2.83
1991 to 2001	−0.0592 (0.010)	0.0609 (ns)	0.2797 (ns)	0.4960	9.01
2001 to 2015	−0.0581 (ns)	0.0545 (ns)	−1.4143 (ns)	0.2780	12.04
MMR					
1999 to 2013	0.0048 (ns)	0.1052 (s)	3.7700 (ns)	0.2411	−0.51
1999 to 2006	0.0071 (ns)	0.1821 (ns)	4.4410 (ns)	0.1226	−2.04
2006 to 2013	−0.0056 (ns)	−0.0057 (ns)	−1.4843 (ns)	0.0930	0.63
Child Full Immunization					
1992–93 to 2015–16	−0.1032 (0.005)	−0.0138 (ns)	−0.8571 (ns)	0.8164	5.72
1992–93 to 1998–99	0.1395 (ns)	−0.0887 (ns)	−5.0050 (ns)	0.5983	−10.12
1998–99 to 2005–06	−0.1567 (ns)	−0.0403 (ns)	−3.9440 (ns)	0.7176	33.34
2005–06 to 2015–16	−0.0867 (ns)	0.0140 (ns)	−2.8070 (ns)	0.7769	14.82
Child Underweight					
1992–93 to 2015–16	−0.0310 (ns)	0.0385 (ns)	−0.0417 (ns)	0.2886	5.42
1992–93 to 1998–99	−0.1113 (ns)	0.0482 (ns)	−2.6860 (ns)	0.1758	18.33
1998–99 to 2005–06	−0.0836 (ns)	0.0998 (s)	0.1651 (ns)	0.1670	12.54
2005–06 to 2015–16	−0.0421 (ns)	0.1281 (s)	1.0672 (ns)	0.3160	5.12

Number of states: 15; degree of freedom: 14.
[a]Speed of convergence per annum.
p-values in parentheses.
ns: not significant.

Trends in health inequalities

One of the major objectives of this study was to measure the convergence in disparity in health status across Indian states. The inequality assessment was categorized into two broad domains: absolute inequality through DMM and AID and relative inequality through the Gini index. A decline in these over the period suggested a convergence and an increase suggested a divergence (Shkolnikov *et al.*, 2003).

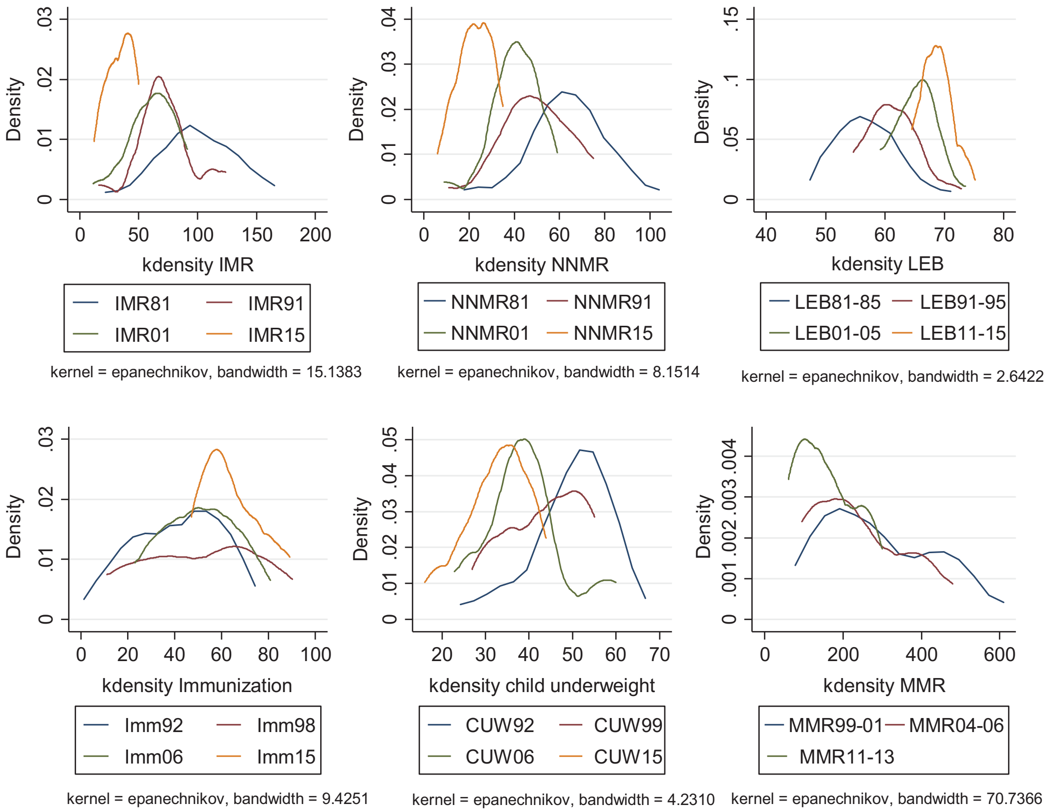

Figure 2. Kernel Density distribution for selected health indicators across the major states of India, 1981–2015.

Table 5 displays the estimates of DMM and Gini indices for all the health indicators for the major Indian states during the period 1981–2015. The DMM and Gini index for LEB declined for the whole period, although the rate of decline became slower in the most recent decade. The DMM for IMR showed a much steeper decline, while Gini index trends were not unidirectional throughout the period. Similarly, DMM continued to show a steady decline in NNMR and MMR for the overall period. Thus, the estimates of the DMM and Gini index for LEB confirmed the presence of the Convergence Hypothesis in absolute and relative inequality. The results indicate different trends for DMM for the Gini index in the case of IMR. Trends in DMM for IMR were declining from 1981 to 2015, but for the Gini index the values were stagnant with little fluctuation. Furthermore, in the case of NNMR and MMR, the Gini index value showed a small increase in the most recent period (2015 and 2013 respectively). These patterns suggest that although absolute inequality in IMR, NNMR and MMR has been on the decline, relative inequality has continued to rise or stagnate rather than show a conclusive decreasing trend.

Discussion

Health convergence, alongside economic convergence, is a compelling theoretical prediction. When it fails to occur, the structural obstacles are usually obvious. Convergence theory in health progress marks the crevices in existing health policies and calls for greater focus on inclusive and strategic policies. In an effort to identify the failure or success of the convergence process in health transition in India, this study examined the Convergence Hypothesis for different health

https://doi.org/10.1017/S0021932020000255 Published online by Cambridge University Press

Table 5. Trends in DMM, AID and Gini index for the health status variables across the major states of India

Trends in health inequalities				
LEB	**1981**	**1991**	**2001**	**2015**
DMM	53.1	47.2	40.6	36.2
Gini index	0.4736	0.3881	0.3142	0.2679
AID	26.6	23.6	20.3	18.1
IMR	**1981**	**1991**	**2001**	**2015**
DMM	35.5	25.5	21.9	13.2
Gini index	0.17	0.1698	0.1745	0.1707
AID	17.8	12.7	11	6.6
NNMR	**1981**	**1991**	**2001**	**2015**
DMM	19	16.1	10.5	9.1
Gini index	0.1402	0.1537	0.1262	0.1736
AID	9.5	8	5.2	4.6
MMR	**1999**	**2005**	**2009**	**2013**
DMM	160.7	142.5	112.8	93.1
Gini index	0.2514	0.2744	0.2575	0.2724
AID	80.3	71.2	56.4	46.6

indicators across the major Indian states using cutting-edge convergence metrics. The findings showed a convergence in life expectancy at birth (LEB) as measured through β-convergence. Similar trends were observed for IMR, Child Full Immunization and Child Underweight. However, there was a significant divergence in NNMR and MMR for the overall period (1981–2015, 1999–2013), with convergence for the most recent period (2001–2015, 2006–2013).

Furthermore, σ-convergence backed the findings of β-convergence for IMR, NNMR and MMR. However, β showed divergence and σ suggested convergence for Child Underweight and Child Full Immunization. Moreover, after adjusting for state-level variation in Illiteracy and NSDP, the results of conditional β-convergence also suggested that there was convergence for LEB, MMR, Child Underweight and Child Full Immunization across the states for the entire period. Interestingly, the results of conditional β-convergence in NNMR showed convergence for the overall period, but divergence for the recent period. However, the findings for IMR suggested that the convergence process was underway for the most recent period (2001–2015) and there was a divergence for the overall period (1991–2015). Other results, such as the Kernel Density Distribution, supported the hypothesis of convergence 'clubs', with the presence of a bimodal distribution for all the selected indicators. Overall, the findings did not support the hypothesis of convergence, although there was some evidence of convergence in a group of states and asymmetrical distribution of growth in health status among major states of India. Hence, the different conclusions from the various convergence measures supported the presence of a weak but not robust convergence process in different health indicators for the study period. This indicates an urgent need for more inclusive policies and programmes to reduce the unfair burden of disease and mortality in the laggard states. Moreover, the application of different convergence metrics works as a robustness check in the assessment of convergence process in select health indicators for India over the period.

The findings further suggest that despite economic prosperity in the country, regions that were under-privileged in child nutrition and literacy level were more likely to fall behind. Literacy in general, and mother's education in particular, is having a much stronger impact on child health and their survival compared with the historical persistence role of economic conditions (Gachter & Theurl, 2011). The σ-convergence shows that the state differentials in different indicators of the health status of the population have become smaller over time. On the other hand, β-convergence with more insights on distributional changes in individual states showed that states with the highest mortality or adverse health condition in the past showed greater improvements than states with lower mortality in the past.

Similarly, conditional β-convergence accounted for structural differences, i.e. differences in education level, economic status, disease prevention, provision of care, environment and state-specific endowment at the onset (Gachter & Theurl, 2011; Janssen *et al.*, 2016). Previous studies in this field have mostly reported a convergence process in health status using β- and σ-convergence metrics (Nixon, 2001; Roberto *et al.*, 2007; Janssen *et al.*, 2016). However, non-parametric models provide substantial information on the entire distribution of health status among a population (Quah, 1993; Wang, 2004). Thus, for a comprehensive examination of health status and its temporal distribution, there is a need for statistically diverse measures. The rationale stated above for the use of different measures would help to choose the best possible scenarios by considering the data quality and its reliability. However, the use of different measures does not have much impact on the outcomes of the study indicators, but they can act as robustness checks for one another.

Therefore, constant evaluation of health progress across different Indian regions and socioeconomic groups, and subsequent revision of health policies, has become an essential step towards ensuring equity in health status (Dorius, 2008; Goli & Arokiasamy, 2013, 2014; Goli, 2014; Goli & Siddiqui, 2015). This might be because growth, inequality and the catching-up process is omnipresent in the success story of developed countries. The transition to convergence is not a certain process, and convergence may be replaced by divergence and vice-versa at any time (Moser *et al.*, 2005; McMichael *et al.*, 2004; Dorius & Firebaugh, 2010). Similarly, the last few decades have shown that there is a trend towards a mortality trap, or reversals or stalling of further improvements, among advanced nations (Bloom & Canning, 2007; Clark, 2011). Thus, a constant evaluation of health status progress and its distribution will help policymakers to adopt a dynamic strategic approach for having inclusive growth to mark success and achieve the targets of the ongoing SDGs (Rahman *et al.*, 2017).

This paper contributes to future health policy and programmes in India by suggesting areas where there should be greater focus to reduce regional disparities and improve average health status. Convergence measures could be useful tools to measure and monitor health progress and distribution and measure whether or not there is catch-up in health measures. Disparities in health may then be reduced through appropriate policy interventions. The study has also highlighted the importance of different convergence metrics for the monitoring of health status and its distribution, taking into consideration the substantial socioeconomic and geographical disparity among Indian states. The assessment of regional progress in health indicators identifies the advantages and disadvantages of ongoing policies and informs policymakers. Convergence analysis provides an important tool for assessing progress towards the SDGs at the country, regional and the global level.

The success story of India's reduction in mortality and acceleration in the average life expectancy is widely acknowledged. However, the tempo and quantum of progress in health status are not uniform and stable across the states. Health disparities find their genesis historically through social, economic and political mechanisms that lead to social stratification according to income, levels of education, occupation, gender, caste and social groups (WHO, 2008). Thus, the lack of adequate progress on these underlying social determinants of health should be considered as a failure of India's public health achievements in the laggard states (Reddy *et al.*, 2011; Goli, 2014).

https://doi.org/10.1017/S0021932020000255 Published online by Cambridge University Press

Although government policies, such as the National Health Mission (NHM), act as a catalyst for establishing effective integration and convergence of health services, they suffer from poor investment centrally, but especially in the laggard states (Government of India, 2017). The larger health goal for a nation like India should the reduction of inter-state, intra-state and socioeconomic gradients in health. Health care services should be available, accessible and affordable through publicly funded health systems if poverty is to be eliminated and inequality minimized. Similarly, in order to achieve health for all, and address the needs of everyone, future health policies should be framed under the umbrella of the SDGs and should be boosted by a substantial rise in government health care investment. India's public investment (1.2% of its gross domestic product) on health care is meager in comparison to that of countries with successful convergence-focused health transitions (Drèze & Sen, 2012).

Acknowledgments. The datasets generated and/or analysed in this study are available in the public domain and can be accessed from the Office of Registrar General of India, Sample Registration System and Reports of the National Family and Health Survey 1991–2015 (NFHS-I-IV). Also, statistics were taken from the Planning Commission, Government of India, and the Ministry of Health and Family Welfare (MoHFW), Government of India.

Funding. The research did not receive financial support from any source.

Conflict of Interest. The authors declare that they have no conflicts of interest.

Ethics Approval. The study used the dataset available in the public domain for specific and intensive analyses as a part of the authors' independent research work. Thus, there is no need to seek a separate ethical clearance for this study.

References

Atkinson T (2015) *Inequality: What Can Be done?* Harvard University Press.

Barro RJ (1991) Economic growth in a cross-section of countries. *Quarterly Journal of Economics* **106**, 407–444.

Barro RJ and Sala-I-Martin X (1991) Convergence across states and regions. *Brooking Papers of Economy Activity* **1**, 107–182.

Barro RJ and Sala-I-Martin X (1992) Convergence. *Journal of Political Economy* **100**, 223–251.

Barro RJ and Sala-I-Martin X (1995) *Economic Growth*. McGraw-Hill, New York.

Blas E and Kurup SA (2010) Synergy for equity. In Blas E and Kurup SA (eds) *Equity, Social Determinants, and Public Health Programmes*. World Health Organization, Geneva, pp. 261–284.

Bloom DE and Canning D (2007) Mortality traps and the dynamics of health transitions. *Proceedings of the National Academy of Sciences* **104**(41), 16044–16049.

Clark R (2011) World health inequality: convergence, divergence, and development. *Social Science & Medicine* **72**, 617–624.

Deaton A (2013) *The Great Escape: Health Wealth, and Origins of Inequality*. Princeton University Press.

Dorius SF (2008) Global demographic convergence? A reconsideration of changing inter country inequality in fertility. *Population and Development Review* **34**(3), 519–539.

Dorius SF and Firebaugh G (2010) Trends in global gender inequality. *Social Forces* **88**(5), 1941–1968.

Drèze J and Sen AK (2012) *Indian Development: Selected Regional Perspectives*. Oxford University Press.

Drèze J and Sen AK (2013) *An Uncertain Glory: India and its Contradictions*. Princeton University Press.

Franklin RS (2002) Fertility convergence across Italy's regions, 1952–1995. Paper presented at the 41st Annual Meeting, Western Regional Science Association, Monterey, CA, USA.

Franklin RS (2003) Italian fertility, 1864 to 1961: an analysis of regional trends. Paper prepared at the 43rd European Congress of the Regional Science Association, 27–30th August 2003, Jyväskylä, Finland.

Gachter and Theurl (2011) Health status convergence at the local level: empirical evidence from Austria. *International Journal for Equity in Health* **10**, 34. doi: 10.1186/1475-9276-10-34.

Goesling B and Firebaugh G (2004) The trend in international health inequality. *Population and Development Review* **30**(1), 131–146.

Goli S (2014) Demographic convergence and its linkage with health inequalities in India. Doctoral thesis, International Institute for Population Sciences, Mumbai, India.

Goli S and Arokiasamy P (2013) Trends in health and health inequalities among major states of India: assessing progress through convergence models. *Health Economics Policy and Law* **9**(2), 143–168.

Goli S and Arokiasamy P (2014) Maternal and child mortality indicators across 187 countries of the world: converging or diverging. *Global Public Health* **9**(3), 342–360.

Goli S, Moradhvaj, Chakravorty S and Rammohan A (2019) World health status 1950–2015: converging or diverging? *PLoS One* **14**(3), e0213139.

Goli S and Siddiqui MZ (2015) Rise and fall of between-state inequalities in demographic progress in India: application of "inequality life cycle hypothesis". *Social Science Spectrum* **1**(3), 167–180.

Government of India (2017) *Economic Survey Report 2016–17*. Volume 2. Ministry of Finance Department of Economic Affairs Economic Division, Delhi. URL: http://www.thehinducentre.com/multimedia/archive/03193/Economic_Survey_vo_3193544a.pdf (accessed 18th October 2018).

IIPS and Macro International (1995) *National Family Health Survey Report*. Ministry of Health and Family Welfare, Government of India.

IIPS and Macro International (2000) *National Family Health Survey Report*. Ministry of Health and Family Welfare, Government of India.

IIPS and Macro International (2007) *National Family Health Survey Report*. Ministry of Health and Family Welfare, Government of India.

IIPS and Macro International (2017) *National Family Health Survey (1–4) Report*. Ministry of Health and Family Welfare, Government of India.

James KS (2011) India's demographic change: opportunities and challenges. *Science* **29**(333[6042]), 576–580.

James KS and Goli S (2016) Demographic changes in India: is the country prepared for the challenge? *Brown Journal of World Affairs* **23**(1), 169–188.

Jamison DT, Summers LH, Alleyne G *et al.* (2013) *CIH Report Global Health 2035*. The Lancet Commission on Investing in Health.

Janssen F, Hende A, Beer J and Wissen L (2016) Sigma and beta convergence in regional mortality: a case study of the Netherlands. *Demographic Research* **35**, 81−116.

Lim SS, Allen K, Bhutta ZA, Dandona L, Forouzanfar MH, Pullman N *et al.* (2016) Measuring the health-related Sustainable Development Goals in 188 countries: a baseline analysis from the Global Burden of Disease Study 2015. *The Lancet* **388**, 1813–1850.

McMichael AJ, Mckee M, Shkolnikov V and Valkonen T (2004) Mortality trends and setbacks: global convergence or divergence? *The Lancet* **363**, 1155–1159.

Marmot M (2015a) *The Health Gap: The Challenge of an Unequal World*. Bloomsbury Publishing.

Marmot M (2015b) *Status Syndrome: How to Place on the Social Gradient Directly Affects Your Health*. Bloomsbury Publishing.

Milanovic B (2016) Global inequality: a new approach for the age of globalization. *Panoeconomicus* **63**(4), 493–501.

Moser K, Shkolnikov V and Leon D (2005) World mortality 1950–2000: divergence replaces convergence from the late 1980s. *Bulletin of the World Health Organization* **83**(3), 202–209.

Nayyar D (2013) *Catch Up: Developing Countries in the World Economy*. Oxford University Press.

Neumayer E (2003) Beyond income: convergence in living standards, big time. *Structural Change and Economic Dynamics* **14**, 275–296.

Nixon J (2001) Convergence of health care spending and health outcomes in the European Union, 1960‒95. *Centre for Health Economics Discussion Paper Series*, doi: 10.7748/nm.8.2.39.s18

O'Connell M (1981) Regional fertility patterns in the United States: convergence or divergence? *International Regional Science Review* **6**, 1–14.

Office of Registrar General of India (2007) *Sample Registration System Year Book*. Government of India, New Delhi.

Office of Registrar General of India (2009) *Sample Registration System Year Book*. Government of India, New Delhi.

Office of Registrar General of India (2014) *Sample Registration System Year Book*. Government of India, New Delhi.

Office of Registrar General of India (2015) *Sample Registration System Year Book*. Government of India, New Delhi.

Office of Registrar General of India (2017) *Compendium of Sample Registration System Year Books (1981–2016)*. Government of India New Delhi.

Oxfam (2017) *Oxfam Briefing Paper. Starting with People: A Human Economy Approach to Inclusive Growth in Africa*. URL: https://www-cdn.oxfam.org/s3fs-public/file_attachments/bp-inclusive-growth-africa-020517-summ-en.pdf

Piketty T (2014) *Capital in the Twenty-First Century*. Belknap Press of Harvard University Press, Cambridge, MA, and London, UK.

Quah DT (1993) Empirical cross-section dynamics in economic growth. *European Economic Review* **37**, 426–434.

Rahman MM, Karan A, Rahman MS, Parsons A, Abe SK, Bilano V *et al.* (2017) Progress toward universal health coverage: a comparative analysis in 5 South Asian countries. *JAMA Internal Medicine* **177**, 1297–305.

Ram U Jha P and Ram F *et al.* (2013) Neonatal, 1–59 month, and under-5 mortality in 597 Indian districts, 2001 to 2012: estimates from national demographic and mortality surveys. *Lancet Global Health* **1**, e219–e226.

RBI (2017) *Annual Report of RBI*. Reserve Bank of India. https://rbidocs.rbi.org.in/rdocs/AnnualReport/PDFs/RBIAR201617_FE1DA2F97D61249B1B21C4EA66250841F.PDF

Reddy KS, Patel V, Jha P, Paul VK, Kumar AK, Dandona L *et al.* (2011) Towards achievement of universal health care in India by 2020: a call to action. *The Lancet* **8**(377), 760.

Rey S and Montouri DB (1999) US regional income convergence: a spatial econometric perspective. *Regional Studies* **33**, 143–156.

Rivas MDG and Villarroya IS (2016) Testing the Convergence Hypothesis for OECD countries: a reappraisal. *Economics Discussion Paper No. 2016-45*. Kiel Institute for the World Economy.

Roberto MG, Juan DDJ and Jose M (2007) Decentralisation and convergence in health among the provinces of Spain (1980–2001). *Social Science & Medicine* **64**(6), 1253–1264.

Saikia N, Jasilionis D, Ram F and Shkolnikov V (2011) Trends in geographic mortality differentials in India. *Population Studies* **65**(1), 73–89.

Saikia N, Singh A, Jasilionis D and Ram F (2013) Explaining the rural–urban gap in infant mortality in India. *Demographic Research* **29**(18), 473–506.

Shkolnikov VM, Andreev EM and Begun AZ (2003) Gini coefficient as a life table function: computation from discrete data, decomposition of differentials and empirical examples. *Demographic Research* **8**(11), 305–358.

Shkolnikov VM, Andreev EM, Jdanov DA, Jasilionis D, Kravdal Ø, Vågerö D and Valkonen T (2012) Increasing absolute mortality disparities by education in Finland, Norway, and Sweden, 1971–2000. *Journal of Epidemiology and Community Health* **66**, 372–378.

Singh A, Pathak PK, Chauhan RK and Pan W (2011) Infant and child mortality in India in the last two decades: a geospatial analysis. *PLoS One* **6**(11), e26856.

Stiglitz J (2015) *The Great Divide*. Penguin, UK. ISBN: 9780141981222.

Strulik H and Vollmer S (2015) The fertility transition around the world. *Journal of Population Economics* **28**(1), 31.

Taylor S (2009) Wealth, health and equity: convergence to divergence in late 20th-century globalization. *British Medical Bulletin* **91**, 29–48.

Tryggvi T, Herbertsson TT, Orszag JM *et al.* (2000) *Population Dynamics and Convergence in Fertility Rates. SSRN Electronic Journal*, doi: 10.2139/ssrn.273382

UNICEF (2011) *Global Inequality: Beyond the Bottom Billion – A Review of Income Distribution in 141 Countries*. UNICEF. URL: http://www.unicef.org/socialpolicy/index_58230.html (accessed 12th October 2018).

United Nations (2019a) *World Mortality 2019: Data Booklet (ST/ ESA/SER.A/436)*. Population Division, Department of Economic and Social Affairs, United Nations.

United Nations (2019b) *The Sustainable Development Goals Report*. URL: https://unstats.un.org/sdgs/report/2019/The-Sustainable-Development-Goals-Report-2019.pdf (accessed 7th May 2019).

Vallin J, Andreev E, Mesle F and Shkolnikov V (2005) Geographical diversity of cause-of-death patterns and trends in Russia. *Demographic Research* **12**(13), 323-380.

Vallin J and Mesle F (2001) Trends in mortality in Europe since 1950: age-, sex and cause-specific mortality. In Vallin J *et al.* (eds) *Trends in Mortality and Differential Mortality*. Council of Europe Publishing, Strasbourg, pp. 31–184.

Vallin J and Mesle F (2004) Convergences and divergences in mortality: a new approach to health transition. *Demographic Research* **S2**(2), 11-44.

Visaria L (2004a) Mortality trends and the health transition. In Dyson T *et al.* (eds) *Twenty-first Century India – Population, Economy, Human Development, and the Environment*. Oxford University Press, New Delhi, pp. 32–56.

Visaria L (2004b) The continuing fertility transition. In Dyson T *et al.* (eds) *Twenty-first Century India – Population, Economy, Human Development, and the Environment*. Oxford University Press, New Delhi, pp. 57–73.

Wang Y (2004) A nonparametric analysis of the personal income distribution across the provinces and states in the US and Canada. *Regional and Sectoral Economic Studies* **4**(1), 5–24.

Whitehead M, Dahgren G and Evans T (2001) Equity and health sector reforms: can low-income countries escape the medical poverty trap? *The Lancet* **358**, 833–836.

WHO (2008) *World Health Report on Primary Health Care: Now More Than Ever*. World Health Organization, Geneva.

WHO (2015) *Monitoring Health Inequality: An Essential Step for Achieving Health Equity*. World Health Organization, Geneva.

Wilson C (2001) On the scale of global demographic convergence 1950–2000. *Population Development Review* **27**, 155–171.

Wilson C (2011) Understanding global demographic convergence since 1950. *Population and Development Review* **37**, 375–388.

Young AT, Higgins MJ and Levy D (2008) Σ-convergence versus β-convergence: evidence form U.S. county-level data. *Journal of Money, Credit, and Banking* **40**, 1083–1093.

Cite this article: Siddiqui MZ, Goli S, and Rammohan A (2021). Testing the regional Convergence Hypothesis for the progress in health status in India during 1980–2015. *Journal of Biosocial Science* **53**, 379–395. https://doi.org/10.1017/S0021932020000255