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Hospitalisation trends in India from serial nationwide surveys: 1995 to 2014

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ABSTRACT

Objectives: We report hospitalisation trends in India contrasting the older population (aged 60 years or more) with those under 60 years and quantify the factors contributing to the change in hospitalisation rate of the older population between 1995 and 2014.

Design: Repeated cross-sectional analytical study.

Setting: Nationally representative sample, India.

Data sources: 3 consecutive healthcare surveys conducted by the National Sample Survey Organisation in 1995-96, 2004 and 2014 with sample sizes ranging from 333,104 to 629,888.

Participants: Older population and those under 60 years who reported at least one episode of hospitalisation in 365-days reference period.

Methods: Descriptive statistics, multivariate analyses and a regression decomposition technique were used to attain the study objectives.

Result: The annual hospitalisation rate per 1000 increased from 16.6 to 37.0 in India from 1995-96 to 2014. The hospitalisation rate was about half in the less developed than the more developed states in 2014 (26.1 vs 48.6 per 1000). Poor people used more public than private hospitals; this differential was higher in the more developed (40.7% vs 22.9%) than the less developed (54.3% vs 40.1%) states in 2014. When compared to the younger population, the older population had a 3.6 times higher hospitalisation rate (109.9 vs 30.7) and a greater proportion of hospitalisation for non-communicable diseases (80.5% vs 56.7%) in 2014. Amongst the older population, hospitalisation rates were comparatively lower for females, poor, and rural residents. Propensity change contributed to 86.5% of the increase in hospitalisation among the older population and compositional change contributed 9.3%.

Conclusion: The older population in India has a much higher hospitalisation rate and has continuing greater socioeconomic differentials in hospitalisation rates. Specific policy focus

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on the requirements of the older population for hospital care in India is needed in light of the anticipated increase in their proportion in the population.

Keywords Ageing, decomposition, expansion of morbidity, hospitalisation, non-communicable diseases, older population, propensity

Stregths and limitations of this study

- The use of large scale data from nationwide surveys in India over the past two decades provides the most updated trends for hospitalisation.
- The evidence on the changing hospitalisation rate by age groups and the reasons behind the increased hospitalisation of the older population is timely for policy formulation given the rapid population ageing and shifting disease burden.
- It was not possible for us to study the contribution of the supply side factors in the increased hospitalisation.
- Self-reported data and the nature of cross-sectional data may lead to recall and reporting biases, which may have affected the accuracy of the results.

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INTRODUCTION

The improvement in life expectancy in India has not been matched by the improvements in levels of health of the population.[1 2] The difference between life expectancy and healthy life expectancy was 7.2 years for the male population and 8.0 years for the female population in 1990, which increased to 7.6 years and 9.4 years, respectively in 2013, suggesting that India's population loses more years of healthy life to disability today than it did 20 years ago. The older population in India suffer from the higher burden of disease at older ages, particularly chronic diseases and disabilities.[3-11] The rapidly ageing population will continue to be one of the major determinants of the change in disease burden over the next two decades.[5] Higher disease burden at older ages results in greater demand for healthcare, particularly hospitalisation.[12-15] Hospital care is an important aspect of any health system, especially regarding the treatment of the more vulnerable older segment of the population.[16 17]

Monitoring change in hospitalisation rates is important to highlight the necessity for health policies to allocate resources and services to respond to the diverse healthcare needs of different segments of the population. Here, we report the comparative analysis of the hospitalisation trends between 1995 and 2014 for different age groups across the less and more developed states of India, and for various disease conditions. We contrast the hospitalisation trends in the older population with the rest and quantify the propensity and compositional change that may contribute to the change in hospitalisation rates of the older population.

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MATERIALS AND METHODS

Ethics statement

The study is based on secondary data available in public domain with no identifiable information on the survey participants. Exemption from ethics review was obtained from Institutional Ethics Committee at the Public Health Foundation of India and Research Ethics Committee at the London School of Hygiene and Tropical Medicine.

Data description

We used individual level data from three rounds of the National Sample Survey Organisation (NSSO): survey on healthcare of 1995-96 (52nd round), survey on morbidity and healthcare of 2004 (60th round), and survey on social consumption: health of 2014 (71st round) conducted under the stewardship of Ministry of Statistics and Programme Implementation, Government of India. Details of the sampling design, survey instruments, and findings can be found in the national reports.[18-20]

Briefly, all the three surveys obtained detailed data on all hospitalisation episodes in the reference period of 365 days prior to the survey for a large, nationally representative population sample of all age groups (including deceased members) in India. Admission for the treatment of an ailment and discharge thereof from the hospital was considered as a case of hospitalisation irrespective of the duration of stay. The survey also collected information on demographic and socioeconomic characteristics of the individuals in the household. In addition, there was a special module for the persons aged 60 years or more, which collected information on the various aspects of older population: these pertain to state of economic independence, person supporting, amount of loans withstanding, living arrangement, physical mobility status, current state of health, and relative state of health.

The sample design adopted by the NSSO 1995-96, NSSO 2004 and NSSO 2014 surveys were essentially a two-stage stratified design, with census villages and urban blocks

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as the first-stage units for the rural and urban areas, respectively, and households as the second-stage units. All the three surveys were sufficiently similar to permit the construction of comparable variables which could be used to make statistical inferences about change in parameter estimates between the surveys. Individual level data was collected for a nationally representative sample of 629,888 in NSSO 1995-96, 383,338 in NSSO 2004, and 333,104 in NSSO 2014. The sample of the older population in these surveys was: 33,990 in NSSO 1995-96, 34,831 in NSSO 2004, and 27,245 in NSSO 2014 surveys.

Measures

We used monthly per capita consumption expenditure (MPCE) adjusted to the household size and composition as a proxy for economic status. The equivalence scale used was $e_h = (A_h + 0.5K_h)^{0.75}$, where A_h was the number of adults in the household, and K_h was the number of children 0–14 years. Parameters were set on the basis of estimates summarised by Deaton.[21] The state-specific adult equivalent mean MPCE was used as a cut-off to categorise households into poor and non-poor.

We present analysis at the state level for the 35 states and union territories in India by classifying them into two groups –less developed and more developed states. The less developed states include the 18 states namely, eight Empowered Action Group states (Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Uttar Pradesh, Uttaranchal, Odisha and Rajasthan), 8 North-eastern states (Assam, Arunachal Pradesh, Manipur, Mizoram, Meghalaya, Nagaland, Sikkim and Tripura), Himachal Pradesh, and Jammu and Kashmir.[22] State-specific rates were estimated for the 19 major states of India, with a population over 10 million in 2011 census, accounting for 97% of India's population. For comparison Bihar, Madhya Pradesh, Uttar Pradesh, and Andhra Pradesh were considered as undivided states at all survey points.

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Cause of hospitalisation was categorised into non-communicable diseases and injuries (NCDs), and communicable diseases and nutritional disorders (CDs) using the Global Burden of Disease 2013 classification.[2] The diseases included in the two broad categories are listed in Table S1.

Anderson's model of healthcare utilisation was used to study the determinants of hospitalisation.[23] Based on the availability of data age, sex, marital status, social group, and education were identified as predisposing variables; place of residence, states, economic independence, economic status, and living arrangement as enabling factors; and physical mobility status, self-rated health (SRH), and SRH compared to previous year as the need variables, which are likely to affect hospitalisation in the older population. These variables were dichotomised for all analyses.

For comparative analysis, age was categorised as "under 60 years" and "older population". The population under 60 years comprised of children aged 0-14 years and adults aged 15-59 years. All those aged 60 years or more were categorised as older population in accordance with the official definition for older persons as used by the Indian government, which is also consistent with the United Nations definition for an older person in the developing world, as adopted at the World Assembly on Aging convened in Vienna in 1982.[24 25]

Initial analysis of trends and differentials in hospitalisation rate was performed on all persons surveyed including deceased members. However, for the subsequent descriptive, multivariate, and decomposition analyses performed on the older population, the deceased was excluded because the information on several important background variables was not collected for them in the surveys.

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Statistical methods

Descriptive analysis was used to examine the change in hospitalisation rate for all diseases, NCDs, and CDs at both aggregate and subgroup levels for all ages, and the change in the composition of the older population in India between 1995 and 2014. The annual hospitalisation rate was defined as the number of episodes of hospitalisation in a given reference period per 1000 of the population exposed to the risk. A change in rate was defined as statistically significant if the 95% confidence interval (CI) of the estimates for the two periods did not overlap.

A logit model was used to evaluate the effect of covariates on the probability of hospitalisation in the older population. The model employed was of the form:

$$Ln[P_i/(1- P_i)]= \sum \beta_i X_i \qquad (1)$$

where $Ln[P_i/(1- P_i)]$ was the log odds of hospitalisation, X_i was a vector of explanatory variables, and β_i was a vector of regression coefficients. The model was checked for multicollinearity.

A regression decomposition technique was used to decompose the change in hospitalisation rate into its constituent parts.[26-28] A multivariate logit model was estimated for each period. For example, the equation for the period 1995-96 was

$$Ln[P_i/(1-P_i)]_{(1995\text{-}96)} = \beta_0 + \beta_i X_{i(1995\text{-}96)} + \cdots\cdots\cdots + \beta_n X_{n(1995\text{-}96)}$$

$$i=1,2,3,4\cdots\cdots\cdots\cdots n \qquad (2)$$

while the equation for the period 2014 was

$$Ln[P_i/(1-P_i)]_{(2014)} = \beta_0 + \beta_i X_{i(2014)} + \cdots\cdots\cdots + \beta_n X_{n(2014)}$$

$$i=1,2,3,4\cdots\cdots\cdots\cdots n \qquad (3)$$

The difference $Ln[P_i/(1-P_i)]_{(2014)} - Ln[P_i/(1-P_i)]_{(1995\text{-}96)}$ was decomposed using equation (4), which considered 1995-96 as the base period.

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$$Logit_{(2014)} - Logit_{(1995\text{-}96)} = [(\beta_{0(2014)} - \beta_{0(1995\text{-}96)}) + \sum P_{ij(1995\text{-}96)} (\beta_{ij(2014)} - \beta_{ij(1995\text{-}96)})] + \sum \beta_{ij(1995\text{-}96)}$$

$$(P_{ij(2014)} - P_{ij(1995\text{-}96)}) + \cdots\cdots\cdots\cdots + \sum (\beta_{ij(2014)} - \beta_{ij(1995\text{-}96)}) (P_{ij(2014)} - P_{ij(1995\text{-}96)}) \quad (4)$$

Where,

$P_{ij(2014)}$ = Proportion of j^{th} category of the i^{th} covariate in NSS 2014

$P_{ij(1995\text{-}96)}$ = Proportion of j^{th} category of the i^{th} covariate in NSS 1995-96

$\beta_{ij(2014)}$ = Coefficient for the j^{th} category of the i^{th} covariate in NSS 2014

$\beta_{ij(1995\text{-}96)}$ = Coefficient for the j^{th} category of the i^{th} covariate in NSS 1995-96

$\beta_{0(2014)}$ = Regression constant in NSS 2014

$\beta_{0(1995\text{-}96)}$ = Regression constant in NSS 1995-96

This procedure yields three components: 1) propensity defined as the change brought by variation in the impact of determinants; 2) composition defined as the change due to variation in the proportion of determinants, and 3) interaction which reflects the change as a result of the interplay between compositional and propensity change.[29]

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RESULTS

Hospitalisation trends and differentials

The annual hospitalisation rate per 1000 increased 2.23 times from 16.6 in 1995-96 to 37.0 in 2014 (Table 1). The increase in hospitalisation rate was higher for NCDs compared to CDs (3.61 vs 2.25 times) in the past two decades. Population under 60 years accounted for 83.0% of all hospitalisations in 1995-96, which declined to 76.4% in 2014. Older persons comprised 8.6% of India's population and accounted for 23.6% of all hospital stays (9.8 million hospitalisations) in 2014. Compared to the population under 60 years, the overall hospitalisation rate was 3.58 times higher, and the hospitalisation rate for NCDs was 5.09 times higher for the older population in 2014. The mean length of stay for the older population was 2.79 days longer in 1995-96, which declined to 0.67 days in 2014. The proportion hospitalised more than once was 1.71 times higher for older population compared to those under 60 years in 2014. Hospitalisation rate disaggregated by age and disease groups for the years 1995-96, 2004 and 2014 is presented in Table S2.

Table 1. Characteristics of hospitalisation of the population in 1995-96, 2004 and 2014, India.

	1995-96			2004			2014		
Characteristics of hospitalisation	**Under 60 years**	**60 years or more**	**All ages**	**Under 60 years**	**60 years or more**	**All ages**	**Under 60 years**	**60 years or more**	**All ages**
Hospitalisation rate per 1000	14.6	49.7	16.6	24.5	76.4	28.2	30.7	109.9	37.0
Hospitalisation rate per 1000 for communicable diseases	5.5	9.5	5.7	7.9	12.7	8.3	12.3	18.4	12.8
Hospitalisation rate per 1000 for non-communicable diseases	5.0	28.7	6.4	11.7	54.0	14.7	17.4	88.5	23.1
% of hospitalised cases treated in public hospitals	45.4	42.7	44.9	41.1	39.2	40.6	39.2	35.9	38.4
Mean length of stay (in days)	11.7	14.5	12.2	9.1	9.5	9.2	6.9	7.5	7.0
% hospitalised more than once in last 365 days	7.2	12.4	8.0	9.7	13.3	10.4	10.2	17.4	11.8
% of hospitalised persons who died in last 365 days	6.1	14.6	7.5	2.8	7.1	3.6	3.0	12.4	5.06
Estimated hospitalised cases (in millions) (%)	11.6 (83.0)	2.4 (17.0)	14.0 (1.7)	21.9 (80.8)	5.2 (19.2)	27.2 (2.8)	31.8 (76.4)	9.8 (23.6)	41.6 (3.7)
Percentage of India's population*	93.5	6.5		92.7	7.3		91.1	8.9	

*Estimated from World Population Prospects: The 2015 Revision.

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Males and females under 60 years had similar hospitalisation rates while older males had 64% higher hospitalisation rate compared to older females in 1995-96 (Fig.1). The gender gap reduced by 2014 because of the higher increase in hospitalisation rate for older females compared to older males (2.71 vs 1.89 times). As compared to poor, amongst older population, the non-poor had 62% higher hospitalisation rate, while amongst population under 60 years, the non-poor had 36% higher hospitalisation rate in 2014. In 1995-96, the urban residents aged 60 years or more had 71% higher hospitalisation rate compared to rural residents, which declined to 34% higher in 2014. As compared to the less developed states, the hospitalisation rate in the more developed states was 2.82 times higher for the older population and 2.07 times higher for those under 60 years; however, the differential become similar by 2014.

The more developed states had 2.21 times and 1.86 times higher hospitalisation rate than the less developed states in 1995-96 and 2014, respectively (Table 2). The contribution of NCDs to total hospitalisation increased from 38.6% in 1995-96 to 62.2% in 2014. The hospitalisation rate increased 2.21 times for older population and 2.01 times for population under 60 years between 1995-96 and 2014. The share of NCDs to total hospitalisation was higher for the older population compared to the population under 60 years (80.5% vs 56.7% in 2014-15). Between 1995-96 and 2014, the increase in hospitalisation rate was higher in the less developed compared to the more developed states, more so for the older population for all diseases (3.12 vs 1.89 times), NCDs (4.50 vs 2.63 times), and CDs (2.59 vs 1.66 times). This also holds true for the population under 60 years. The hospitalisation rate for older population by disease groups in the major states of India is shown for 1995-96, 2004 and 2014 in Table S3.

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Table 2. Hospitalisation rate per 1000 (95% CI) by disease groups in the less and more developed states in 1995-96, 2004 and 2014, India.

States	60 years or more								
	1995-96			2004			2014		
	All hospitalisations	NCDs	CDs	All hospitalisations	NCDs	CDs	All hospitalisations	NCDs	CDs
More developed states	70.9(66.1-75.8)	41.7(37.7-45.8)	12.7(10.8-14.6)	104.6(99.8-109.4)	74.6(70.4-78.7)	17.1(15.1-19.1)	134.3(128.0-140.7)	109.7(103.9-115.5)	21.1(18.8-23.5)
Less developed states	25.1(22.3-27.9)	13.6(12.1-15.1)	5.8(4.0-7.6)	41.6(38.4-44.9)	28.6(25.8-31.4)	7.3(6.2-8.4)	78.4(71.3-85.5)	61.2(54.6-67.8)	15.0(12.7-17.2)
India	49.7(46.8-52.6)	28.7(26.5-31.0)	9.5(8.2-10.8)	76.4(73.4-79.4)	54.0(51.4-56.5)	12.7(11.5-13.9)	109.9(105.2-114.5)	88.5(84.2-92.8)	18.4(16.8-20.1)
States	Under 60 years								
	1995-96			2004			2014		
	All hospitalisations	NCDs	CDs	All hospitalisations	NCDs	CDs	All hospitalisations	NCDs	CDs
More developed states	19.5(18.9-20.1)	7.0(6.6-7.3)	7.1(6.7-7.4)	33.1(32.3-34.0)	16.1(15.5-16.7)	10.5(10.0-11.1)	39.9(38.8-40.9)	23.5(22.6-24.4)	15.0(14.3-15.6)
Less developed states	9.4(8.9-9.8)	2.9(2.7-3.1)	3.7(3.4-4.0)	15.7(15.2-16.1)	7.3(7.0-7.6)	5.2(4.9-5.4)	22.3(21.5-23.1)	11.8(11.2-12.4)	9.9(9.4-10.4)
India	14.6(14.2-15.0)	5.0(4.8-5.2)	5.5(5.2-5.7)	24.5(24.0-24.9)	11.7(11.4-12.1)	7.9(7.6-8.2)	30.7(30.0-31.4)	17.4(16.9-17.9)	12.3(11.9-12.7)
States	All ages								
	1995-96			2004			2014		
	All hospitalisations	NCDs	CDs	All hospitalisations	NCDs	CDs	All hospitalisations	NCDs	CDs
More developed states	22.5(21.9-23.1)	9.0(8.6-9.4)	7.4(7.0-7.7)	38.7(37.8-39.6)	20.6(20.0-21.3)	11.1(10.6-11.6)	48.6(47.5-49.8)	31.5(30.5-32.4)	15.6(14.9-16.2)
Less developed states	10.2(9.8-10.6)	3.5(3.3-3.7)	3.8(3.6-4.1)	17.5(17.0-18.0)	8.7(8.4-9.0)	5.4(5.1-5.6)	26.1(25.2-27.0)	15.2(14.4-15.9)	10.2(9.7-10.7)
India	16.6(16.2-17.0)	6.4(6.1-6.6)	5.7(5.5-5.9)	28.2(27.7-28.7)	14.7(14.4-15.1)	8.3(8.0-8.6)	37.0(36.3-37.7)	23.1(22.5-23.7)	12.8(12.4-13.2)

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Between 1995-96 and 2014, the hospitalisation in public hospitals declined from 44.9% to 38.4% (Table 3). The use of public hospitals was higher in the less developed compared to the more developed (47.6% vs 33.2%) states in 2014. Poor were hospitalised more in public hospitals; this differential was higher in the more developed (40.7% vs 22.9%) compared to the less developed (54.3% vs 40.1%) states in 2014. In less developed states, the decline in the use of public hospitals was higher for the non-poor compared to the poor (-25.3% vs -16.7%), while, in the more developed states, both non-poor and poor showed a similar decline. Amongst older population, the decline in the use of public hospitals was higher for the non-poor compared to the poor (-24.3% vs -17.2%), while, for the population under 60 years, there was similar decline. The hospitalisation in public hospitals among the older population in the major states of India for 1995-96, 2004 and 2014 is presented in Table S4.

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Table 3. Hospitalisation in public hospitals (95% CI) by economic status in the less and more developed states in 1995-96, 2004 and 2014, India.

	60 years or more								
	1995-96			2004			2014		
States	Non-poor	Poor	Total	Non-poor	Poor	Total	Non-poor	Poor	Total
Less developed states	53.3(45.6-60.8)	64.8(56.0-72.7)	57.1(51.3-62.6)	38.7(33.6-44.2)	59.5(54.9-63.9)	48.9(45.0-52.9)	36.0(30.4-41.9)	55.0(48.9-60.9)	45.2(40.9-49.6)
More developed states	27.2(23.6-31.1)	52.4(46.9-57.8)	38.5(35.0-42.1)	28.1(25.0-31.3)	42.6(39.4-45.8)	36.1(33.9-38.4)	20.7(18.0-23.6)	41.1(38.2-44.1)	31.6(29.5-33.8)
India	34.1(30.4-37.9)	54.6(49.9-59.2)	42.7(39.7-45.8)	30.9(28.3-33.6)	46.3(43.6-49.1)	39.2(37.3-41.2)	25.8(23.2-28.4)	45.2(42.5-47.9)	35.9(33.9-37.8)
	Under 60 years								
	1995-96			2004			2014		
States	Non-poor	Poor	Total	Non-poor	Poor	Total	Non-poor	Poor	Total
Less developed states	53.8(51.1-56.4)	65.3(60.6-69.7)	58.0(55.6-60.4)	43.5(41.4-45.6)	51.7(49.6-53.8)	47.8(46.3-49.3)	41.3(38.7-43.9)	54.2(51.7-56.7)	48.2(46.4-50.0)
More developed states	30.0(28.3-31.9)	51.9(49.6-54.2)	40.0(38.5-41.5)	28.1(26.4-29.9)	44.1(42.4-45.8)	38.0(36.7-39.2)	23.7(21.8-25.6)	40.6(38.9-42.3)	33.7(32.4-35.1)
India	37.9(36.3-39.4)	55.3(53.2-57.4)	45.4(44.1-46.7)	33.8(32.4-35.1)	46.2(44.9-47.6)	41.1(40.1-42.1)	30.9(29.4-32.5)	45.4(44.0-46.9)	39.2(38.2-40.3)
	All ages								
	1995-96			2004			2014		
States	Non-poor	Poor	Total	Non-poor	Poor	Total	Non-poor	Poor	Total
Less developed states	53.7(51.2-56.2)	65.2(61.0-69.2)	57.9(55.7-60.0)	42.5(40.5-44.5)	52.5(50.6-54.5)	47.7(46.3-49.1)	40.1(37.7-42.6)	54.3(52.0-56.6)	47.6(45.9-49.3)
More developed states	29.5(27.9-31.1)	52.0(49.8-54.1)	39.7(38.3-41.1)	28.0(26.5-29.6)	43.7(42.3-45.3)	37.5(36.4-38.6)	22.9(21.3-24.5)	40.7(57.8-60.7)	33.2(32.1-34.3)
India	37.2(35.8-38.7)	55.2(53.3-57.1)	44.9(43.7-46.1)	33.1(31.9-34.3)	46.2(44.9-47.4)	40.6(39.8-41.5)	29.6(28.3-31.0)	45.4(44.1-46.6)	38.4(37.5-39.4)

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All subgroups of the older population showed a significant increase in hospitalisation rates, but there was considerable variation in the amount of change (Table 4). Between 1995-96 and 2014, the increase in hospitalisation rate was higher for females (2.82 vs 1.87 times), single (3.04 vs 1.89 times), poor (2.72 vs 1.87 times), illiterate (2.45 vs 1.77 times), rural residents (2.32 vs 1.88 times), and those living in the less developed states (3.07 vs 1.95 times) compared to their respective counterparts. This reduced the differential in hospitalisation rate by gender, marital status, economic status, place of residence, and states. The differentials in hospitalisation rates by age and the social group remained similar in the past two decades.

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Table 4. Hospitalisation rate per 1000 (95% CI) for older population by background characteristics in 1995-96, 2004 and 2014, India.

Background characteristics	All hospitalisations		
Predisposing variables	**1995-96**	**2004**	**2014**
Age (years)			
60-69	37.6(34.8-40.5)	62.2(58.8-65.6)	82.6(77.6-87.6)
70+	53.1(47.8-58.4)	90.6(85.3-96.0)	124.4(116.4-132.4)
Sex			
Male	53.9(49.3-58.4)	80.3(76.3-84.2)	101.0(95.5-106.6)
Female	33.3(30.4-36.1)	63.7(59.5-67.9)	94.0(87.5-100.5)
Marital status			
Currently married	50.8(46.8-54.9)	75.6(72.0-79.1)	95.9(91.2-100.7)
Single	32.9(29.8-36.0)	66.8(61.9-71.6)	100.1(91.8-108.4)
Social group			
Non-SC/ST	46.7(43.5-50.0)	78.8(75.3-82.2)	105.2(100.0-110.4)
SC/ST	32.9(28.4-37.3)	50.7(45.8-55.5)	71.8(65.8-77.9)
Education			
Literate	65.9(60.7-71.1)	106.3(100.6-112.0)	116.7(110.2-123.2)
Illiterate	34.0(30.9-37.2)	54.2(50.9-57.5)	83.2(77.5-88.8)
Enabling variables			
Place of residence			
Urban	63.1(58.7-67.4)	99.5(92.8-106.3)	118.6(111.2-126.0)
Rural	37.9(34.7-41.1)	63.2(60.0-66.3)	87.8(82.6-93.1)
States			
More developed states	62.1(57.8-66.5)	98.4(93.8-103.0)	121.0(114.9-127.1)
Less developed states	21.8(19.0-24.5)	39.5(36.4-42.6)	67.0(61.2-72.9)
Economic dependency			
Economically independent	35.8(30.9-40.8)	63.2(58.9-67.5)	89.2(80.2-98.2)
Economically dependent	47.2(44.0-50.4)	77.9(74.1-81.7)	100.7(96.0-105.5)
Economic status			
Non-poor	68.6(62.6-74.6)	94.9(89.2-100.6)	128.2(119.1-137.4)
Poor	29.4(26.9-31.9)	59.8(56.5-63.0)	80.1(75.8-84.3)
Living arrangement			
With family	44.2(41.4-47.0)	74.1(71.1-77.1)	95.3(91.4-99.3)
Alone	31.1(22.2-40.0)	54.0(41.1-67.0)	146.2(99.3-193.2)
Need variables			
Physical mobility status			
Mobile	38.0(35.4-40.7)	62.5(59.8-65.3)	84.3(80.3-88.3)
Immobile	91.3(78.8-103.7)	193.9(175.0-212.8)	249.4(222.3-276.5)
Self-rated health			
Good	31.2(28.9-33.4)	54.3(51.5-57.1)	67.8(63.8-71.7)
Poor	96.9(86.4-107.4)	138.3(129.5-147.1)	200.2(186.8-213.7)
SRH compared to previous year			
Better or same	31.9(29.4-34.5)	57.4(54.6-60.1)	70.1(66.0-74.3)
Worse	78.3(70.7-85.9)	138.9(128.9-148.9)	179.5(167.8-191.2)
Total	43.4(40.8-46.1)	72.0(69.1-74.8)	97.5(93.2-101.7)

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Compositional change

Most of the older population lived in rural areas but their proportion decreased by 9.3 percentage points (78.1 % to 68.8%) between 1995-96 and 2014 (Table 5). There was 5.2 percentage points (58.3% in 1995-96 to 63.4% in 2014) increase in the proportion of currently married older population. Literacy in the older population increased by 13.0 percentage points by 2014. In 1995-96, most of the older population were physically mobile (89.5%), less than 70 years of age (62.5%), resident of the more developed states (53.7%), economically dependent (68.9%), and reporting good SRH (80.8%), with only marginal change in their proportions. The majority of the older population were non-SC/ST (76.4%), poor (64.2%), living with family (95.6%), and reporting better or nearly same SRH compared to past year (74.3%) in 1995-96 and their proportion remained unchanged in 2014.

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Table 5. Background characteristics of the older population in 1995-96, 2004 and 2014, India.

	1995-96		2004		2014	
Background characteristics	**N**	**%**	**N**	**%**	**N**	**%**
Predisposing variables						
Age (years)						
60-69	21,124	62.5	22,546	65.3	17,160	64.5
70+	12,866	37.5	12,264	34.7	10,085	35.5
Sex						
Male	17,173	49.4	17,750	50.0	13,692	49.2
Female	16,817	50.6	17,081	50.0	13,553	50.8
Marital status						
Currently married	20,111	58.3	20,959	59.2	17,947	63.4
Single	13,852	41.8	13,872	40.8	9,298	36.6
Social group						
Non-SC/ST	26,089	76.4	26,291	76.0	20,823	76.8
SC/ST	7,880	23.6	8,531	24.0	6,422	23.2
Education						
Literate	12,406	29.5	13,514	34.2	13,362	42.6
Illiterate	21,543	70.5	21,301	65.8	13,883	57.4
Enabling variables						
Place of residence						
Urban	13,035	21.9	12,566	24.3	12,226	31.2
Rural	20,955	78.1	22,265	75.7	15,019	68.8
States						
More developed states	17,389	53.7	17,019	55.2	14,466	56.3
Less developed states	16,601	46.3	17,812	44.8	12,779	43.7
Economic dependency						
Economically independent	10,149	31.1	11,800	34.0	7,159	28.3
Economically dependent	23,061	68.9	22,429	66.0	20,075	71.7
Economic status						
Non-poor	15,407	35.8	14,372	34.8	11,738	36.1
Poor	18,583	64.2	20,459	65.2	15,507	63.9
Living arrangement						
With Family	32,482	95.6	32,595	94.8	26,659	95.9
Alone	1,174	4.4	1,509	5.2	586	4.1
Need variables						
Physical mobility status						
Mobile	29,697	89.5	30,821	91.9	24,499	92.0
Immobile	3,635	10.5	3,224	8.1	2,735	8.0
Self-rated health						
Good	27,263	80.8	24,965	76.4	20,143	77.6
Poor	6,217	19.3	8,216	23.7	7,091	22.4
SRH compared to previous year						
Better or same	25,018	74.3	25,971	79.3	19,590	75.0
Worse	8,430	25.7	7,210	20.7	7,644	25.0
N	33,990		34,831		27,245	

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Determinants of hospitalisation

Older population reporting poor SRH (AOR 2.42 95% CI 1.91-3.07) and living alone (AOR 2.13 95% CI 1.44-3.16) had the highest odds of hospitalisation in 1995-96 and 2014, respectively (Table 6). Poor older population were 59% (95% CI 0.35-0.48) and 37% (95% CI 0.55-0.72) less likely to be hospitalised in 1995-96 and 2014, respectively. The economically dependent older population was 32% (95% CI 1.08-1.62) more likely to be hospitalised in 1995-96. Older population living in the less developed states had lower odds of hospitalisation in 1995-96 (AOR 0.34 95% CI 0.29- 0.40) and 2014 (AOR 0.54 95% CI 0.47-0.61). In 1995-96, female and single older population were 30% (95% CI 0.60-0.83) and 34% (95% CI 0.57-0.77) less likely to be hospitalised, respectively. The older population belonging to SC/ST had lower odds of hospitalisation (AOR 0.81, 95% CI 0.70-0.94) compared to non-SC/ST in 2014. In 2014, physically immobile and those reporting SRH worse than previous year had 85% (95% CI 1.15-2.27) and 67% (95% CI 1.44-1.94) higher odds of being hospitalised, respectively. After adjusting for the covariates, age and place of residence ceased to be significant predictors of hospitalisation.

Between 1995-96 and 2014, there was a modest increase in intercept for the outcome variable. This suggests that when all the explanatory variables in the logit model were set equal to their reference categories, the probability of hospitalisation was significantly higher in 2014 than in 1995-96 for the older population. Comparison of 1995-96 and 2014 coefficients showed the convergence of differentials in hospitalisation by gender, marital status, economic status, living arrangement, and states. Although, these variables continued to have a positive impact on hospitalisation, the differential by these characteristics narrowed down in the older population by 2014 (Table 6).

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Table 6. Determinants of hospitalisation for the older population in 1995-96 and 2014, India.

Background characteristics	Whether hospitalised						
	$\beta_{1995-96}$	Exp ($\beta_{1995-96}$)	95% CI for Exp ($\beta_{1995-96}$)	β_{2014}	Exp (β_{2014})	95% CI for Exp (β_{2014})	$\beta_{2014} - \beta_{1995-96}$
Predisposing variables							
Age (years) (ref.=young old)							
Others	-0.028	0.97	[0.83 - 1.14]	0.124	1.13	[0.99 - 1.29]	0.152
Sex (ref.=male)							
Female	-0.352	0.70	[0.60 - 0.83]	-0.050	0.95	[0.83 - 1.10]	0.302*
Marital Status (ref.=currently married)							
Single	-0.416	0.66	[0.57 - 0.77]	-0.130	0.88	[0.76 - 1.02]	0.286*
Social group (ref.=non-SC/STs)							
SC/STs	0.017	1.02	[0.84 - 1.23]	-0.211	0.81	[0.70 - 0.94]	-0.229
Literacy status (ref.= literate)							
Illiterate	-0.278	0.76	[0.63 - 0.91]	-0.224	0.80	[0.70 - 0.92]	0.055
Enabling variables							
Place of residence (ref.= urban)							
Rural	-0.112	0.89	[0.76 - 1.04]	-0.032	0.97	[0.85 - 1.11]	0.080
States (ref. more developed states)							
Less developed states	-1.070	0.34	[0.29 - 0.40]	-0.619	0.54	[0.47 - 0.61]	0.451*
Economic dependence (ref.= independent)							
Economically dependent	0.281	1.32	[1.08 - 1.62]	0.004	1.00	[0.85 - 1.18]	-0.277*
Economic status (ref.=non-poor)							
Poor	-0.895	0.41	[0.35 - 0.48]	-0.462	0.63	[0.55 - 0.72]	0.432*
Living arrangement (ref.= living with family)							
Living alone	0.197	1.22	[0.85 - 1.74]	0.757	2.13	[1.44 - 3.16]	0.560*
Need variables							
Physical mobility status (ref.= mobile)							
Immobile	0.400	1.49	[1.21 - 1.84]	0.617	1.85	[1.51 - 2.27]	0.217
Self-rated health (ref. good SRH)							
Poor SRH	0.884	2.42	[1.91 - 3.07]	0.736	2.09	[1.78 - 2.44]	-0.149
SRH compared to last year (ref. better or nearly the same)							
Worse SRH	0.475	1.61	[1.31 - 1.98]	0.515	1.67	[1.44 - 1.94]	0.039
Constant	-2.466	0.08	[0.07 - 0.10]	-2.238	0.11	[0.09 - 0.12]	0.228*
N	32,780			27,234			

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Decomposition of increase in hospitalisation rate

For the older population in India, the propensity change explained 86.6% of the increase in hospitalisation rate between 1995-96 and 2014 (Table 7). The improved propensity to use hospital care by economically poor, residents of the less developed states, females, and singles contributed 16.4%, 12.3%, 9.0% and 7.1% of the increase in hospitalisation rate, respectively, regardless of the change in their composition. The change in intercept accounted for 13.5% of the increase in hospitalisation rate. Change in the composition of the characteristics of older population had a modest influence on the level of hospitalisation; contributing 9.2% of the increase in hospitalisation. Many of the changes in the population structure during the inter-survey period favoured increased hospitalisation, except gender and physical mobility status. The increase in the proportion of literates, those reporting poor SRH, economically dependent, and single contributed 2.1%, 1.7%, 1.6% and 1.3% of the increase in hospitalisation rate, respectively between 1995-96 and 2014, regardless of the change in the likelihood of hospitalisation by the subgroups.

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Table 7. Decomposition of increase in hospitalisation for the older population between 1995-96 and 2014, India.

	Contribution to the increase in hospitalisation (%)*		
Background characteristics	**Propensity**	**Composition**	**Interaction**
70 years or more	0.06 (3.4)	0.00 (0.0)	0.00 (-0.2)
Female	0.15 (9.0)	0.00 (-0.1)	0.00 (0.0)
Single	0.12 (7.1)	0.02 (1.3)	-0.01 (-0.9)
SC/ST	-0.05 (-3.2)	0.00 (0.0)	0.00 (0.0)
Illiterate	0.04 (2.3)	0.04 (2.1)	-0.01 (-0.4)
Rural	0.06 (3.7)	0.01 (0.6)	-0.01 (-0.4)
Less developed states	0.21 (12.3)	0.03 (1.6)	-0.01 (-0.7)
Economically dependent	-0.19 (-11.3)	0.01 (0.5)	-0.01 (-0.5)
Economically poor	0.28 (16.4)	0.00 (0.1)	0.00 (-0.1)
Living alone	0.02 (1.4)	0.00 (0.0)	0.00 (-0.1)
Physically immobile	0.02 (1.3)	-0.01 (-0.6)	-0.01 (-0.3)
Poor self-rated health	-0.03 (-1.7)	0.03 (1.7)	0.00 (-0.3)
Worse self-rated health than previous year	0.01 (0.6)	0.00 (-0.2)	0.00 (0.0)
Intercept	0.23 (13.5)		
% contribution to the overall increase	86.6	9.2	4.2

*Percent contribution has been calculated as the ratio of the contribution of the covariate and the sum of the absolute contribution of covariates under the propensity, composition and interaction components multiplied by 100.

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DISCUSSION

Hospitalisation is an important indicator of the demand for curative care and is an integral part of any health system. Studies in India have analysed hospitalisation, but they are restricted in their approach and lack comprehensive assessment of rate over time.[16 30-34] We used data from serial nationwide healthcare surveys done in India by the NSSO over the last 20 years to report the comparative analysis of hospitalisation trends for all age groups across less and more developed states of India, and for various disease conditions. In light of the anticipated increase in older population and their high demand for healthcare, we decompose the change in hospitalisation of the older population in the past two decades.

Hospitalisation rate in India increased two-fold between 1995-96 and 2014. The increase in hospitalisation was higher for non-communicable diseases compared to communicable diseases. This finding is consistent with the shift in the disease burden towards non-communicable diseases in India.[35 36] The hospitalisation rate was higher in the more developed compared to the less developed states; however, there was a declining trend in the differential. Higher use of healthcare in the developed states in India has been reported previously.[10 34] Interestingly, we found that the increase in hospitalisation rate was more pronounced in the less developed than the more developed states. A plausible reason for this could be the increased burden of chronic, degenerative, and lifestyle diseases in the less developed states because of their rapid advancement through the health transition process. Other factors contributing to this could be the greater availability of health services, better access to healthcare, or the increased propensity to use healthcare.

Poor used more public hospitals; this differential was higher in the more developed than the less developed states in 2014. The continuing inadequacies of the public health system and the unrestricted growth of private providers are the important reasons for the decline in the use of public hospitals. The decline in the use of public hospitals was higher for

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the non-poor in the less developed states, which implies that in spite of decline, the poor in the less developed states still largely use public hospitals. The increasing provision of inpatient care in private hospitals and the consequent decline in the utilisation of public hospitals is likely to impose a higher financial risk on individuals and households.[37 38]

The results indicated clear distinction in levels and differentials in hospitalisation rate between older population and population under 60 years. The older population had more than three times higher hospitalisation than any other age groups. Contributing 8.6% to India's population, older population accounted for nearly one-fourth of all hospital stays in 2014. The improved longevity coupled by the increased years of poor health at older ages is predominantly responsible for the difference between the hospitalisation rates of the two age groups. Data from the Global Burden of Disease Study suggest that, of the total disease burden, measured as disability-adjusted life years lost in India, that among the older population was 11.8% in 1990, which increased to 22.3% of the total disease burden in 2013.[36] Additionally, the older population has twice the burden of NCDs compared to their younger counterparts. Consistent with the disease burden, our results showed that the contribution of the older population in total hospitalisation increased in the past two decades, and they had higher hospitalisation for NCDs, more frequent hospitalisation, and longer duration of stay in hospital in any given year.

In the population under 60 years, there was no evidence for gender differential, while, in the older population, a higher proportion of males were hospitalised. Studies from the developed nations have also found that the older women have less hospital stays than their male counterparts.[15 39-42] Greater economic dependency among females at older ages is a major driver of the gender differential in healthcare use in India.[32] On a positive note, we found that the improved likelihood of using hospital care by female older population contributed to the decline in gender differential among the older population.

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In the absence of a health financing system, low level of health insurance coverage and high out of pocket cost of healthcare, economic status becomes an important factor affecting healthcare use. We found that economic vulnerability hinders healthcare utilisation at all ages, but more so at older ages. The economic inequality in hospitalisation among the older population is evident in India.[16] Older population rely more on family and other social structures for financial support, and, therefore, they might not have adequate resources for hospital care. Financial empowerment of the poor older population can be one way of effectively improving the healthcare utilisation.

An important finding of this study is that the propensity change has contributed most to the two-fold increase in hospitalisation of the older population in India between 1995-96 and 2014. A plausible explanation could be better awareness of the medical conditions and health among the population.[43] A relatively higher increase in hospitalisation among the poor compared to the non-poor older population has contributed most to the increase in hospitalisation rate attributed to propensity change. This indicates a decline in the differentials in healthcare use by economic status in the past two decades. It has been argued that lowering of inequality will not make the situation more equitable for the poor if there is a high increase in the rate of hospitalisation, a decline in dependence on government hospitals, and a steep hike in the cost of hospital care.[34]

The increase in hospitalisation rate was moderately influenced by the factors not explicitly considered in the model. The supply side factors like the expansion of private healthcare market and consequent improvement in the availability of health services could have propelled the use of healthcare.[34] The expansion of morbidity, with a heavier and cumulated concentration of chronic diseases at older ages, could be another potential driver of the increase in hospitalisation.[44 45] Compositional change contributed marginally to the increase in hospitalisation of the older population over the past two decades. It would be

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interesting to see how the anticipated compositional change influences the future demand for hospitalisation.

Some limitations of this study must be considered while interpreting the results. First, we used individual determinants and did not examine the full array of determinants of healthcare use. Data on the supply side of healthcare provision were not available from the NSSO surveys, nor were comparable data available from other secondary sources corresponding to the survey time points. Second, the use of self-reported data on diseases from the NSSO surveys may be associated with biases. However, we report hospitalisation trends for broad categories of diseases which may be reasonable. Even with these limitations, this study uses large-scale data from the nationwide surveys in India over the past two decades to provide timely insights into the changing hospitalisation rate by age groups, and the reasons behind the increased hospitalisation of the older population in an era of rapid population ageing and shifting disease burden. Given the anticipated further increase of the older population and their higher demand for healthcare, it is time for the policy makers to pay particular attention to planning how adequate resources and mechanisms can be put in place for the provision of geriatric healthcare in India.

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AUTHORS' CONTRIBUTIONS

AP extracted the data, conducted statistical analysis, interpreted the findings, and wrote the first draft of the manuscript. GBP contributed to the initial concept of the paper and guided the statistical analysis. LC provided critical comments on the manuscript for intellectual content. LD provided detailed guidance on the study design, analysis, interpretation of findings and drafting of the manuscript. All authors approved the final version of the manuscript.

COMPETING INTERESTS

There are no competing interests

DATA SHARING STATEMENT

The authors confirm that all data underlying the findings are fully available without restriction. Data are publicly available and can be obtained from the Ministry of Statistics and Programme Implementation, Government of India, New Delhi: http://mospi.nic.in/Mospi_New/site/inner.aspx?status=3&menu_id=75

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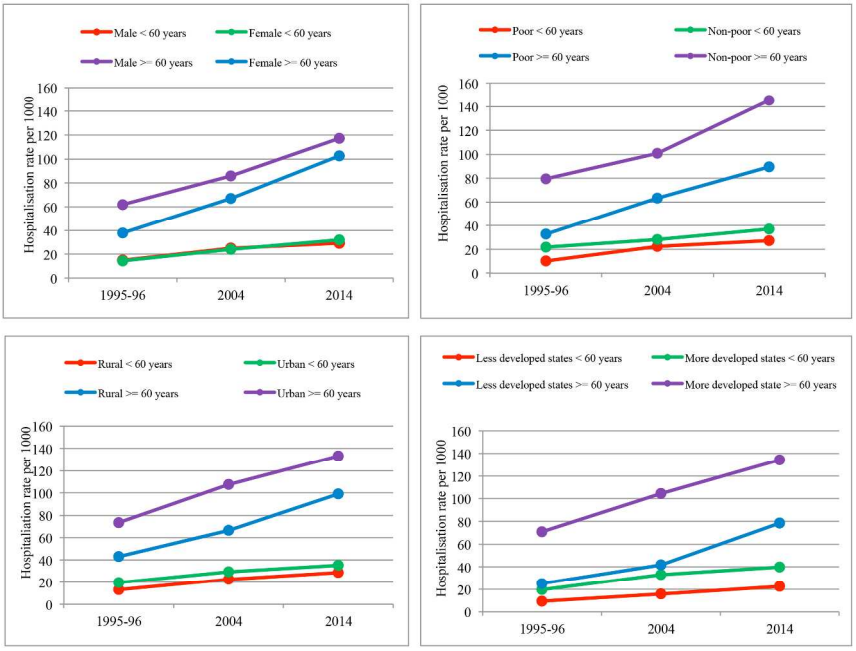

Fig 1. Socioeconomic and demographic differentials in hospitalisation rates in 1995-96, 2004 and 2014, India.

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S1 Table. List of diseases grouped according to Global Burden of Disease (GBD) study categorisation of diseases, 2013.

Communicable diseases and nutritional disorders (CDs)	Non-communicable diseases and injuries (NCDs)
Tuberculosis	Neoplasms
STDs including HIV/AIDs	○ Cancer and other tumours
Diarrhoeal diseases:	Cardiovascular and circulatory diseases
○ Cholera	○ Heart disease, Hypertension
○ Diarrhoea/dysentery/gastro-enteritis	○ Rheumatic fever
○ Amoebiosis	Chronic respiratory diseases
Respiratory infections and other common infectious disease	○ Bronchial Asthma and related conditions
○ Dengue/Influenza	Digestive diseases
○ Pneumonia	○ Gastrointestinal bleeding/piles
○ Respiratory (including ear/nose/throat) ailments	○ Gastritis/gastric/peptic ulcer
○ Cough and acute bronchitis	○ Cirrhosis/hydrocele
○ Pleurisy	○ Food poisoning
○ Meningitis and viral encephalitis	Neurological disorder:
○ Diptheria	○ Cerebral stroke
○ Pertussis/whooping cough	○ Other diseases of nerves
○ Tetanus	○ Epilepsy/headache
○ Measles/chicken pox/mumps/eruptive	○ Nervous and general debility
Neglected tropical diseases and malaria:	○ Cerebral haemorrhage, thrombosis
○ Filariasis	Mental and behavioural disorders
○ Trachoma	Diabetes, urogenital, blood and endocrine diseases
○ Worm infestation/Guinea worm	○ Diabetes
○ Leprosy	○ Disease of kidney/urinary system/prostrate disorders
Neonatal and maternal disorders	○ Gynaecological disorders
Nutritional deficiencies:	○ Goiter/Thyroid disorders
○ Anemia/bleeding disorders	Musculoskeletal disorders
○ Under-nutrition	○ Disorders of joints and bones
○ Scurvy	○ Locomotor disability
○ Other malnutrition diseases (Beri-Beri , Ricket)	Other non-communicable diseases
Other communicable diseases and nutrition disorders:	Skin and subcutaneous diseases
○ Hepatitis/Jaundice/diseases of liver	Sense organ diseases:
○ Fever of unknown origin/fever of short duration/malaria/typhoid	○ Glucoma
	○ Cataracts
	○ Hearing loss, adult onset
	○ Vision disorders, age related
	○ Diseases of ear/nose/throat
	○ Speech disability
	Oral disorders
	Accidents/injury/burns/fractures/poisoning
	Congenital anomalies

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S2 Table. Hospitalisation rate per 1000 (95% CI) by disease groups in 1995-96, 2004 and 2014, India.

	1995-96			2004			2014		
Age (years)	**CDs**	**NCDs**	**Other diseases***	**CDs**	**NCDs**	**Other diseases***	**CDs**	**NCDs**	**Other diseases***
0-4	7.8(7.0-8.6)	2.2(1.8-2.6)	4.1(3.4-4.8)	15.0(13.8-16.1)	4.4(3.8-4.9)	4.5(3.9-5.1)	25.0(23.3-26.7)	8.3(7.3-9.3)	0.9(0.7-1.2)
5-14	3.0(2.7-3.3)	2.0(1.8-2.3)	1.8(1.5-2.0)	5.6(5.2-6.1)	4.0(3.6-0.5)	2.1(1.8-2.3)	7.6(7.0-8.1)	6.6(5.8-7.3)	0.3(0.2-0.3)
15-29	6.0(5.5-6.4)	3.6(3.3-3.9)	4.3(3.9-4.8)	5.9(5.5-6.4)	10.3(9.7-10.9)	5.1(4.7-5.5)	12.2(11.5-12.9)	11.6(10.8-12.4)	0.8(0.6-0.9)
30-44	6.0(5.5-6.5)	6.8(6.3-7.3)	4.9(4.5-5.4)	7.5(6.8-8.2)	15.8(15.0-16.6)	6.4(5.9-6.9)	11.1(10.2-12.1)	22.1(20.9-23.3)	1.3(1.0-1.6)
45-59	6.4(5.7-7.2)	14.1(12.9-15.2)	7.4(6.7-8.2)	10.5(9.6-11.3)	30.1(28.6-31.6)	7.2(6.5-7.9)	13.1(11.8-14.3)	41.7(39.7-43.7)	1.8(1.5-2.0)
60-69	8.6(7.2-10.0)	24.4(22.0-26.8)	9.2(8.0-10.5)	12.2(10.7-13.8)	45.2(42.1-48.2)	8.0(6.8-9.2)	17.1(15.0-19.3)	72.8(68.0-77.7)	2.2(1.4-3.1)
70-79	9.9(7.4-12.4)	35.2(29.9-40.5)	13.0(10.8-15.2)	14.0(11.8-16.3)	71.9(66.1-77.7)	11.2(9.1-13.2)	18.4(15.5-21.4)	111.7(101.1-122.3)	3.7(1.5-5.9)
80+	14.7(7.6-21.7)	37.0(27.9-46.1)	20.7(12.0-29.3)	12.5(8.6-16.5)	64.3(55.2-73.3)	15.2(10.6-19.7)	28.2(22.6-33.8)	130.4(116.3-144.6)	6.0(1.6-10.4)
All ages	5.7(5.5-5.9)	6.4(6.1-6.6)	4.5(4.3-4.8)	8.3(8.0-8.6)	14.7(14.4-15.1)	5.1(4.9-5.4)	12.8(12.4-13.2)	23.1 (22.5-23.7)	1.1(1.0-1.2)

*Includes other diagnosed and undiagnosed diseases

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S3 Table. Hospitalisation rate per 1000 (95% CI) for the older population by disease groups in the major states in 1995-96, 2004 and 2014, India.

States	1995-96			2004			2014		
	All diseases	NCDs	CDs	All diseases	NCDs	CDs	All diseases	NCDs	CDs
Less developed states	25.1(22.3-27.9)	13.6(12.1-15.1)	5.8(4.0-7.6)	41.6(38.4-44.9)	28.6(25.8-31.4)	7.3(6.2-8.4)	78.4(71.3-85.5)	61.2(54.6-67.8)	15.0(12.7-17.2)
Assam	28.9(20.4-37.3)	16.3(10.1-22.4)	6.2(2.2-10.2)	35.7(24.0-47.5)	26.6(15.4-37.7)	5.3(3.0-7.7)	37.0(24.0-50.0)	29.3(16.6-42.0)	5.9(3.3-8.5)
Bihar	15.4(10.7-20.1)	8.1(5.2-11.0)	4.4(1.0-7.9)	28.1(24.1-32.2)	19.4(16.2-22.7)	4.7(3.1-6.4)	52.6(37.2-68.1)	44.9(29.9-59.9)	6.5(2.9-10.1)
Madhya Pradesh	29.7(24.4-35.0)	16.7(12.8-20.5)	7.4(4.6-10.2)	47.2(39.2-55.3)	34.7(27.3-42.2)	9.4(6.6-12.3)	101.2(72.9-129.5)	80.0(53.0-106.9)	18.9(10.4-27.4)
Odisha	44.1(21.2-66.9)	12.0(7.9-16.1)	14.8(-1.0-30.5)	42.0(32.2-51.9)	21.0(15.7-26.4)	14.6(6.8-22.4)	79.6(63.3-95.8)	57.7(42.7-72.8)	20.2(14.3-26.2)
Rajasthan	34.3(25.6-43.1)	21.6(14.5-28.8)	4.6(2.5-6.7)	56.7(45.9-67.5)	37.0(30.0-44.0)	6.4(3.5-9.3)	101.9(88.6-115.2)	75.4(64.0-86.8)	25.2(18.5-31.9)
Uttar Pradesh	18.6(15.1-22.0)	11.8(9.5-14.2)	3.4(1.2-5.6)	38.6(32.0-45.2)	27.7(21.6-33.8)	5.5(4.1-6.9)	78.5(65.5-91.4)	62.5(50.8-74.2)	12.7(8.6-16.7)
Jammu & Kashmir	34.3(15.8-52.9)	19.4(4.6-34.1)	8.7(-1.8-19.3)	48.5(36.4-60.6)	39.0(28.0-50.0)	6.3(1.9-10.7)	68.5(50.4-86.7)	55.9(39.8-71.9)	11.2(2.9-19.6)
More developed states	70.9(66.1-75.8)	41.7(37.7-45.8)	12.7(10.8-14.6)	104.6(99.8-109.4)	74.6(70.4-78.7)	17.1(15.1-19.1)	134.3(128.0-140.7)	109.7(103.9-115.5)	21.1(18.8-23.5)
Andhra Pradesh	47.0(36.5-57.6)	30.8(21.7-40.0)	6.2(3.2-9.2)	65.9(57.2-74.5)	54.4(46.3-62.5)	5.8(3.6-8.0)	111.2(96.4-126.0)	94.1(80.6-107.6)	12.9(8.1-17.7)
Gujarat	45.9(36.2-55.6)	18.4(13.9-22.9)	19.3(11.3-27.3)	102.5(86.7-118.2)	64.6(52.5-76.8)	27.3(18.4-36.2)	123.7(105.8-141.7)	98.0(83.4-112.5)	24.9(14.4-35.3)
Haryana	79.6(57.0-102.1)	51.5(33.4-69.6)	20.9(9.1-32.7)	81.8(57.2-106.5)	61.0(38.5-83.5)	13.7(5.4-22.0)	89.2(71.5-106.8)	75.3(58.7-91.9)	13.1(7.1-19.1)
Karnataka	52.5(37.8-67.2)	30.5(18.4-42.6)	8.0(2.6-13.3)	80.4(68.2-92.6)	54.0(44.7-63.3)	10.5(5.7-15.3)	110.3(96.9-123.7)	89.2(76.9-101.4)	19.8(14.6-25.1)
Kerala	200.5(175.8-225.1)	110.5(9.2-3186.4)	39.0(27.9-50.2)	279.1(251.7-306.5)	190.5(168.3-212.6)	47.0(34.9-59.0)	281.3(249.1-313.5)	216.2(18.9-15279.5)	51.5(36.2-66.7)
Maharashtra	70.4(60.3-80.5)	42.9(3.5-618.2)	10.9(7.6-14.2)	96.6(85.0-108.2)	76.0(65.1-86.8)	11.1(8.0-14.1)	119.9(103.1-136.7)	103.0(86.5-119.4)	14.4(11.1-17.7)
Punjab	45.6(34.0-57.2)	21.7(14.0-29.3)	4.7(1.7-7.7)	80.7(63.2-98.2)	58.8(43.7-73.8)	12.5(5.1-19.8)	103.7(80.0-127.5)	89.5(66.6-112.5)	12.7(6.8-18.6)
Tamil Nadu	72.7(52.7-92.7)	52.3(3.3-370.9)	7.7(5.2-10.2)	105.6(92.0-119.2)	71.9(60.9-82.9)	23.1(15.8-30.4)	138.1(118.5-157.7)	115.3(96.6-134.0)	22.1(16.3-27.8)
West Bengal	41.5(33.0-50.1)	22.1(17.4-26.9)	8.0(2.3-13.7)	68.5(59.5-77.4)	46.7(38.8-54.6)	11.5(8.4-14.6)	109.4(98.1-120.7)	86.3(76.0-96.6)	18.7(14.3-23.1)
India	49.7(46.8-52.6)	28.7(26.5-31.0)	9.5(8.2-10.8)	76.4(73.4-79.4)	54.0(51.4-56.5)	12.7(11.5-13.9)	109.9(105.2-114.5)	88.5(84.2-92.8)	18.4(16.8-20.1)

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S4 Table. Hospitalisation in public hospitals (95% CI) among the older population in the major states in 1995-96, 2004 and 2014, India.

	1995-96			2004			2014		
States	Non-poor	Poor	Total	Non-poor	Poor	Total	Non-poor	Poor	Total
Less developed states	53.3(45.6-60.8)	64.8(56.0-72.7)	57.1(51.3-62.6)	38.7(33.6-44.2)	59.5(54.9-63.9)	48.9(45.0-52.9)	36.0(30.4-41.9)	55.0(48.9-60.9)	45.2(40.9-49.6)
Assam	78.8(61.2-89.8)	67.2(33.3-89.4)	76.0(60.1-86.9)	47.7(25.4-70.9)	83.8(66.7-93.0)	64.4(44.9-80.1)	78.3(65.3-87.4)	86.6(72.0-94.2)	82.3(72.3-89.2)
Bihar	35.5(19.6-55.4)	22.9(9.1-46.7)	31.3(18.4-48.0)	14.3(9.5-20.9)	27.5(19.2-37.7)	21.3(16.0-27.6)	20.5(11.9-33.0)	42.8(32.6-53.6)	28.8(20.3-39.1)
Madhya Pradesh	43.6(33.3-54.4)	72.0(56.5-83.6)	51.4(42.2-60.5)	35.1(26.8-44.4)	67.0(53.1-78.4)	51.6(43.1-60.0)	24.5(14.8-37.7)	48.1(31.3-65.3)	37.2(26.2-49.8)
Odisha	92.6(81.6-97.3)	93.4(84.5-97.3)	92.9(85.5-96.6)	74.6(61.2-84.6)	86.9(76.3-93.2)	81.1(72.6-87.5)	71.0(58.8-80.8)	85.8(76.9-91.6)	79.2(72.5-84.7)
Rajasthan	60.7(44.1-75.1)	44.7(23.7-67.7)	55.6(42.1-68.4)	52.7(39.0-66.0)	70.9(60.3-79.7)	59.9(50.0-69.1)	48.8(40.5-57.2)	66.5(57.2-74.7)	58.9(52.4-65.0)
Uttar Pradesh	30.9(22.8-40.4)	54.2(38.2-69.4)	38.6(30.2-47.8)	24.7(17.4-33.9)	44.7(36.7-53.0)	34.3(27.7-41.5)	26.8(18.5-37.0)	30.8(23.0-39.9)	28.4(22.4-35.3)
Jammu & Kashmir	94.5(82.7-98.4)	99.6(97.1-100.0)	97.7(93.6-99.2)	92.6(84.6-96.6)	85.9(71.3-93.8)	89.1(80.7-94.0)	87.1(73.9-94.1)	94.9(86.7-98.1)	92.6(86.2-96.1)
More developed states	27.2(23.6-31.1)	52.4(46.9-57.8)	38.5(35.0-42.1)	28.1(25.0-31.3)	42.6(39.4-45.8)	36.1(33.9-38.4)	20.7(18.0-23.6)	41.1(38.2-44.1)	31.6(29.5-33.8)
Andhra Pradesh	16.3(10.0-25.5)	42.2(27.9-57.9)	24.6(17.6-33.2)	24.1(15.9-34.7)	38.8(30.8-47.4)	32.0(26.2-38.5)	14.6(8.7-23.3)	29.9(22.8-38.0)	22.6(17.7-28.3)
Gujarat	27.2(15.9-42.5)	64.9(47.1-79.3)	40.6(30.0-52.2)	17.7(11.2-26.8)	33.6(24.4-44.3)	25.4(19.5-32.3)	16.7(10.3-26.0)	33.6(26.0-42.0)	24.9(19.5-31.2)
Haryana	39.8(24.7-57.0)	25.2(10.8-48.4)	33.3(22.0-46.8)	20.8(11.5-34.6)	18.2(9.2-33.0)	19.6(12.5-29.2)	6.9(3.8-12.4)	52.9(39.0-66.3)	29.7(21.3-39.8)
Karnataka	33.0(19.6-49.9)	46.3(27.5-66.3)	35.1(23.1-49.5)	20.8(12.9-31.6)	51.4(40.6-62.0)	35.4(28.3-43.2)	26.5(16.3-40.1)	28.5(22.4-35.5)	27.8(22.1-34.2)
Kerala	21.1(14.4-29.9)	55.1(47.2-62.8)	42.0(35.9-48.4)	26.9(20.2-34.9)	41.0(35.0-47.3)	35.6(31.0-40.5)	20.3(14.4-27.8)	49.5(42.3-56.7)	33.8(28.8-39.3)
Maharashtra	15.2(9.9-22.8)	35.8(26.3-46.5)	25.1(19.4-31.9)	22.7(15.6-31.7)	36.2(29.0-44.1)	30.7(25.4-36.5)	9.3(6.2-13.7)	29.7(22.3-38.2)	20.5(15.7-26.3)
Punjab	35.8(22.9-51.1)	41.8(22.7-63.7)	38.3(27.0-51.0)	32.4(20.0-47.9)	25.2(14.4-40.2)	29.4(20.4-40.3)	22.3(7.5-50.6)	24.8(16.1-36.2)	23.6(13.8-37.3)
Tamil Nadu	21.5(14.1-31.5)	69.4(49.7-83.9)	43.2(29.3-58.2)	16.7(11.6-23.3)	43.5(34.8-52.6)	33.6(27.7-40.1)	13.6(9.2-19.7)	40.7(32.9-49.1)	30.8(25.7-36.4)
West Bengal	62.3(51.5-72.0)	83.0(65.1-92.7)	69.0(59.6-77.1)	60.2(51.6-68.3)	82.1(75.0-87.5)	69.0(63.2-74.2)	49.8(43.2-56.4)	72.1(63.4-79.4)	61.0(55.9-65.9)
India	34.1(30.4-37.9)	54.6(49.9-59.2)	42.7(39.7-45.8)	30.9(28.3-33.6)	46.3(43.6-49.1)	39.2(37.3-41.2)	25.8(23.2-28.4)	45.2(42.5-47.9)	35.9(33.9-37.8)

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5-6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	-
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
Results			

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Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	-
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	16-17
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	9-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-15
		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	18-29
Discussion			
Key results	18	Summarise key results with reference to study objectives	22-24
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	25
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	22-24
Generalisability	21	Discuss the generalisability (external validity) of the study results	25
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	26

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Hospitalisation trends in India from serial cross-sectional nationwide surveys: 1995 to 2014

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Hospitalisation trends in India from serial cross-sectional nationwide surveys: 1995 to 2014

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ABSTRACT

Objectives: We report hospitalisation trends in India contrasting the older population (aged 60 years or more) with those under 60 years and quantify the factors contributing to the change in hospitalisation rate of the older population between 1995 and 2014.

Design: Serial cross-sectional study.

Setting: Nationally representative sample, India.

Data sources: 3 consecutive National Sample Surveys (NSS) on healthcare utilisation in 1995-96, 2004, and 2014.

Participants: 633,405 individuals in NSS 1995-96, 385,055 in NSS 2004, and 335,499 in NSS 2014.

Methods: Descriptive statistics, multivariate analyses, and a regression decomposition technique were used to attain the study objectives.

Result: The annual hospitalisation rate per 1000 increased from 16.6 to 37.0 in India from 1995-96 to 2014. The hospitalisation rate was about half in the less developed than the more developed states in 2014 (26.1 vs 48.6 per 1000). Poor people used more public than private hospitals; this differential was higher in the more developed (40.7% vs 22.9%) than the less developed (54.3% vs 40.1%) states in 2014. When compared to the younger population, the older population had a 3.6 times higher hospitalisation rate (109.9 vs 30.7) and a greater proportion of hospitalisation for non-communicable diseases (80.5% vs 56.7%) in 2014. Amongst the older population, hospitalisation rates were comparatively lower for females, poor, and rural residents. Propensity change contributed to 86.5% of the increase in hospitalisation among the older population and compositional change contributed 9.3%.

Conclusion: The older population in India has a much higher hospitalisation rate and has continuing greater socioeconomic differentials in hospitalisation rates. Specific policy focus

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on the requirements of the older population for hospital care in India is needed in light of the anticipated increase in their proportion in the population.

Keywords Aging, decomposition, expansion of morbidity, hospitalisation, non-communicable diseases, older population, propensity

Stregths and limitations of this study

- The use of large scale data from nationwide surveys in India over two decades provides the most updated trends for hospitalisation.
- The evidence on the changing hospitalisation rate by age groups and the reasons behind the increased hospitalisation of the older population is timely for policy formulation given the population aging and shifting disease burden.
- It was not possible for us to study the contribution of the supply side factors in the increased hospitalisation.
- Self-reported data and the nature of cross-sectional data may lead to recall and reporting biases, which may have affected the accuracy of the results.

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INTRODUCTION

The improvement in life expectancy in India has not been matched by the improvements in levels of health of the population.[1 2] The difference between life expectancy and healthy life expectancy was 7.2 years for the male population and 8.0 years for the female population in 1990, which increased to 7.6 years and 9.4 years, respectively in 2013, suggesting that India's population continues to lose years of healthy life to disability. The older population in India suffer from the higher burden of disease at older ages, particularly chronic diseases and disabilities.[3-11] The aging population in India will continue to be one of the major determinants of the change in disease burden over the next two decades.[5] Higher disease burden rates at older ages result in greater demand for healthcare, particularly hospitalisation.[12-15] Hospital care is an important aspect of any health system, especially regarding the treatment of the more vulnerable older segment of the population.[16 17]

Monitoring change in hospitalisation rates is important to highlight the necessity for health policies to allocate resources and services to respond to the diverse healthcare needs of different segments of the population. Studies in India have analysed hospitalisation, but they are restricted in their approach and lack comprehensive assessment of rate over time.[16 18-22] The purpose of this study was to analyse hospitalisation trends from nationally representative data between 1995 and 2014 for different age groups across the less and more developed states of India, and for various disease groups. In addition to this, we aimed to compare the hospitalisation trends of the older population with the population under 60 years, and quantify the propensity and compositional change that may contribute to the change in hospitalisation rates of the older population.

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METHODS

Ethics statement

The study is based on secondary data from the National Sample Surveys with no identifiable information on the survey participants. Exemption from ethics approval for analysis of the National Sample Surveys data was obtained from the institutional ethics committees of the Public Health Foundation of India and the London School of Hygiene and Tropical Medicine.

Data sources and participants

We used individual level data from National Sample Survey (NSS) on healthcare utilisation conducted in all Indian states in 1995-96, 2004, and 2014.[23-25] These surveys record the utilisation of healthcare for both inpatient and outpatient care, with hospitalisation episodes in 365 days reference period recorded in detail. In addition, information of certain aspects of the condition of the older population was also collected. Individual level data was collected for a nationally representative sample of 633,405 in NSS 1995-96, 385,055 in NSS 2004, and 335,499 in NSS 2014. The sample of the older population in these surveys was: 35,274 in NSS 1995-96, 35,567 in NSS 2004, and 28,397 in NSS 2014. Samples with missing values in the independent variables were dropped to obtain a final sample for each survey. The proportion of missing cases on any independent variable across the three surveys was less than 4% of the total sample (Table S1). Though there was variation in sample size; the sample design was uniform across the three surveys. This permits the construction of comparable variables which could be used to make statistical inferences about change in parameter estimates.

Initial analyses of trends and differentials in hospitalisation rates were performed on all persons surveyed including deceased members. However, for the subsequent descriptive, multivariate, and decomposition analyses performed on the older population, the deceased was excluded because the questions on several important background variables were only

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asked to the older persons who were alive on the date of survey. The sample of deceased older population is reported in Table S1.

Measures

Our outcome variable was hospitalisation rate defined as the number of episodes of hospitalisation in 365 days reference period per 1000 of the population exposed to the risk. The cause of hospitalisation was categorised into non-communicable diseases and injuries (NCDs), and communicable diseases and nutritional disorders (CDs) using the Global Burden of Disease 2013 classification.[2] The diseases included in the two broad categories are listed in Table S2.

We used monthly per capita consumption expenditure (MPCE) adjusted to the household size and composition as a proxy for economic status. The equivalence scale used was $e_h = (A_h + 0.5K_h)^{0.75}$, where A_h was the number of adults in the household, and K_h was the number of children 0–14 years. Parameters were set on the basis of estimates summarised by Deaton.[26] The state-specific adult equivalent mean MPCE was used as a cut-off to categorise households into poor and non-poor.

We present analyses at the state level for the 35 states and union territories in India by classifying them into two groups –less developed and more developed states. The less developed states include the 18 states namely, eight empowered action group states (Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Uttar Pradesh, Uttaranchal, Odisha and Rajasthan), 8 north-eastern states (Assam, Arunachal Pradesh, Manipur, Mizoram, Meghalaya, Nagaland, Sikkim and Tripura), Himachal Pradesh, and Jammu and Kashmir.[27] State-specific rates were estimated for the 19 major states of India, with a population over 10 million in 2011 census, accounting for 97% of India's population. For comparison Bihar, Madhya Pradesh, Uttar Pradesh, and Andhra Pradesh were considered as undivided states at all survey points.

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The Andersen's model of healthcare utilisation was used to study the association of individuals' predisposing, enabling, and need variables with hospitalisation.[28] Based on the availability of data age, sex, marital status, social group, and education were identified as predisposing variables; place of residence, states, economic independence, economic status, and living arrangement as enabling factors; and physical mobility status, current self-rated health (SRH), and SRH compared to previous year as the need variables, which are likely to affect hospitalisation in the older population. These variables were dichotomised for all analyses.

Statistical methods

Descriptive analyses were used to examine the change in hospitalisation rate for all diseases, NCDs, and CDs at both aggregate and subgroup levels for all ages, and the change in the composition of the older population in India between 1995 and 2014.

A logit model was used to evaluate the effect of covariates on the probability of hospitalisation in the older population. The model employed was of the form:

$$Ln[P_i/(1- P_i)]= \sum \beta_i X_i \qquad (1)$$

where $Ln[P_i/(1- P_i)]$ was the log odds of hospitalisation, X_i was a vector of explanatory variables, and β_i was a vector of regression coefficients. The model was checked for multicollinearity. Fit of the model was assessed using the p-value of the F-adjusted mean residual goodness-of-fit statistic. A p-value below 0.05 was not considered a good fit.

A regression decomposition technique was used to decompose the change in hospitalisation rate into its constituent parts.[29-31] A multivariate logit model was estimated for each period. For example, the equation for the period 1995-96 was

$$Ln[P_i/(1-P_i)]_{(1995\text{-}96)} = \beta_0 + \beta_i X_{i(1995\text{-}96)} + \cdots\cdots\cdots\cdots + \beta_n X_{n(1995\text{-}96)}$$

$$i=1,2,3,4\cdots\cdots\cdots\cdots n \qquad (2)$$

while the equation for the period 2014 was

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$$Ln[P_i/(1\text{-}P_i)]_{(2014)} = \beta_0 + \beta_i X_{i(2014)} + \cdots\cdots\cdots\cdots + \beta_n X_{n(2014)}$$

$$i=1,2,3,4\cdots\cdots\cdots\cdots n \qquad (3)$$

The difference $Ln[P_i/(1\text{-}P_i)]_{(2014)} - Ln[P_i/(1\text{-}P_i)]_{(1995\text{-}96)}$ was decomposed using equation (4), which considered 1995-96 as the base period.

$$Logit_{(2014)} - Logit_{(1995\text{-}96)} = [(\beta_{0(2014)} - \beta_{0(1995\text{-}96)}) + \sum P_{ij(1995\text{-}96)} (\beta_{ij(2014)} - \beta_{ij(1995\text{-}96)})] + \sum \beta_{ij(1995\text{-}96)} (P_{ij(2014)} - P_{ij(1995\text{-}96)}) + \cdots\cdots\cdots\cdots + \sum (\beta_{ij(2014)} - \beta_{ij(1995\text{-}96)}) (P_{ij(2014)} - P_{ij(1995\text{-}96)}) \qquad (4)$$

Where,

$P_{ij(2014)}$ = Proportion of j^{th} category of the i^{th} covariate in NSS 2014

$P_{ij(1995\text{-}96)}$ = Proportion of j^{th} category of the i^{th} covariate in NSS 1995-96

$\beta_{ij(2014)}$ = Coefficient for the j^{th} category of the i^{th} covariate in NSS 2014

$\beta_{ij(1995\text{-}96)}$ = Coefficient for the j^{th} category of the i^{th} covariate in NSS 1995-96

$\beta_{0(2014)}$ = Regression constant in NSS 2014

$\beta_{0(1995\text{-}96)}$ = Regression constant in NSS 1995-96

This procedure yields three components: 1) propensity defined as the change brought by variation in the impact of determinants; 2) composition defined as the change due to variation in the proportion of determinants, and 3) interaction which reflects the change as a result of the interplay between compositional and propensity change.[32] We used p-values for the Wald test to assess the difference between the coefficients from the two logit models. We report 95% confidence intervals (95% CI) for all estimates. Sampling weights were used to account for the two-stage stratified sampling design of the national sample surveys throughout the analyses.

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RESULTS

Hospitalisation trends and differentials

The annual hospitalisation rate per 1000 increased 2.23 times between 1995 and 2014; the increase was higher for NCDs than CDs (3.61 vs 2.25 times) (Table 1). The contribution of NCDs to total hospitalisation increased from 38.6% in 1995-96 to 62.2% in 2014. The hospitalisation rate increased with age, and was highest for the population aged 70 years or more. The hospitalisation rate increased 2.21 times for older population, and 2.01 times for population under 60 years between 1995 and 2014. When compared to younger population, the older population had more than three times higher hospitalisation rates, and a greater proportion of hospitalisations for NCDs.

Table 1 Hospitalisation rate per 1000 (95% CI) by age and disease groups in 1995-96, 2004 and 2014, India

	Hospitalisation rates per 1000 (95% CI)			Estimated hospitalised cases (in millions) (%)
Age (years)	NCDs	CDs	All diseases	
		1995-96		
0-4	2.2 (1.8-2.6)	7.8 (7.0-8.6)	14.1 (12.9-15.3)	1.4 (9.7)
5-14	2.0 (1.8-2.3)	3.0 (2.7-3.3)	6.8 (6.3-7.2)	1.4 (10.3)
15-29	3.6 (3.3-3.9)	6.0 (5.5-6.4)	13.9 (13.2-14.7)	3.1 (22.0)
30-44	6.8 (6.3-7.3)	6.0 (5.5-6.5)	17.8 (17.0-18.6)	2.9 (20.5)
45-59	14.1 (12.9-15.2)	6.4 (5.7-7.2)	28.0 (26.4-29.5)	2.9 (20.5)
60-69	24.4 (22.0-26.8)	8.6 (7.2-10.0)	42.2 (39.2-45.2)	1.2 (8.9)
70 or more	35.7 (31.1-40.3)	11.1 (8.5-13.7)	61.8 (55.9-67.7)	1.1 (8.1)
Under 60 years	5.0 (4.8-5.2)	5.5 (5.2-5.7)	14.6 (14.2-15.0)	11.6 (83.0)
60 years or more	28.7 (26.4-31.0)	9.5 (8.2-10.8)	49.7 (46.8-52.7)	2.4 (17.0)
All ages	6.4 (6.1-6.6)	5.7 (5.5-5.9)	16.6 (16.2-17.0)	14.0 (1.7)
		2004		
0-4	4.4 (3.8-4.9)	15.0 (13.8-16.1)	23.9 (22.5-25.4)	2.6 (9.5)
5-14	4.0 (3.6-0.5)	5.6 (5.2-6.1)	11.8 (11.1-12.5)	2.7 (9.9)
15-29	10.3 (9.7-10.9)	5.9 (5.5-6.4)	21.4 (20.5-22.2)	5.4 (19.9)
30-44	15.8 (15.0-16.6)	7.5 (6.8-8.2)	29.7 (28.5-30.9)	5.7 (21.0)
45-59	30.1 (28.6-31.6)	10.5 (9.6-11.3)	47.8 (45.9-49.6)	5.6 (20.5)
60-69	45.2 (42.1-48.2)	12.2 (10.7-13.8)	65.7 (62.1-69.3)	2.9 (10.6)
70 or more	70.0 (65.0-74.9)	13.7 (11.7-15.6)	95.9 (90.3-101.6)	2.3 (8.5)
Under 60 years	11.7 (11.4-12.1)	7.9 (7.6-8.2)	24.5 (24.0-24.9)	21.9 (80.8)

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60 years or more	54.0 (51.3-56.6)	12.7 (11.5-14.0)	76.4 (73.3-79.5)	5.2 (19.2)
All ages	14.7 (14.4-15.1)	8.3 (8.0-8.6)	28.2 (27.7-28.7)	27.2 (2.8)
		2014		
0-4	8.3 (7.3-9.3)	25.0 (23.3-26.7)	34.2 (32.3-36.2)	3.4 (8.2)
5-14	6.6 (5.8-7.3)	7.6 (7.0-8.1)	14.4 (13.5-15.4)	3.3 (7.8)
15-29	11.6 (10.8-12.4)	12.2 (11.5-12.9)	24.6 (23.5-25.7)	7.5 (17.9)
30-44	22.1 (20.9-23.3)	11.1 (10.2-12.1)	34.6 (33.0-36.1)	8.4 (20.2)
45-59	41.7 (39.7-43.7)	13.1 (11.8-14.3)	56.5 (54.2-58.9)	9.2 (22.2)
60-69	72.8 (68.0-77.7)	17.1 (15.0-19.3)	92.2 (86.8-97.5)	5.3 (12.7)
70 or more	116.2 (107.4-124.9)	20.8 (18.2-23.4)	141.2 (131.9-150.5)	4.6 (11.0)
Under 60 years	17.4 (16.9-17.9)	12.3 (11.9-12.7)	30.7 (30.0-31.4)	31.8 (76.4)
60 years or more	88.5 (84.1-92.9)	18.4 (16.8-20.1)	109.9 (105.1-114.7)	9.8 (23.6)
All ages	23.1 (22.5-23.7)	12.8 (12.4-13.2)	37.0 (36.3-37.7)	41.6 (3.7)

CI, confidence intervals.

Males and females under 60 years had similar hospitalisation rates, while the older males had 64% higher hospitalisation rate than the older females in 1995-96 (Fig.1). The gender gap reduced for the older population by 2014 because of the higher increase in hospitalisation rate for the females compared to the males (2.71 vs 1.89 times). As compared to poor, amongst older population, the non-poor had 62% higher hospitalisation rate, while amongst population under 60 years, the non-poor had 36% higher hospitalisation rate in 2014. In 1995-96, the urban residents aged 60 years or more had 71% higher hospitalisation rate than the rural residents, which declined to 34% higher in 2014. As compared to the less developed states, the hospitalisation rate in the more developed states was 2.82 times higher for the older population and 2.07 times higher for those under 60 years; however, the differential become similar by 2014.

The more developed states had 2.21 times and 1.86 times higher hospitalisation rate than the less developed states in 1995-96 and 2014, respectively (Table 2). Between 1995 and 2014, the increase in hospitalisation rate was higher in the less developed compared to the more developed states, more so for the older population for all diseases (3.12 vs 1.89 times), NCDs (4.50 vs 2.63 times), and CDs (2.59 vs 1.66 times). The hospitalisation rate for older

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population by disease groups in the major states of India is shown for 1995-96, 2004 and 2014 in Table S3.

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Table 2 Hospitalisation rates per 1000 (95% CI) by disease groups in the less and more developed states in 1995-96, 2004 and 2014, India

	Hospitalisation rates per 1000 (95% CI)								
	60 years or more								
	1995-96			2004			2014		
States	All hospitalisations	NCDs	CDs	All hospitalisations	NCDs	CDs	All hospitalisations	NCDs	CDs
Less developed	25.1 (22.3-27.9)	13.6 (12.1-15.1)	5.8 (4.0-7.6)	41.6 (38.4-44.9)	28.6 (25.8-31.4)	7.3 (6.2-8.4)	78.4 (71.3-85.5)	61.2 (54.6-67.8)	15.0 (12.7-17.2)
More developed	70.9 (66.1-75.8)	41.7 (37.7-45.8)	12.7 (10.8-14.6)	104.6 (99.8-109.4)	74.6 (70.4-78.7)	17.1 (15.1-19.1)	134.3 (128.0-140.7)	109.7 (103.9-115.5)	21.1 (18.8-23.5)
India	49.7 (46.8-52.6)	28.7 (26.5-31.0)	9.5 (8.2-10.8)	76.4 (73.4-79.4)	54.0 (51.4-56.5)	12.7 (11.5-13.9)	109.9 (105.2-114.5)	88.5 (84.2-92.8)	18.4 (16.8-20.1)
	Under 60 years								
	1995-96			2004			2014		
States	All hospitalisations	NCDs	CDs	All hospitalisations	NCDs	CDs	All hospitalisations	NCDs	CDs
Less developed	9.4 (8.9-9.8)	2.9 (2.7-3.1)	3.7 (3.4-4.0)	15.7 (15.2-16.1)	7.3 (7.0-7.6)	5.2 (4.9-5.4)	22.3 (21.5-23.1)	11.8 (11.2-12.4)	9.9 (9.4-10.4)
More developed	19.5 (18.9-20.1)	7.0 (6.6-7.3)	7.1 (6.7-7.4)	33.1 (32.3-34.0)	16.1 (15.5-16.7)	10.5 (10.0-11.1)	39.9 (38.8-40.9)	23.5 (22.6-24.4)	15.0 (14.3-15.6)
India	14.6 (14.2-15.0)	5.0 (4.8-5.2)	5.5 (5.2-5.7)	24.5 (24.0-24.9)	11.7 (11.4-12.1)	7.9 (7.6-8.2)	30.7 (30.0-31.4)	17.4 (16.9-17.9)	12.3 (11.9-12.7)
	All ages								
	1995-96			2004			2014		
States	All hospitalisations	NCDs	CDs	All hospitalisations	NCDs	CDs	All hospitalisations	NCDs	CDs
Less developed	10.2 (9.8-10.6)	3.5 (3.3-3.7)	3.8 (3.6-4.1)	17.5 (17.0-18.0)	8.7 (8.4-9.0)	5.4 (5.1-5.6)	26.1 (25.2-27.0)	15.2 (14.4-15.9)	10.2 (9.7-10.7)
More developed	22.5 (21.9-23.1)	9.0 (8.6-9.4)	7.4 (7.0-7.7)	38.7 (37.8-39.6)	20.6 (20.0-21.3)	11.1 (10.6-11.6)	48.6 (47.5-49.8)	31.5 (30.5-32.4)	15.6 (14.9-16.2)
India	16.6 (16.2-17.0)	6.4 (6.1-6.6)	5.7 (5.5-5.9)	28.2 (27.7-28.7)	14.7 (14.4-15.1)	8.3 (8.0-8.6)	37.0 (36.3-37.7)	23.1 (22.5-23.7)	12.8 (12.4-13.2)

CI, confidence intervals.

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Between 1995 and 2014, the hospitalisation in public hospitals declined from 44.9% to 38.4% (Table 3). The use of public hospitals was higher in the less developed than the more developed states in 2014 (47.6% vs 33.2%). Poor were hospitalised more in public hospitals; this differential was higher in the more developed (40.7% vs 22.9%) compared to the less developed states (54.3% vs 40.1%) in 2014. In less developed states, the decline in the use of public hospitals was higher for the non-poor than the poor (-25.3% vs -16.7%), while in the more developed states, both non-poor and poor showed a similar decline. The hospitalisation in public hospitals for the older population in the major states of India for 1995-96, 2004 and 2014 is presented in Table S4.

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Table 3 Hospitalisation rates per 1000 (95% CI) in public hospitals by economic status in the less and more developed states in 1995-96, 2004 and 2014, India

	Hospitalisation rates per 1000 (95% CI) in public hospitals								
	60 years or more								
	1995-96			2004			2014		
States	**Non-poor**	**Poor**	**Total**	**Non-poor**	**Poor**	**Total**	**Non-poor**	**Poor**	**Total**
Less developed	53.3 (45.6-60.8)	64.8 (56.0-72.7)	57.1 (51.3-62.6)	38.7 (33.6-44.2)	59.5 (54.9-63.9)	48.9 (45.0-52.9)	36.0 (30.4-41.9)	55.0 (48.9-60.9)	45.2 (40.9-49.6)
More developed	27.2 (23.6-31.1)	52.4 (46.9-57.8)	38.5 (35.0-42.1)	28.1 (25.0-31.3)	42.6 (39.4-45.8)	36.1 (33.9-38.4)	20.7 (18.0-23.6)	41.1 (38.2-44.1)	31.6 (29.5-33.8)
India	34.1 (30.4-37.9)	54.6 (49.9-59.2)	42.7 (39.7-45.8)	30.9 (28.3-33.6)	46.3 (43.6-49.1)	39.2 (37.3-41.2)	25.8 (23.2-28.4)	45.2 (42.5-47.9)	35.9 (33.9-37.8)
	Under 60 years								
	1995-96			2004			2014		
States	**Non-poor**	**Poor**	**Total**	**Non-poor**	**Poor**	**Total**	**Non-poor**	**Poor**	**Total**
Less developed	53.8 (51.1-56.4)	65.3 (60.6-69.7)	58.0 (55.6-60.4)	43.5 (41.4-45.6)	51.7 (49.6-53.8)	47.8 (46.3-49.3)	41.3 (38.7-43.9)	54.2 (51.7-56.7)	48.2 (46.4-50.0)
More developed	30.0 (28.3-31.9)	51.9 (49.6-54.2)	40.0 (38.5-41.5)	28.1 (26.4-29.9)	44.1 (42.4-45.8)	38.0 (36.7-39.2)	23.7 (21.8-25.6)	40.6 (38.9-42.3)	33.7 (32.4-35.1)
India	37.9 (36.3-39.4)	55.3 (53.2-57.4)	45.4 (44.1-46.7)	33.8 (32.4-35.1)	46.2 (44.9-47.6)	41.1 (40.1-42.1)	30.9 (29.4-32.5)	45.4 (44.0-46.9)	39.2 (38.2-40.3)
	All ages								
	1995-96			2004			2014		
States	**Non-poor**	**Poor**	**Total**	**Non-poor**	**Poor**	**Total**	**Non-poor**	**Poor**	**Total**
Less developed	53.7 (51.2-56.2)	65.2 (61.0-69.2)	57.9 (55.7-60.0)	42.5 (40.5-44.5)	52.5 (50.6-54.5)	47.7 (46.3-49.1)	40.1 (37.7-42.6)	54.3 (52.0-56.6)	47.6 (45.9-49.3)
More developed	29.5 (27.9-31.1)	52.0 (49.8-54.1)	39.7 (38.3-41.1)	28.0 (26.5-29.6)	43.7 (42.3-45.3)	37.5 (36.4-38.6)	22.9 (21.3-24.5)	40.7 (57.8-60.7)	33.2 (32.1-34.3)
India	37.2 (35.8-38.7)	55.2 (53.3-57.1)	44.9 (43.7-46.1)	33.1 (31.9-34.3)	46.2 (44.9-47.4)	40.6 (39.8-41.5)	29.6 (28.3-31.0)	45.4 (44.1-46.6)	38.4 (37.5-39.4)

CI, confidence intervals.

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All subgroups of the older population showed a significant increase in hospitalisation rates, but there was considerable variation in the amount of change (Table 4). Between 1995 and 2014, the increase in hospitalisation rate was higher for females (2.82 vs 1.87 times), single (3.04 vs 1.89 times), poor (2.72 vs 1.87 times), illiterate (2.45 vs 1.77 times), rural residents (2.32 vs 1.88 times), and those living in the less developed states (3.07 vs 1.95 times) compared to their respective counterparts. This reduced the differential in hospitalisation rate by gender, marital status, economic status, place of residence, and states.

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Table 4 Hospitalisation rate per 1000 (95% CI) for older population by background characteristics in 1995-96, 2004 and 2014, India

Background characteristics	Hospitalisation rates per 1000 (95% CI)		
Predisposing variables	**1995-96**	**2004**	**2014**
Age (years)			
60-69	37.6 (34.8-40.5)	62.2 (58.8-65.6)	82.6 (77.6-87.6)
70 or more	53.1 (47.8-58.4)	90.6 (85.3-96.0)	124.4 (116.4-132.4)
Sex			
Male	53.9 (49.3-58.4)	80.3 (76.3-84.2)	101.0 (95.5-106.6)
Female	33.3 (30.4-36.1)	63.7 (59.5-67.9)	94.0 (87.5-100.5)
Marital status			
Currently married	50.8 (46.8-54.9)	75.6 (72.0-79.1)	95.9 (91.2-100.7)
Single	32.9 (29.8-36.0)	66.8 (61.9-71.6)	100.1 (91.8-108.4)
Caste			
Non-SC/STs	46.7 (43.5-50.0)	78.8 (75.3-82.2)	105.2 (100.0-110.4)
SC/STs	32.9 (28.4-37.3)	50.7 (45.8-55.5)	71.8 (65.8-77.9)
Education			
Literate	65.9 (60.7-71.1)	106.3 (100.6-112.0)	116.7 (110.2-123.2)
Illiterate	34.0 (30.9-37.2)	54.2 (50.9-57.5)	83.2 (77.5-88.8)
Enabling variables			
Place of residence			
Urban	63.1 (58.7-67.4)	99.5 (92.8-106.3)	118.6 (111.2-126.0)
Rural	37.9 (34.7-41.1)	63.2 (60.0-66.3)	87.8 (82.6-93.1)
States			
More developed	62.1 (57.8-66.5)	98.4 (93.8-103.0)	121.0 (114.9-127.1)
Less developed	21.8 (19.0-24.5)	39.5 (36.4-42.6)	67.0 (61.2-72.9)
Economic dependency			
Economically independent	35.8 (30.9-40.8)	63.2 (58.9-67.5)	89.2 (80.2-98.2)
Economically dependent	47.2 (44.0-50.4)	77.9 (74.1-81.7)	100.7 (96.0-105.5)
Economic status			
Non-poor	68.6 (62.6-74.6)	94.9 (89.2-100.6)	128.2 (119.1-137.4)
Poor	29.4 (26.9-31.9)	59.8 (56.5-63.0)	80.1 (75.8-84.3)
Living arrangement			
With family	44.2 (41.4-47.0)	74.1 (71.1-77.1)	95.3 (91.4-99.3)
Alone	31.1 (22.2-40.0)	54.0 (41.1-67.0)	146.2 (99.3-193.2)
Need variables			
Physical mobility status			
Mobile	38.0 (35.4-40.7)	62.5 (59.8-65.3)	84.3 (80.3-88.3)
Immobile	91.3 (78.8-103.7)	193.9 (175.0-212.8)	249.4 (222.3-276.5)
Current self-rated health (SRH)			
Good	31.2 (28.9-33.4)	54.3 (51.5-57.1)	67.8 (63.8-71.7)
Poor	96.9 (86.4-107.4)	138.3 (129.5-147.1)	200.2 (186.8-213.7)
SRH compared to previous year			
Better or same	31.9 (29.4-34.5)	57.4 (54.6-60.1)	70.1 (66.0-74.3)
Worse	78.3 (70.7-85.9)	138.9 (128.9-148.9)	179.5 (167.8-191.2)
Total	43.4 (40.8-46.1)	72.0 (69.1-74.8)	97.5 (93.2-101.7)

CI, confidence intervals.

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Compositional change

Most of the older population lived in rural areas, but their proportion decreased by 9.3 percentage points (78.1 % to 68.8%) between 1995 and 2014 (Table 5). There was 5.2 percentage points (58.3% in 1995-96 to 63.4% in 2014) increase in the proportion of currently married older population. Literacy in the older population increased by 13.0 percentage points by 2014. In 1995-96, most of the older population were physically mobile (89.5%), less than 70 years of age (62.5%), resident of the more developed states (53.7%), economically dependent (68.9%), and reported good SRH (80.8%), with only marginal change in their proportions. The majority of the older population were non-SC/STs (76.4%), poor (64.2%), living with family (95.6%), and reporting better or nearly same SRH compared to past year (74.3%) in 1995-96 and their proportion remained unchanged in 2014.

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Table 5 Background characteristics of the older population in 1995-96, 2004 and 2014, India

Background characteristics	1995-96		2004		2014	
Predisposing variables	**N**	**% (95% CI)**	**N**	**% (95% CI)**	**N**	**% (95% CI)**
Age (years)						
60-69	21,124	62.5 (61.6-63.4)	22,546	65.3 (64.6-66.0)	17,160	64.5 (63.2-65.8)
70 or more	12,866	37.5 (36.6-38.4)	12,264	34.7 (34.0-35.4)	10,085	35.5 (34.2-36.8)
Sex						
Male	17,173	49.4 (48.5-50.4)	17,750	50.0 (49.3-50.8)	13,692	49.2 (47.8-50.6)
Female	16,817	50.6 (49.6-51.5)	17,081	50.0 (49.2-50.7)	13,553	50.8 (49.4-52.2)
Marital status						
Currently married	20,111	58.3 (57.3-59.2)	20,959	59.2 (58.5-60.0)	17,947	63.4 (62.1-64.7)
Single	13,852	41.7 (40.8-42.7)	13,872	40.8 (40.0-41.5)	9,298	36.6 (35.3-37.9)
Caste						
Non-SC/STs	26,089	76.4 (75.6-77.2)	26,291	76.0 (75.3-76.6)	20,823	76.8 (75.6-77.9)
SC/STs	7,880	23.6 (22.8-24.4)	8,531	24.0 (23.4-24.7)	6,422	23.2 (22.1-24.4)
Education						
Literate	12,406	29.5 (28.7-30.4)	13,514	34.2 (33.5-34.9)	13,362	42.6 (41.2-43.9)
Illiterate	21,543	70.5 (69.6-71.3)	21,301	65.8 (65.1-66.5)	13,883	57.4 (56.1-58.8)
Enabling variables						
Place of residence						
Urban	13,035	21.9 (21.3-22.5)	12,566	24.3 (23.7-24.9)	12,226	31.2 (30.0-32.4)
Rural	20,955	78.1 (77.5-78.7)	22,265	75.7 (75.1-76.3)	15,019	68.8 (67.6-70.0)
States						
More developed	17,389	53.7 (52.8-54.7)	17,019	55.2 (54.4-55.9)	14,466	56.3 (54.9-57.6)
Less developed	16,601	46.3 (45.3-47.2)	17,812	44.8 (44.1-45.6)	12,779	43.7 (42.4-45.1)
Economic dependency						
Economically independent	10,149	31.1 (30.2-32.0)	11,800	34.0 (33.3-34.7)	7,159	28.3 (27.0-29.6)
Economically dependent	23,061	68.9 (68.0-69.8)	22,429	66.0 (65.3-66.7)	20,075	71.7 (70.4-73.0)
Economic status						
Non-poor	15,407	35.8 (35.0-36.7)	14,372	34.8 (34.1-35.5)	11,738	36.1 (34.8-37.4)
Poor	18,583	64.2 (63.3-65.0)	20,459	65.2 (64.5-65.9)	15,507	63.9 (62.6-65.2)
Living arrangement						
With Family	32,482	95.6 (95.2-96.0)	32,595	94.8 (94.4-95.1)	26,659	95.9 (95.3-96.5)
Alone	1,174	4.4 (4.0-4.8)	1,509	5.2 (4.9-5.6)	586	4.1 (3.5-4.7)
Need variables						
Physical mobility status						
Mobile	29,697	89.5 (88.9-90.1)	30,821	91.9 (91.5-92.3)	24,499	92.0 (91.3-92.7)
Immobile	3,635	10.5 (9.9-11.1)	3,224	8.1 (7.7-8.5)	2,735	8.0 (7.3-8.7)
Current self-rated health (SRH)						
Good	27,263	80.8 (79.9-81.5)	24,965	76.4 (75.7-77.0)	20,143	77.6 (76.4-78.7)
Poor	6,217	19.2 (18.5-20.1)	8,216	23.6 (23.0-24.3)	7,091	22.4 (21.3-23.6)
SRH compared to previous year						
Better or same	25,018	74.3 (73.4-75.1)	25,971	79.3 (78.7-79.9)	19,590	75.0 (73.8-76.2)
Worse	8,430	25.7 (24.9-26.6)	7,210	20.7 (20.1-21.3)	7,644	25.0 (23.8-26.2)
N	33,990		34,831		27,245	

CI, confidence intervals.

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Determinants of hospitalisation

Older population reporting poor SRH (AOR 2.42 95% CI 1.91-3.07) and living alone (AOR 2.13 95% CI 1.44-3.16) had the highest odds of hospitalisation in 1995-96 and 2014, respectively (Table 6). Poor older population were 59% (95% CI 0.35-0.48) and 37% (95% CI 0.55-0.72) less likely to be hospitalised in 1995-96 and 2014, respectively. The economically dependent older population was 32% (95% CI 1.08-1.62) more likely to be hospitalised in 1995-96. Older population living in the less developed states had lower odds of hospitalisation in 1995-96 (AOR 0.34 95% CI 0.29- 0.40) and 2014 (AOR 0.54 95% CI 0.47-0.61). In 1995-96, female and single older population were 30% (95% CI 0.60-0.83) and 34% (95% CI 0.57-0.77) less likely to be hospitalised, respectively. The older population belonging to SC/STs had lower odds of hospitalisation (AOR 0.81, 95% CI 0.70-0.94) compared to non-SC/STs in 2014. In 2014, physically immobile and those reporting SRH worse than previous year had 85% (95% CI 1.15-2.27) and 67% (95% CI 1.44-1.94) higher odds of being hospitalised, respectively. After adjusting for the covariates, age and place of residence were not significantly associated with hospitalisation.

Between 1995 and 2014, there was a modest increase in intercept for the outcome variable suggesting that when all the explanatory variables in the logit model were set equal to their reference categories, the probability of hospitalisation was significantly higher in 2014 than in 1995-96 for the older population. Comparison of 1995-96 and 2014 coefficients showed the convergence of differentials in hospitalisation by gender, marital status, economic status, living arrangement, and states (Table 6).

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Table 6 Determinants of hospitalisation for the older population in 1995-96 and 2014, India

Background characteristics	Whether hospitalised							
	$\beta_{1995-96}$	Exp ($\beta_{1995-96}$)	95% CI for Exp ($\beta_{1995-96}$)	β_{2014}	Exp (β_{2014})	95% CI for Exp (β_{2014})	$\beta_{2014} - \beta_{1995-96}$	p-Value for Wald test ($\beta_{2014} - \beta_{1995-96}$)
Predisposing variables								
Age (years) (ref.=60-69)								
70 or more	-0.028	0.97	[0.83 - 1.14]	0.124	1.13	[0.99 - 1.29]	0.152	0.147
Sex (ref.=male)								
Female	-0.352	0.70	[0.60 - 0.83]	-0.050	0.95	[0.83 - 1.10]	0.302	0.006
Marital Status (ref.=currently married)								
Single	-0.416	0.66	[0.57 - 0.77]	-0.130	0.88	[0.76 - 1.02]	0.286	0.009
Caste (ref.=non-SC/STs)								
SC/STs	0.017	1.02	[0.84 - 1.23]	-0.211	0.81	[0.70 - 0.94]	-0.229	0.060
Literacy status (ref.= literate)								
Illiterate	-0.278	0.76	[0.63 - 0.91]	-0.224	0.80	[0.70 - 0.92]	0.055	0.645
Enabling variables								
Place of residence (ref.= urban)								
Rural	-0.112	0.89	[0.76 - 1.04]	-0.032	0.97	[0.85 - 1.11]	0.080	0.446
States (ref.= more developed)								
Less developed	-1.070	0.34	[0.29 - 0.40]	-0.619	0.54	[0.47 - 0.61]	0.451	<0.001
Economic dependence (ref.= independent)								
Economically dependent	0.281	1.32	[1.08 - 1.62]	0.004	1.00	[0.85 - 1.18]	-0.277	0.035
Economic status (ref.=non-poor)								
Poor	-0.895	0.41	[0.35 - 0.48]	-0.462	0.63	[0.55 - 0.72]	0.432	<0.001
Living arrangement (ref.= living with family)								
Living alone	0.197	1.22	[0.85 - 1.74]	0.757	2.13	[1.44 - 3.16]	0.560	0.039
Need variables								
Physical mobility status (ref.= mobile)								
Immobile	0.400	1.49	[1.21 - 1.84]	0.617	1.85	[1.51 - 2.27]	0.217	0.149
Current self-rated health (ref.= good SRH)								
Poor SRH	0.884	2.42	[1.91 - 3.07]	0.736	2.09	[1.78 - 2.44]	-0.149	0.306
SRH compared to last year (ref.= better or nearly the same)								
Worse SRH	0.475	1.61	[1.31 - 1.98]	0.515	1.67	[1.44 - 1.94]	0.039	0.763
Constant	-2.466	0.08	[0.07 - 0.10]	-2.238	0.11	[0.09 - 0.12]	0.228	0.037
F-adjusted test statistic	1.61			0.81				
p-Value	0.106			0.611				
N	32,780			27,234				

CI, confidence intervals.

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Decomposition of increase in hospitalisation rate

For the older population in India, the propensity change explained 86.6% of the increase in hospitalisation rate between 1995 and 2014 (Table 7). The improved propensity to use hospital care by economically poor, residents of the less developed states, females, and singles contributed 16.4%, 12.3%, 9.0%, and 7.1% of the increase in hospitalisation rate, respectively, regardless of the change in their composition. The change in intercept accounted for 13.5% of the increase in hospitalisation rate. Change in the composition of the characteristics of older population had a modest influence on the level of hospitalisation; contributing 9.2% of the increase in hospitalisation. Many of the changes in the population structure during the inter-survey period favoured increased hospitalisation, except gender and physical mobility status. The increase in the proportion of literates, those reporting poor SRH, economically dependent, and single contributed 2.1%, 1.7%, 1.6%, and 1.3% of the increase in hospitalisation rate, respectively between 1995 and 2014, regardless of the change in the likelihood of hospitalisation by the subgroups.

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Table 7 Decomposition of increase in hospitalisation for the older population between 1995 and 2014, India

	Contribution to the increase in hospitalisation (%)*		
Background characteristics	**Propensity**	**Composition**	**Interaction**
70 years or more	0.06 (3.4)	0.00 (0.0)	0.00 (-0.2)
Female	0.15 (9.0)	0.00 (-0.1)	0.00 (0.0)
Single	0.12 (7.1)	0.02 (1.3)	-0.01 (-0.9)
SC/STs	-0.05 (-3.2)	0.00 (0.0)	0.00 (0.0)
Illiterate	0.04 (2.3)	0.04 (2.1)	-0.01 (-0.4)
Rural	0.06 (3.7)	0.01 (0.6)	-0.01 (-0.4)
Less developed states	0.21 (12.3)	0.03 (1.6)	-0.01 (-0.7)
Economically dependent	-0.19 (-11.3)	0.01 (0.5)	-0.01 (-0.5)
Economically poor	0.28 (16.4)	0.00 (0.1)	0.00 (-0.1)
Living alone	0.02 (1.4)	0.00 (0.0)	0.00 (-0.1)
Physically immobile	0.02 (1.3)	-0.01 (-0.6)	-0.01 (-0.3)
Poor SRH	-0.03 (-1.7)	0.03 (1.7)	0.00 (-0.3)
Worse SRH than previous year	0.01 (0.6)	0.00 (-0.2)	0.00 (0.0)
Intercept	0.23 (13.5)		
% contribution to the overall increase	86.6	9.2	4.2

*Percent contribution has been calculated as the ratio of the contribution of the covariate and the sum of the absolute contribution of covariates under the propensity, composition and interaction components multiplied by 100.

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DISCUSSION

This report provides evidence on trends in hospitalisation rates in India over two decades up to 2014, and compares the older population with population under 60 years. Five key findings relating to hospitalisation trends and differentials emerge from this study. First, the hospitalisation rate increased two-fold between 1995 and 2014; the increase was higher for NCDs and in less developed states. Second, poor people used more public hospitals; this differential was higher in the more developed than the less developed states. Third, the older population had higher hospitalisation rates and greater proportion of hospitalisation for NCDs than the population under 60 years. Fourth, amongst the older population, the hospitalisation rate was comparatively lower for females, poor, and rural residents. Fifth, propensity change was largely responsible for the increase in hospitalisation among the older population in India over these two decades.

Hospitalisation is an important indicator of the demand for curative care and is an integral part of any health system. The increase in hospitalisation rate found in our study could be due to the growing awareness about the health prevention and other precautionary measures along with proper diagnosis of the health conditions. The evidence on increasing hospitalisation is vital for planning of resources to meet the growing demand for inpatient care and for formulating viable publicly funded financial risk protection mechanism. To provide targeted financial protective intervention it would also be useful to know whether the increase in hospitalisation was due to higher hospitalisations for preventive care among the rich or emergency inpatient care among the poor. Data from the global burden of disease study suggests that of the total disease burden, measured as disability-adjusted life years lost in India, the contribution of noncommunicable disease and injuries has increased from 38.4% in 1990 to 64.2% in 2013.[33] The higher increase in hospitalisation for NCDs over two decades is consistent with the shifting disease burden trends in India.

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The developed states in India with good health indicators are usually found to report higher use of healthcare.[10 22] Higher hospitalisation rate in the more developed states of India may indicate a higher volume of health services provided by heath sector, rather than reflect higher morbidity prevalence. Interestingly, we found that the increase in hospitalisation rate between 1995 and 2014 was more pronounced in the less developed than the more developed states. A plausible reason for this could be the increased burden of chronic, degenerative, and lifestyle diseases in the less developed states because of their advancement through the health transition process. Other factors contributing to this could be the greater availability of health services, better access to healthcare, or the increased propensity to use healthcare.

The increase in the use of private hospitals over two decades in India is a matter of concern from the equity point of view and has cost implications for the poor. The continuing inadequacies of the public health system and the unrestricted growth of private providers are possible reasons for the decline in the use of public hospitals. The decline in the use of public hospitals was found to be higher for the non-poor in the less developed states, which implies that in spite of decline, the poor in the less developed states still largely use public hospitals. The increasing provision of inpatient care in private hospitals and the consequent decline in the utilisation of public hospitals is likely to impose a higher financial risk on individuals and households.[34 35] Strengthening the public funding model of service delivery in India would increase the ability of public facilities to meet the increasing demand for healthcare and thereby improve the utilisation of inpatient care by the poor.

Our results indicated clear distinction in levels and differentials in hospitalisation rate between older population and population under 60 years. The older population had more than three times higher hospitalisation than any other age groups. Contributing 8.6% to India's population, older population accounted for nearly one-fourth of all hospital stays in 2014. The improved longevity coupled by the increased years of poor health at older ages is

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predominantly responsible for the difference between the hospitalisation rates of the two age groups. Data from the global burden of disease study suggest that in India in 1990, disease burden among the older population accounted for 11.8% of the total disease burden. In 2013, this burden had increased to 22.3% of the total disease burden, and noncommunicable diseases and injuries made up 82.3% of the total disease burden.[33] Our results showed that the contribution of the older population in total hospitalisation increased over two decades, and they had higher hospitalisation rates for NCDs in any given year. However, the hospitalisations in absolute number and their contribution in total hospitalisations remain higher for the population under 60 years. Evidence suggests that over the past 25 years the burden of premature death and health loss from NCDs such as heart disease, stroke, chronic obstructive pulmonary disease, and road traffic injuries has increased substantially, while the burden due to lower respiratory infections, tuberculosis, diarrhea and neonatal disorders remains high in India.[33] For the purpose of planning of the resources for universal health coverage and reducing premature mortality it is important to continue focusing on the child and adult population which account for majority of India's population. At the same time, given the increasing proportion of older population it is equally important to allocate resources and provide healthcare services to cater to their specific healthcare needs.

In the population under 60 years, there was no evidence for gender differential, while, in the older population, a higher proportion of males were hospitalised. Studies from the developed nations have also found that the older women have less hospital stays than their male counterparts.[15 36-39] Greater economic dependency among females at older ages is a major driver of the gender differential in healthcare use in India.[20] On a positive note, we found that the improved likelihood of using hospital care by female older population contributed to the decline in gender differential among the older population.

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In the absence of a health financing system, low level of health insurance coverage and high out of pocket cost of healthcare, economic status becomes an important factor affecting healthcare use. We found that the non-poor had higher hospitalisation rates than the poor; this differential was higher for the older population than the other ages. Based on the Andersen's model of healthcare use, we found that the poor older population had significantly less likelihood of using hospital care even after controlling for health profiles. The economic inequality in hospitalisation among the older population is evident in India.[16] Older population rely more on family and other social structures for financial support, and therefore, they might not have adequate resources for hospital care. Financial empowerment of the poor older population can be one way of effectively improving the healthcare utilisation.

An important finding of this study is that the propensity change has contributed most to the two-fold increase in hospitalisation of the older population in India between 1995 and 2014. A plausible explanation could be better awareness of the medical conditions and health among the population.[40] A relatively higher increase in hospitalisation among the poor compared to the non-poor older population has contributed most to the increase in hospitalisation rate attributed to propensity change. This indicates a decline in the differentials in healthcare use by economic status over two decades. It has been argued that lowering of inequality will not make the situation more equitable for the poor if there is a high increase in the rate of hospitalisation, a decline in dependence on government hospitals, and a steep hike in the cost of hospital care.[22]

The increase in hospitalisation rate was moderately influenced by the factors not explicitly considered in the model. The supply side factors like the expansion of private healthcare market and consequent improvement in the availability of health services could have propelled the use of healthcare.[22] The expansion of morbidity, with a heavier and

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cumulated concentration of chronic diseases at older ages, could be another potential driver of the increase in hospitalisation.[41 42] Compositional change contributed marginally to the increase in hospitalisation of the older population over the past two decades. It would be interesting to see how the anticipated compositional change influences the future demand for hospitalisation.

The findings of this report must be interpreted in the light of some limitations. First, we used individual determinants and did not examine the full array of determinants of healthcare use as suggested by the Andersen's model of healthcare use. Data on the supply side of healthcare provision were not available from the national sample surveys, nor were comparable data available from other secondary sources corresponding to the survey time points. Second, the use of self-reported data on diseases from the national sample surveys may be associated with biases. However, we report hospitalisation trends for broad groups of diseases which may be reasonable. Even with these limitations, this study uses large-scale data from the nationwide surveys in India over two decades to provide insights into the changing hospitalisation rate by age groups, and the reasons behind the increased hospitalisation of the older population. Given the anticipated further increase of the older population and their higher demand for healthcare, it is time for the policy makers to pay particular attention to planning how adequate resources and mechanisms can be put in place for the provision of geriatric healthcare in India.

FIGURE LEGEND

Fig 1. Socioeconomic and demographic differentials in hospitalisation rates in 1995-96, 2004 and 2014, India

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AUTHORS' CONTRIBUTIONS

AP extracted the data, conducted statistical analysis, interpreted the findings, and wrote the first draft of the manuscript. GBP contributed to the initial concept of the paper and guided the statistical analysis. LC provided critical comments on the manuscript for intellectual content. LD provided detailed guidance on the study design, analysis, interpretation of findings and drafting of the manuscript. All authors approved the final version of the manuscript.

COMPETING INTERESTS

There are no competing interests

DATA SHARING STATEMENT

The authors confirm that all data underlying the findings are fully available without restriction. Data are publicly available and can be obtained from the Ministry of Statistics and Programme Implementation, Government of India, New Delhi: http://mospiold.nic.in/Mospi_New/site/inner.aspx?status=3&menu_id=37

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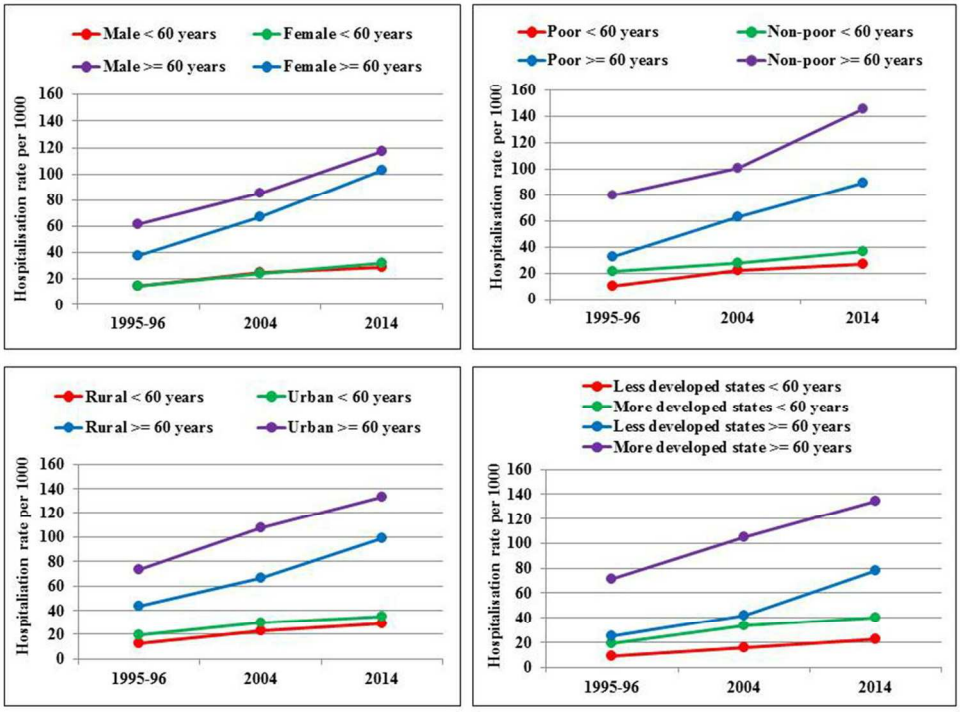

Fig 1. Socioeconomic and demographic differentials in hospitalisation rates in 1995-96, 2004 and 2014, India

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Table S1. Percent distribution of missing and deceased samples in 1995-96, 2004 and 2014, India

	1995-96		2004		2014	
Background characteristics	**N**	**%**	**N**	**%**	**N**	**%**
All ages						
Age	55	0.00	38	0.01	0	0.00
Sex	2	0.00	0	0.00	0	0.00
Place of residence	0	0.00	0	0.00	0	0.00
States	0	0.00	0	0.00	0	0.00
Economic status	0	0.00	0	0.00	0	0.00
N (including deceased persons)	633,405		385,055		335,499	
60 years or more						
Marital status	27	0.12	0	0.00	0	0.00
Caste	21	0.05	9	0.01	0	0.00
Education	41	0.12	16	0.04	0	0.00
Economic dependency	780	2.29	602	1.45	11	0.01
Living arrangement	334	0.85	727	1.72	0	0.00
Physical mobility status	658	1.93	786	1.93	11	0.01
Self-rated health (SRH)	510	1.52	1,650	3.95	11	0.01
SRH compared to previous year	542	1.58	1,650	3.94	11	0.01
N (excluding deceased persons)	33,990		34,831		27,245	
% of hospitalised persons who died in 365 days reference period	1,284	3.05	736	2.32	1,152	2.18
N (including deceased persons)	35,274		35,567		28,397	

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Table S2. List of diseases grouped according to Global Burden of Disease (GBD) study categorisation of diseases, 2013

Communicable diseases and nutritional disorders (CDs)	**Non-communicable diseases and injuries (NCDs)**
Tuberculosis	Neoplasms
STDs including HIV/AIDs	○ Cancer and other tumours
Diarrhoeal diseases:	Cardiovascular and circulatory diseases
○ Cholera	○ Heart disease, Hypertension
○ Diarrhoea/dysentery/gastro-enteritis	○ Rheumatic fever
○ Amoebiosis	Chronic respiratory diseases
Respiratory infections and other common infectious disease	○ Bronchial Asthma and related conditions
○ Dengue/Influenza	Digestive diseases
○ Pneumonia	○ Gastrointestinal bleeding/piles
○ Respiratory (including ear/nose/throat) ailments	○ Gastritis/gastric/peptic ulcer
○ Cough and acute bronchitis	○ Cirrhosis/hydrocele
○ Pleurisy	○ Food poisoning
○ Meningitis and viral encephalitis	Neurological disorder:
○ Diptheria	○ Cerebral stroke
○ Pertussis/whooping cough	○ Other diseases of nerves
○ Tetanus	○ Epilepsy/headache
○ Measles/chicken pox/mumps/eruptive	○ Nervous and general debility
Neglected tropical diseases and malaria:	○ Cerebral haemorrhage, thrombosis
○ Filariasis	Mental and behavioural disorders
○ Trachoma	Diabetes, urogenital, blood and endocrine diseases
○ Worm infestation/Guinea worm	○ Diabetes
○ Leprosy	○ Disease of kidney/urinary system/prostrate disorders
Neonatal and maternal disorders	○ Gynaecological disorders
Nutritional deficiencies:	○ Goiter/Thyroid disorders
○ Anemia/bleeding disorders	Musculoskeletal disorders
○ Under-nutrition	○ Disorders of joints and bones
○ Scurvy	○ Locomotor disability
○ Other malnutrition diseases (Beri-Beri , Ricket)	Other non-communicable diseases
Other communicable diseases and nutrition disorders:	Skin and subcutaneous diseases
○ Hepatitis/Jaundice/diseases of liver	Sense organ diseases:
○ Fever of unknown origin/fever of short duration/malaria/typhoid	○ Glucoma
	○ Cataracts
	○ Hearing loss, adult onset
	○ Vision disorders, age related
	○ Diseases of ear/nose/throat
	○ Speech disability
	Oral disorders
	Accidents/injury/burns/fractures/poisoning
	Congenital anomalies

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Table S3. Hospitalisation rates per 1000 (95% CI) for the older population by disease groups in the major states in 1995-96, 2004 and 2014, India

	Hospitalisation rates per 1000 (95% CI)								
	1995-96			2004			2014		
States	**All diseases**	**NCDs**	**CDs**	**All diseases**	**NCDs**	**CDs**	**All diseases**	**NCDs**	**CDs**
Less developed	25.1 (22.3-27.9)	13.6 (12.1-15.1)	5.8 (4.0-7.6)	41.6 (38.4-44.9)	28.6 (25.8-31.4)	7.3 (6.2-8.4)	78.4 (71.3-85.5)	61.2 (54.6-67.8)	15.0 (12.7-17.2)
Assam	28.9 (20.4-37.3)	16.3 (10.1-22.4)	6.2 (2.2-10.2)	35.7 (24.0-47.5)	26.6 (15.4-37.7)	5.3 (3.0-7.7)	37.0 (24.0-50.0)	29.3 (16.6-42.0)	5.9 (3.3-8.5)
Bihar	15.4 (10.7-20.1)	8.1 (5.2-11.0)	4.4 (1.0-7.9)	28.1 (24.1-32.2)	19.4 (16.2-22.7)	4.7 (3.1-6.4)	52.6 (37.2-68.1)	44.9 (29.9-59.9)	6.5 (2.9-10.1)
Madhya Pradesh	29.7 (24.4-35.0)	16.7 (12.8-20.5)	7.4 (4.6-10.2)	47.2 (39.2-55.3)	34.7 (27.3-42.2)	9.4 (6.6-12.3)	101.2 (72.9-129.5)	80.0 (53.0-106.9)	18.9 (10.4-27.4)
Odisha	44.1 (21.2-66.9)	12.0 (7.9-16.1)	14.8 (-1.0-30.5)	42.0 (32.2-51.9)	21.0 (15.7-26.4)	14.6 (6.8-22.4)	79.6 (63.3-95.8)	57.7 (42.7-72.8)	20.2 (14.3-26.2)
Rajasthan	34.3 (25.6-43.1)	21.6 (14.5-28.8)	4.6 (2.5-6.7)	56.7 (45.9-67.5)	37.0 (30.0-44.0)	6.4 (3.5-9.3)	101.9 (88.6-115.2)	75.4 (64.0-86.8)	25.2 (18.5-31.9)
Uttar Pradesh	18.6 (15.1-22.0)	11.8 (9.5-14.2)	3.4 (1.2-5.6)	38.6 (32.0-45.2)	27.7 (21.6-33.8)	5.5 (4.1-6.9)	78.5 (65.5-91.4)	62.5 (50.8-74.2)	12.7 (8.6-16.7)
Jammu & Kashmir	34.3 (15.8-52.9)	19.4 (4.6-34.1)	8.7 (-1.8-19.3)	48.5 (36.4-60.6)	39.0 (28.0-50.0)	6.3 (1.9-10.7)	68.5 (50.4-86.7)	55.9 (39.8-71.9)	11.2 (2.9-19.6)
More developed	70.9 (66.1-75.8)	41.7 (37.7-45.8)	12.7 (10.8-14.6)	104.6 (99.8-109.4)	74.6 (70.4-78.7)	17.1 (15.1-19.1)	134.3 (128.0-140.7)	109.7 (103.9-115.5)	21.1 (18.8-23.5)
Andhra Pradesh	47.0 (36.5-57.6)	30.8 (21.7-40.0)	6.2 (3.2-9.2)	65.9 (57.2-74.5)	54.4 (46.3-62.5)	5.8 (3.6-8.0)	111.2 (96.4-126.0)	94.1 (80.6-107.6)	12.9 (8.1-17.7)
Gujarat	45.9 (36.2-55.6)	18.4 (13.9-22.9)	19.3 (11.3-27.3)	102.5 (86.7-118.2)	64.6 (52.5-76.8)	27.3 (18.4-36.2)	123.7 (105.8-141.7)	98.0 (83.4-112.5)	24.9 (14.4-35.3)
Haryana	79.6 (57.0-102.1)	51.5 (33.4-69.6)	20.9 (9.1-32.7)	81.8 (57.2-106.5)	61.0 (38.5-83.5)	13.7 (5.4-22.0)	89.2 (71.5-106.8)	75.3 (58.7-91.9)	13.1 (7.1-19.1)
Karnataka	52.5 (37.8-67.2)	30.5 (18.4-42.6)	8.0 (2.6-13.3)	80.4 (68.2-92.6)	54.0 (44.7-63.3)	10.5 (5.7-15.3)	110.3 (96.9-123.7)	89.2 (76.9-101.4)	19.8 (14.6-25.1)
Kerala	200.5 (175.8-225.1)	110.5 (9.2-3186.4)	39.0 (27.9-50.2)	279.1 (251.7-306.5)	190.5 (168.3-212.6)	47.0 (34.9-59.0)	281.3 (249.1-313.5)	216.2 (18.9-15279.5)	51.5 (36.2-66.7)
Maharashtra	70.4 (60.3-80.5)	42.9 (3.5-618.2)	10.9 (7.6-14.2)	96.6 (85.0-108.2)	76.0 (65.1-86.8)	11.1 (8.0-14.1)	119.9 (103.1-136.7)	103.0 (86.5-119.4)	14.4 (11.1-17.7)
Punjab	45.6 (34.0-57.2)	21.7 (14.0-29.3)	4.7 (1.7-7.7)	80.7 (63.2-98.2)	58.8 (43.7-73.8)	12.5 (5.1-19.8)	103.7 (80.0-127.5)	89.5 (66.6-112.5)	12.7 (6.8-18.6)
Tamil Nadu	72.7 (52.7-92.7)	52.3 (3.3-370.9)	7.7 (5.2-10.2)	105.6 (92.0-119.2)	71.9 (60.9-82.9)	23.1 (15.8-30.4)	138.1 (118.5-157.7)	115.3 (96.6-134.0)	22.1 (16.3-27.8)
West Bengal	41.5 (33.0-50.1)	22.1 (17.4-26.9)	8.0 (2.3-13.7)	68.5 (59.5-77.4)	46.7 (38.8-54.6)	11.5 (8.4-14.6)	109.4 (98.1-120.7)	86.3 (76.0-96.6)	18.7 (14.3-23.1)
India	49.7 (46.8-52.6)	28.7 (26.5-31.0)	9.5 (8.2-10.8)	76.4 (73.4-79.4)	54.0 (51.4-56.5)	12.7 (11.5-13.9)	99.9 (105.2-114.5)	88.5 (84.2-92.8)	18.4 (16.8-20.1)

CI, confidence intervals.

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Table S4. Hospitalisation rates per 1000 (95% CI) in public hospitals among the older population in the major states in 1995-96, 2004 and 2014, India

	Hospitalisation rates per 1000 (95% CI) in public hospitals								
	1995-96			2004			2014		
States	Non-poor	Poor	Total	Non-poor	Poor	Total	Non-poor	Poor	Total
Less developed	53.3 (45.6-60.8)	64.8 (56.0-72.7)	57.1 (51.3-62.6)	38.7 (33.6-44.2)	59.5 (54.9-63.9)	48.9 (45.0-52.9)	36.0 (30.4-41.9)	55.0 (48.9-60.9)	45.2 (40.9-49.6)
Assam	78.8 (61.2-89.8)	67.2 (33.3-89.4)	76.0 (60.1-86.9)	47.7 (25.4-70.9)	83.8 (66.7-93.0)	64.4 (44.9-80.1)	76.3 (65.3-87.4)	86.6 (72.0-94.2)	82.3 (72.3-89.2)
Bihar	35.5 (19.6-55.4)	22.9 (9.1-46.7)	31.3 (18.4-48.0)	14.3 (9.5-20.9)	27.5 (19.2-37.7)	21.3 (16.0-27.6)	20.5 (11.9-33.0)	42.8 (32.6-53.6)	28.8 (20.3-39.1)
Madhya Pradesh	43.6 (33.3-54.4)	72.0 (56.5-83.6)	51.4 (42.2-60.5)	35.1 (26.8-44.4)	67.0 (53.1-78.4)	51.6 (43.1-60.0)	24.5 (14.8-37.7)	48.1 (31.3-65.3)	37.2 (26.2-49.8)
Odisha	92.6 (81.6-97.3)	93.4 (84.5-97.3)	92.9 (85.5-96.6)	74.6 (61.2-84.6)	86.9 (76.3-93.2)	81.1 (72.6-87.5)	71.0 (58.8-80.8)	85.8 (76.9-91.6)	79.2 (72.5-84.7)
Rajasthan	60.7 (44.1-75.1)	44.7 (23.7-67.7)	55.6 (42.1-68.4)	52.7 (39.0-66.0)	70.9 (60.3-79.7)	59.9 (50.0-69.1)	48.8 (40.5-57.2)	66.5 (57.2-74.7)	58.9 (52.4-65.0)
Uttar Pradesh	30.9 (22.8-40.4)	54.2 (38.2-69.4)	38.6 (30.2-47.8)	24.7 (17.4-33.9)	44.7 (36.7-53.0)	34.3 (27.7-41.5)	26.8 (18.5-37.0)	30.8 (23.0-39.9)	28.4 (22.4-35.3)
Jammu & Kashmir	94.5 (82.7-98.4)	99.6 (97.1-100.0)	97.7 (93.6-99.2)	92.6 (84.6-96.6)	85.9 (71.3-93.8)	89.1 (80.7-94.0)	81.1 (73.9-94.1)	94.9 (86.7-98.1)	92.6 (86.2-96.1)
More developed	27.2 (23.6-31.1)	52.4 (46.9-57.8)	38.5 (35.0-42.1)	28.1 (25.0-31.3)	42.6 (39.4-45.8)	36.1 (33.9-38.4)	20.7 (18.0-23.6)	41.1 (38.2-44.1)	31.6 (29.5-33.8)
Andhra Pradesh	16.3 (10.0-25.5)	42.2 (27.9-57.9)	24.6 (17.6-33.2)	24.1 (15.9-34.7)	38.8 (30.8-47.4)	32.0 (26.2-38.5)	14.6 (8.7-23.3)	29.9 (22.8-38.0)	22.6 (17.7-28.3)
Gujarat	27.2 (15.9-42.5)	64.9 (47.1-79.3)	40.6 (30.0-52.2)	17.7 (11.2-26.8)	33.6 (24.4-44.3)	25.4 (19.5-32.3)	16.7 (10.3-26.0)	33.6 (26.0-42.0)	24.9 (19.5-31.2)
Haryana	39.8 (24.7-57.0)	25.2 (10.8-48.4)	33.3 (22.0-46.8)	20.8 (11.5-34.6)	18.2 (9.2-33.0)	19.6 (12.5-29.2)	6.9 (3.8-12.4)	52.9 (39.0-66.3)	29.7 (21.3-39.8)
Karnataka	33.0 (19.6-49.9)	46.3 (27.5-66.3)	35.1 (23.1-49.5)	20.8 (12.9-31.6)	51.4 (40.6-62.0)	35.4 (28.3-43.2)	26.5 (16.3-40.1)	28.5 (22.4-35.5)	27.8 (22.1-34.2)
Kerala	21.1 (14.4-29.9)	55.1 (47.2-62.8)	42.0 (35.9-48.4)	26.9 (20.2-34.9)	41.0 (35.0-47.3)	35.6 (31.0-40.5)	20.3 (14.4-27.8)	49.5 (42.3-56.7)	33.8 (28.8-39.3)
Maharashtra	15.2 (9.9-22.8)	35.8 (26.3-46.5)	25.1 (19.4-31.9)	22.7 (15.6-31.7)	36.2 (29.0-44.1)	30.7 (25.4-36.5)	9.3 (6.2-13.7)	29.7 (22.3-38.2)	20.5 (15.7-26.3)
Punjab	35.8 (22.9-51.1)	41.8 (22.7-63.7)	38.3 (27.0-51.0)	32.4 (20.0-47.9)	25.2 (14.4-40.2)	29.4 (20.4-40.3)	12.3 (7.5-50.6)	24.8 (16.1-36.2)	23.6 (13.8-37.3)
Tamil Nadu	21.5 (14.1-31.5)	69.4 (49.7-83.9)	43.2 (29.3-58.2)	16.7 (11.6-23.3)	43.5 (34.8-52.6)	33.6 (27.7-40.1)	13.6 (9.2-19.7)	40.7 (32.9-49.1)	30.8 (25.7-36.4)
West Bengal	62.3 (51.5-72.0)	83.0 (65.1-92.7)	69.0 (59.6-77.1)	60.2 (51.6-68.3)	82.1 (75.0-87.5)	69.0 (63.2-74.2)	47.8 (43.2-56.4)	72.1 (63.4-79.4)	61.0 (55.9-65.9)
India	34.1 (30.4-37.9)	54.6 (49.9-59.2)	42.7 (39.7-45.8)	30.9 (28.3-33.6)	46.3 (43.6-49.1)	39.2 (37.3-41.2)	25.8 (23.2-28.4)	45.2 (42.5-47.9)	35.9 (33.9-37.8)

CI, confidence intervals.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1-2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-6
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	-
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	8
		(*e*) Describe any sensitivity analyses	-
Results			

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Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	-
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	15-18
		(b) Indicate number of participants with missing data for each variable of interest	Appendix Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	15-16
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	19-20
		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-14 and 21-22
Discussion			
Key results	18	Summarise key results with reference to study objectives	23
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	27
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	23-26
Generalisability	21	Discuss the generalisability (external validity) of the study results	23-26
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	28

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Hospitalization trends in India from serial cross-sectional nationwide surveys: 1995 to 2014

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Hospitalization trends in India from serial cross-sectional nationwide surveys: 1995 to 2014

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ABSTRACT

Objectives: We report hospitalization trends for different age groups across the states of India and for various disease groups, compare the hospitalization trends among the older (60 years or more) and the younger (under 60 years) population, and quantify the factors that contribute to the change in hospitalization rates of the older population over two decades.

Design: Serial cross-sectional study.

Setting: Nationally representative sample, India.

Data sources: 3 consecutive National Sample Surveys (NSS) on healthcare utilization in 1995–96, 2004, and 2014.

Participants: 633,405 individuals in NSS 1995–96, 385,055 in NSS 2004, and 335,499 in NSS 2014.

Methods: Descriptive statistics, multivariate analyses, and a regression decomposition technique were used to attain the study objectives.

Result: The annual hospitalization rate per 1000 increased from 16.6 to 37.0 in India from 1995–96 to 2014. The hospitalization rate was about half in the less developed than the more developed states in 2014 (26.1 vs 48.6 per 1000). Poor people used more public than private hospitals; this differential was higher in the more developed (40.7% vs 22.9%) than the less developed (54.3% vs 40.1%) states in 2014. When compared to the younger population, the older population had a 3.6 times higher hospitalization rate (109.9 vs 30.7) and a greater proportion of hospitalization for non-communicable diseases (80.5% vs 56.7%) in 2014. Amongst the older population, hospitalization rates were comparatively lower for females, poor, and rural residents. Propensity change contributed to 86.5% of the increase in hospitalization among the older population and compositional change contributed 9.3%.

Conclusion: The older population in India has a much higher hospitalization rate and has continuing greater socioeconomic differentials in hospitalization rates. Specific policy focus

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on the requirements of the older population for hospital care in India is needed in light of the anticipated increase in their proportion in the population.

Keywords Ageing, decomposition, hospitalization, non-communicable diseases, older population, propensity

Stregths and limitations of this study

- The use of large scale data from nationwide surveys in India over two decades provides the most updated trends for hospitalization.
- The evidence on the changing hospitalization rate by age groups and the reasons behind the increased hospitalization of the older population is timely for policy formulation given the population ageing and shifting disease burden.
- It was not possible for us to study the contribution of the supply side factors in the increased hospitalization.
- Self-reported data and the nature of cross-sectional data may lead to recall and reporting biases, which may have affected the accuracy of the results.

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INTRODUCTION

The improvement in life expectancy in India has not been matched by the improvements in levels of health of the population.[1 2] The older population in India suffer from a higher burden of disease at older ages, particularly chronic diseases and disabilities.[3-11] The ageing population in India will continue to be one of the major determinants of the change in disease burden over the next two decades.[5] Higher disease burden rates at older ages result in greater demand for healthcare, particularly hospitalization.[12-15] Hospital care is an important aspect of any health system, especially regarding the treatment of the more vulnerable older segment of the population.[16 17]

Monitoring change in hospitalization rates is important to highlight the necessity for health policies to allocate resources and services to respond to the diverse healthcare needs of different segments of the population. Studies in India have analyzed hospitalization, but they are restricted in their approach and lack comprehensive assessment of rate over time.[16 18-22] The purpose of this study was to analyze hospitalization trends from nationally representative data between 1995 and 2014 for different age groups across the less and more developed states of India, and for various disease groups. In addition to this, we aimed to compare the hospitalization trends of the older population with the population under 60 years, and quantify the propensity and compositional change that may contribute to the change in hospitalization rates of the older population.

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METHODS

Ethics statement

The study is based on secondary data from the National Sample Surveys with no identifiable information on the survey participants. Exemption from ethics approval for analysis of the National Sample Surveys data was obtained from the institutional ethics committees of the Public Health Foundation of India and the London School of Hygiene and Tropical Medicine.

Data sources and participants

We used individual level data from National Sample Survey (NSS) on healthcare utilization conducted in all Indian states in 1995–96, 2004, and 2014.[23-25] These surveys record the utilization of healthcare for both inpatient and outpatient care, with hospitalization episodes in 365 days reference period recorded in detail. In addition, information of certain aspects of the condition of the older population was also collected. Individual level data was collected for a nationally representative sample of 633,405 in NSS 1995–96, 385,055 in NSS 2004, and 335,499 in NSS 2014. The sample of the older population in these surveys was: 35,274 in NSS 1995–96, 35,567 in NSS 2004, and 28,397 in NSS 2014. Samples with missing values for the independent variables were dropped, meaning that we did a complete case analysis. The proportion of missing cases on any independent variable across the three surveys was less than 4% of the total sample (Table S1). Though there was variation in sample size; the sample design was uniform across the three surveys. This permits the construction of comparable variables which could be used to make statistical inferences about change in parameter estimates.

Initial analyses of trends and differentials in hospitalization rates were performed on all persons surveyed including deceased members. However, for the subsequent descriptive, multivariate, and decomposition analyses performed on the older population, the deceased was excluded because the questions on several important background variables were only

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asked to the older persons who were alive on the date of survey. The sample of deceased older population is reported in Table S1.

Measures

Our outcome variable was hospitalization rate defined as the number of episodes of hospitalization in 365 days reference period per 1000 of the population exposed to the risk. The cause of hospitalization was categorized into non-communicable diseases and injuries (NCDs), and communicable diseases and nutritional disorders (CDs) using the Global Burden of Disease 2013 classification.[2] The diseases included in the two broad categories are listed in Table S2.

We used monthly per capita consumption expenditure (MPCE) adjusted to the household size and composition as a proxy for economic status. The equivalence scale used was $e_h = (A_h + 0.5K_h)^{0.75}$, where A_h was the number of adults in the household, and K_h was the number of children 0–14 years. Parameters were set on the basis of estimates summarized by Deaton.[26] The state-specific adult equivalent mean MPCE was used as a cut-off to categorize households into poor and non-poor.

We present analyses at the state level for the 35 states and union territories in India by classifying them into two groups –less developed and more developed states. The less developed states include the 18 states namely, eight empowered action group states (Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Uttar Pradesh, Uttaranchal, Odisha and Rajasthan), 8 north-eastern states (Assam, Arunachal Pradesh, Manipur, Mizoram, Meghalaya, Nagaland, Sikkim and Tripura), Himachal Pradesh, and Jammu and Kashmir.[27] State-specific rates were estimated for the 19 major states of India, with a population over 10 million in 2011 census, accounting for 97% of India's population. For comparison Bihar, Madhya Pradesh, Uttar Pradesh, and Andhra Pradesh were considered as undivided states at all survey points.

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The Andersen's model of healthcare utilization was used to study the association of individuals' predisposing, enabling, and need variables with hospitalization.[28] Based on the availability of data age, sex, marital status, caste[1], and education were identified as predisposing variables; place of residence, states, economic independence, economic status, and living arrangement as enabling factors; and physical mobility status, current self-rated health (SRH), and SRH compared to previous year as the need variables, which are likely to affect hospitalization in the older population. These variables were dichotomized for all analyses.

Statistical methods

Descriptive analyses were used to examine the change in hospitalization rate for all diseases, NCDs, and CDs at both aggregate and subgroup levels for all ages, and the change in the composition of the older population in India between 1995 and 2014.

A logit model was used to evaluate the effect of covariates on the probability of hospitalization in the older population. The model employed was of the form:

$$Ln[P_i/(1- P_i)]= \sum \beta_i X_i \qquad (1)$$

where $Ln[P_i/(1- P_i)]$ was the log odds of hospitalization, X_i was a vector of explanatory variables, and β_i was a vector of regression coefficients. The model was checked for multicollinearity. Fit of the model was assessed using the p-value of the F-adjusted mean residual goodness-of-fit statistic. A p-value below 0.05 was not considered a good fit.

A regression decomposition technique was used to decompose the change in hospitalization rate into its constituent parts.[29-31] A multivariate logit model was estimated for each period. For example, the equation for the period 1995–96 was

$$Ln[P_i/(1-P_i)]_{(1995–96)} = \beta_0 + \beta_i X_{i(1995–96)} + \cdots\cdots\cdots\cdots + \beta_n X_{n(1995–96)}$$

[1] Caste in India is a social stratification of communities into 4 groups, namely scheduled castes (SCs), scheduled tribes (STs), other backward castes, and other castes. SC/STs are officially designated disadvantaged groups in India.

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$$i=1,2,3,4\cdots\cdots\cdots\cdots n \qquad (2)$$

while the equation for the period 2014 was

$$Ln[P_i/(1\text{-}P_i)]_{(2014)} = \beta_0 + \beta_i X_{i(2014)} + \cdots\cdots\cdots\cdots + \beta_n X_{n(2014)}$$

$$i=1,2,3,4\cdots\cdots\cdots\cdots n \qquad (3)$$

The difference $Ln[P_i/(1\text{-}P_i)]_{(2014)} - Ln[P_i/(1\text{-}P_i)]_{(1995\text{–}96)}$ was decomposed using equation (4), which considered 1995–96 as the base period.

$$Logit_{(2014)} - Logit_{(1995\text{–}96)} = [(\beta_{0(2014)} - \beta_{0(1995\text{–}96)}) + \sum P_{ij(1995\text{–}96)} (\beta_{ij(2014)} - \beta_{ij(1995\text{–}96)})] + \sum \beta_{ij(1995\text{–}96)} (P_{ij(2014)} - P_{ij(1995\text{–}96)}) + \cdots\cdots\cdots\cdots + \sum (\beta_{ij(2014)} - \beta_{ij(1995\text{–}96)}) (P_{ij(2014)} - P_{ij(1995\text{–}96)}) \qquad (4)$$

Where,

$P_{ij(2014)}$ = Proportion of j^{th} category of the i^{th} covariate in NSS 2014

$P_{ij(1995\text{–}96)}$ = Proportion of j^{th} category of the i^{th} covariate in NSS 1995–96

$\beta_{ij(2014)}$ = Coefficient for the j^{th} category of the i^{th} covariate in NSS 2014

$\beta_{ij(1995\text{–}96)}$ = Coefficient for the j^{th} category of the i^{th} covariate in NSS 1995–96

$\beta_{0(2014)}$ = Regression constant in NSS 2014

$\beta_{0(1995\text{–}96)}$ = Regression constant in NSS 1995–96

This procedure yields three components: 1) propensity defined as the change brought by variation in the impact of determinants; 2) composition defined as the change due to variation in the proportion of determinants, and 3) interaction which reflects the change as a result of the interplay between compositional and propensity change.[32] We used p-values for the Wald test to assess the difference between the coefficients from the two logit models. The estimates were generated using survey sampling weights, and the survey design features including the cluster design effect were taken into account to calculate the 95% confidence intervals (95% CI).

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RESULTS

Hospitalization trends and differentials

The annual hospitalization rate per 1000 increased 2.23 times between 1995 and 2014; the increase was higher for NCDs than CDs (3.61 vs 2.25 times) (Table 1). The contribution of NCDs to total hospitalization increased from 38.6% in 1995–96 to 62.2% in 2014. The hospitalization rate increased with age, and was highest for the population aged 70 years or more. The hospitalization rate increased 2.21 times for older population, and 2.01 times for population under 60 years between 1995 and 2014. When compared to younger population, the older population had more than three times higher hospitalization rates, and a greater proportion of hospitalizations for NCDs.

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Table 1 Hospitalization rate per 1000 (95% CI) by age and disease groups in NSS 1995–96, NSS 2004 and NSS 2014, India

	Hospitalization rates per 1000 (95% CI)			Estimated hospitalized cases (in millions) (%)
Age (years)	NCDs	CDs	All diseases	
		NSS 1995–96		
0-4	2.2 (1.8-2.6)	7.8 (7.0-8.6)	14.1 (12.9-15.3)	1.4 (9.7)
5-14	2.0 (1.8-2.3)	3.0 (2.7-3.3)	6.8 (6.3-7.2)	1.4 (10.3)
15-29	3.6 (3.3-3.9)	6.0 (5.5-6.4)	13.9 (13.2-14.7)	3.1 (22.0)
30-44	6.8 (6.3-7.3)	6.0 (5.5-6.5)	17.8 (17.0-18.6)	2.9 (20.5)
45-59	14.1 (12.9-15.2)	6.4 (5.7-7.2)	28.0 (26.4-29.5)	2.9 (20.5)
60-69	24.4 (22.0-26.8)	8.6 (7.2-10.0)	42.2 (39.2-45.2)	1.2 (8.9)
70 or more	35.7 (31.1-40.3)	11.1 (8.5-13.7)	61.8 (55.9-67.7)	1.1 (8.1)
Under 60 years	5.0 (4.8-5.2)	5.5 (5.2-5.7)	14.6 (14.2-15.0)	11.6 (83.0)
60 years or more	28.7 (26.4-31.0)	9.5 (8.2-10.8)	49.7 (46.8-52.7)	2.4 (17.0)
All ages	6.4 (6.1-6.6)	5.7 (5.5-5.9)	16.6 (16.2-17.0)	14.0 (1.7)
		NSS 2004		
0-4	4.4 (3.8-4.9)	15.0 (13.8-16.1)	23.9 (22.5-25.4)	2.6 (9.5)
5-14	4.0 (3.6-0.5)	5.6 (5.2-6.1)	11.8 (11.1-12.5)	2.7 (9.9)
15-29	10.3 (9.7-10.9)	5.9 (5.5-6.4)	21.4 (20.5-22.2)	5.4 (19.9)
30-44	15.8 (15.0-16.6)	7.5 (6.8-8.2)	29.7 (28.5-30.9)	5.7 (21.0)
45-59	30.1 (28.6-31.6)	10.5 (9.6-11.3)	47.8 (45.9-49.6)	5.6 (20.5)
60-69	45.2 (42.1-48.2)	12.2 (10.7-13.8)	65.7 (62.1-69.3)	2.9 (10.6)
70 or more	70.0 (65.0-74.9)	13.7 (11.7-15.6)	95.9 (90.3-101.6)	2.3 (8.5)
Under 60 years	11.7 (11.4-12.1)	7.9 (7.6-8.2)	24.5 (24.0-24.9)	21.9 (80.8)
60 years or more	54.0 (51.3-56.6)	12.7 (11.5-14.0)	76.4 (73.3-79.5)	5.2 (19.2)
All ages	14.7 (14.4-15.1)	8.3 (8.0-8.6)	28.2 (27.7-28.7)	27.2 (2.8)
		NSS 2014		
0-4	8.3 (7.3-9.3)	25.0 (23.3-26.7)	34.2 (32.3-36.2)	3.4 (8.2)
5-14	6.6 (5.8-7.3)	7.6 (7.0-8.1)	14.4 (13.5-15.4)	3.3 (7.8)
15-29	11.6 (10.8-12.4)	12.2 (11.5-12.9)	24.6 (23.5-25.7)	7.5 (17.9)
30-44	22.1 (20.9-23.3)	11.1 (10.2-12.1)	34.6 (33.0-36.1)	8.4 (20.2)
45-59	41.7 (39.7-43.7)	13.1 (11.8-14.3)	56.5 (54.2-58.9)	9.2 (22.2)
60-69	72.8 (68.0-77.7)	17.1 (15.0-19.3)	92.2 (86.8-97.5)	5.3 (12.7)
70 or more	116.2 (107.4-124.9)	20.8 (18.2-23.4)	141.2 (131.9-150.5)	4.6 (11.0)
Under 60 years	17.4 (16.9-17.9)	12.3 (11.9-12.7)	30.7 (30.0-31.4)	31.8 (76.4)
60 years or more	88.5 (84.1-92.9)	18.4 (16.8-20.1)	109.9 (105.1-114.7)	9.8 (23.6)
All ages	23.1 (22.5-23.7)	12.8 (12.4-13.2)	37.0 (36.3-37.7)	41.6 (3.7)

CI, confidence intervals; NSS, national sample survey.

Males and females under 60 years had similar hospitalization rates, while the older males had 64% higher hospitalization rate than the older females in 1995–96 (Fig.1). The gender gap reduced for the older population by 2014 because of the higher increase in hospitalization rate for the females compared to the males (2.71 vs 1.89 times). As compared to poor, amongst older population, the non-poor had 62% higher hospitalization rate, while amongst population under 60 years, the non-poor had 36% higher hospitalization rate in 2014. In 1995–96, the urban residents aged 60 years or more had 71% higher hospitalization rate than the rural residents, which declined to 34% higher in 2014. As compared to the less

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developed states, the hospitalization rate in the more developed states was 2.82 times higher for the older population and 2.07 times higher for those under 60 years; however, the differential become similar by 2014.

The more developed states had 2.21 times and 1.86 times higher hospitalization rate than the less developed states in 1995–96 and 2014, respectively (Table 2). Between 1995 and 2014, the increase in hospitalization rate was higher in the less developed compared to the more developed states, more so for the older population for all diseases (3.12 vs 1.89 times), NCDs (4.50 vs 2.63 times), and CDs (2.59 vs 1.66 times). The hospitalization rate for older population by disease groups in the major states of India is shown for 1995–96, 2004 and 2014 in Table S3.

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Table 2 Hospitalization rates per 1000 (95% CI) by disease groups in the less and more developed states in NSS 1995–96, NSS 2004 and NSS 2014, India

	Hospitalization rates per 1000 (95% CI)								
	60 years or more								
	NSS 1995–96			NSS 2004			NSS 2014		
States	All hospitalizations	NCDs	CDs	All hospitalizations	NCDs	CDs	All hospitalizations	NCDs	CDs
Less developed	25.1 (22.3-27.9)	13.6 (12.1-15.1)	5.8 (4.0-7.6)	41.6 (38.4-44.9)	28.6 (25.8-31.4)	7.3 (6.2-8.4)	78.4 (71.3-85.5)	61.2 (54.6-67.8)	15.0 (12.7-17.2)
More developed	70.9 (66.1-75.8)	41.7 (37.7-45.8)	12.7 (10.8-14.6)	104.6 (99.8-109.4)	74.6 (70.4-78.7)	17.1 (15.1-19.1)	134.3 (128.0-140.7)	109.7 (103.9-115.5)	21.1 (18.8-23.5)
India	49.7 (46.8-52.6)	28.7 (26.5-31.0)	9.5 (8.2-10.8)	76.4 (73.4-79.4)	54.0 (51.4-56.5)	12.7 (11.5-13.9)	109.9 (105.2-114.5)	88.5 (84.2-92.8)	18.4 (16.8-20.1)
	Under 60 years								
	NSS 1995–96			NSS 2004			NSS 2014		
States	All hospitalizations	NCDs	CDs	All hospitalizations	NCDs	CDs	All hospitalizations	NCDs	CDs
Less developed	9.4 (8.9-9.8)	2.9 (2.7-3.1)	3.7 (3.4-4.0)	15.7 (15.2-16.1)	7.3 (7.0-7.6)	5.2 (4.9-5.4)	22.3 (21.5-23.1)	11.8 (11.2-12.4)	9.9 (9.4-10.4)
More developed	19.5 (18.9-20.1)	7.0 (6.6-7.3)	7.1 (6.7-7.4)	33.1 (32.3-34.0)	16.1 (15.5-16.7)	10.5 (10.0-11.1)	39.9 (38.8-40.9)	23.5 (22.6-24.4)	15.0 (14.3-15.6)
India	14.6 (14.2-15.0)	5.0 (4.8-5.2)	5.5 (5.2-5.7)	24.5 (24.0-24.9)	11.7 (11.4-12.1)	7.9 (7.6-8.2)	30.7 (30.0-31.4)	17.4 (16.9-17.9)	12.3 (11.9-12.7)
	All ages								
	NSS 1995–96			NSS 2004			NSS 2014		
States	All hospitalizations	NCDs	CDs	All hospitalizations	NCDs	CDs	All hospitalizations	NCDs	CDs
Less developed	10.2 (9.8-10.6)	3.5 (3.3-3.7)	3.8 (3.6-4.1)	17.5 (17.0-18.0)	8.7 (8.4-9.0)	5.4 (5.1-5.6)	26.1 (25.2-27.0)	15.2 (14.4-15.9)	10.2 (9.7-10.7)
More developed	22.5 (21.9-23.1)	9.0 (8.6-9.4)	7.4 (7.0-7.7)	38.7 (37.8-39.6)	20.6 (20.0-21.3)	11.1 (10.6-11.6)	48.6 (47.5-49.8)	31.5 (30.5-32.4)	15.6 (14.9-16.2)
India	16.6 (16.2-17.0)	6.4 (6.1-6.6)	5.7 (5.5-5.9)	28.2 (27.7-28.7)	14.7 (14.4-15.1)	8.3 (8.0-8.6)	37.0 (36.3-37.7)	23.1 (22.5-23.7)	12.8 (12.4-13.2)

CI, confidence intervals, NSS, national sample survey.

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Between 1995 and 2014, the hospitalization in public hospitals declined from 44.9% to 38.4% (Table 3). The use of public hospitals was higher in the less developed than the more developed states in 2014 (47.6% vs 33.2%). Poor were hospitalized more in public hospitals; this differential was higher in the more developed (40.7% vs 22.9%) compared to the less developed states (54.3% vs 40.1%) in 2014. In less developed states, the decline in the use of public hospitals was higher for the non-poor than the poor (-25.3% vs -16.7%), while in the more developed states, both non-poor and poor showed a similar decline. The hospitalization in public hospitals for the older population in the major states of India for 1995–96, 2004 and 2014 is presented in Table S4.

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Table 3 Hospitalization rates per 1000 (95% CI) in public hospitals by economic status in the less and more developed states in NSS 1995–96, NSS 2004 and NSS 2014, India

	Hospitalization rates per 1000 (95% CI) in public hospitals								
	60 years or more								
	NSS 1995–96			NSS 2004			NSS 2014		
States	Non-poor	Poor	Total	Non-poor	Poor	Total	Non-poor	Poor	Total
Less developed	53.3 (45.6-60.8)	64.8 (56.0-72.7)	57.1 (51.3-62.6)	38.7 (33.6-44.2)	59.5 (54.9-63.9)	48.9 (45.0-52.9)	36.0 (30.4-41.9)	55.0 (48.9-60.9)	45.2 (40.9-49.6)
More developed	27.2 (23.6-31.1)	52.4 (46.9-57.8)	38.5 (35.0-42.1)	28.1 (25.0-31.3)	42.6 (39.4-45.8)	36.1 (33.9-38.4)	20.7 (18.0-23.6)	41.1 (38.2-44.1)	31.6 (29.5-33.8)
India	34.1 (30.4-37.9)	54.6 (49.9-59.2)	42.7 (39.7-45.8)	30.9 (28.3-33.6)	46.3 (43.6-49.1)	39.2 (37.3-41.2)	25.8 (23.2-28.4)	45.2 (42.5-47.9)	35.9 (33.9-37.8)
	Under 60 years								
	NSS 1995–96			NSS 2004			NSS 2014		
States	Non-poor	Poor	Total	Non-poor	Poor	Total	Non-poor	Poor	Total
Less developed	53.8 (51.1-56.4)	65.3 (60.6-69.7)	58.0 (55.6-60.4)	43.5 (41.4-45.6)	51.7 (49.6-53.8)	47.8 (46.3-49.3)	41.3 (38.7-43.9)	54.2 (51.7-56.7)	48.2 (46.4-50.0)
More developed	30.0 (28.3-31.9)	51.9 (49.6-54.2)	40.0 (38.5-41.5)	28.1 (26.4-29.9)	44.1 (42.4-45.8)	38.0 (36.7-39.2)	23.7 (21.8-25.6)	40.6 (38.9-42.3)	33.7 (32.4-35.1)
India	37.9 (36.3-39.4)	55.3 (53.2-57.4)	45.4 (44.1-46.7)	33.8 (32.4-35.1)	46.2 (44.9-47.6)	41.1 (40.1-42.1)	30.9 (29.4-32.5)	45.4 (44.0-46.9)	39.2 (38.2-40.3)
	All ages								
	NSS 1995–96			NSS 2004			NSS 2014		
States	Non-poor	Poor	Total	Non-poor	Poor	Total	Non-poor	Poor	Total
Less developed	53.7 (51.2-56.2)	65.2 (61.0-69.2)	57.9 (55.7-60.0)	42.5 (40.5-44.5)	52.5 (50.6-54.5)	47.7 (46.3-49.1)	40.1 (37.7-42.6)	54.3 (52.0-56.6)	47.6 (45.9-49.3)
More developed	29.5 (27.9-31.1)	52.0 (49.8-54.1)	39.7 (38.3-41.1)	28.0 (26.5-29.6)	43.7 (42.3-45.3)	37.5 (36.4-38.6)	22.9 (21.3-24.5)	40.7 (57.8-60.7)	33.2 (32.1-34.3)
India	37.2 (35.8-38.7)	55.2 (53.3-57.1)	44.9 (43.7-46.1)	33.1 (31.9-34.3)	46.2 (44.9-47.4)	40.6 (39.8-41.5)	29.6 (28.3-31.0)	45.4 (44.1-46.6)	38.4 (37.5-39.4)

CI, confidence intervals, NSS, national sample survey.

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All subgroups of the older population showed a significant increase in hospitalization rates, but there was considerable variation in the amount of change (Table 4). Between 1995 and 2014, the increase in hospitalization rate was higher for females (2.82 vs 1.87 times), single (3.04 vs 1.89 times), poor (2.72 vs 1.87 times), illiterate (2.45 vs 1.77 times), rural residents (2.32 vs 1.88 times), and those living in the less developed states (3.07 vs 1.95 times) compared to their respective counterparts. This reduced the differential in hospitalization rate by gender, marital status, economic status, place of residence, and states.

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Table 4 Hospitalization rate per 1000 (95% CI) for older population by background characteristics in NSS 1995–96, NSS 2004 and NSS 2014, India

Background characteristics	Hospitalization rates per 1000 (95% CI)		
Predisposing variables	**NSS 1995–96**	**NSS 2004**	**NSS 2014**
Age (years)			
60-69	37.6 (34.8-40.5)	62.2 (58.8-65.6)	82.6 (77.6-87.6)
70 or more	53.1 (47.8-58.4)	90.6 (85.3-96.0)	124.4 (116.4-132.4)
Sex			
Male	53.9 (49.3-58.4)	80.3 (76.3-84.2)	101.0 (95.5-106.6)
Female	33.3 (30.4-36.1)	63.7 (59.5-67.9)	94.0 (87.5-100.5)
Marital status			
Currently married	50.8 (46.8-54.9)	75.6 (72.0-79.1)	95.9 (91.2-100.7)
Single	32.9 (29.8-36.0)	66.8 (61.9-71.6)	100.1 (91.8-108.4)
Caste			
Non-SC/STs	46.7 (43.5-50.0)	78.8 (75.3-82.2)	105.2 (100.0-110.4)
SC/STs	32.9 (28.4-37.3)	50.7 (45.8-55.5)	71.8 (65.8-77.9)
Education			
Literate	65.9 (60.7-71.1)	106.3 (100.6-112.0)	116.7 (110.2-123.2)
Illiterate	34.0 (30.9-37.2)	54.2 (50.9-57.5)	83.2 (77.5-88.8)
Enabling variables			
Place of residence			
Urban	63.1 (58.7-67.4)	99.5 (92.8-106.3)	118.6 (111.2-126.0)
Rural	37.9 (34.7-41.1)	63.2 (60.0-66.3)	87.8 (82.6-93.1)
States			
More developed	62.1 (57.8-66.5)	98.4 (93.8-103.0)	121.0 (114.9-127.1)
Less developed	21.8 (19.0-24.5)	39.5 (36.4-42.6)	67.0 (61.2-72.9)
Economic dependency			
Economically independent	35.8 (30.9-40.8)	63.2 (58.9-67.5)	89.2 (80.2-98.2)
Economically dependent	47.2 (44.0-50.4)	77.9 (74.1-81.7)	100.7 (96.0-105.5)
Economic status			
Non-poor	68.6 (62.6-74.6)	94.9 (89.2-100.6)	128.2 (119.1-137.4)
Poor	29.4 (26.9-31.9)	59.8 (56.5-63.0)	80.1 (75.8-84.3)
Living arrangement			
With family	44.2 (41.4-47.0)	74.1 (71.1-77.1)	95.3 (91.4-99.3)
Alone	31.1 (22.2-40.0)	54.0 (41.1-67.0)	146.2 (99.3-193.2)
Need variables			
Physical mobility status			
Mobile	38.0 (35.4-40.7)	62.5 (59.8-65.3)	84.3 (80.3-88.3)
Immobile	91.3 (78.8-103.7)	193.9 (175.0-212.8)	249.4 (222.3-276.5)
Current self-rated health (SRH)			
Good	31.2 (28.9-33.4)	54.3 (51.5-57.1)	67.8 (63.8-71.7)
Poor	96.9 (86.4-107.4)	138.3 (129.5-147.1)	200.2 (186.8-213.7)
SRH compared to previous year			
Better or same	31.9 (29.4-34.5)	57.4 (54.6-60.1)	70.1 (66.0-74.3)
Worse	78.3 (70.7-85.9)	138.9 (128.9-148.9)	179.5 (167.8-191.2)
Total	43.4 (40.8-46.1)	72.0 (69.1-74.8)	97.5 (93.2-101.7)

CI, confidence intervals; NSS, national sample survey; SC/STs, scheduled castes/scheduled tribes are officially designated disadvantaged groups in India.

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Compositional change

Most of the older population lived in rural areas, but their proportion decreased by 9.3 percentage points (78.1 % to 68.8%) between 1995 and 2014 (Table 5). There was 5.2 percentage points (58.3% in 1995–96 to 63.4% in 2014) increase in the proportion of currently married older population. Literacy in the older population increased by 13.0 percentage points by 2014. In 1995–96, most of the older population were physically mobile (89.5%), less than 70 years of age (62.5%), resident of the more developed states (53.7%), economically dependent (68.9%), and reported good SRH (80.8%), with only marginal change in their proportions. The majority of the older population were non-SC/STs (76.4%), poor (64.2%), living with family (95.6%), and reporting better or nearly same SRH compared to past year (74.3%) in 1995–96 and their proportion remained unchanged in 2014.

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Table 5 Background characteristics of the older population in NSS 1995–96, NSS 2004 and NSS 2014, India

Background characteristics	NSS 1995–96		NSS 2004		NSS 2014	
Predisposing variables	**N**	**% (95% CI)**	**N**	**% (95% CI)**	**N**	**% (95% CI)**
Age (years)						
60-69	21,124	62.5 (61.6-63.4)	22,546	65.3 (64.6-66.0)	17,160	64.5 (63.2-65.8)
70 years or more	12,866	37.5 (36.6-38.4)	12,264	34.7 (34.0-35.4)	10,085	35.5 (34.2-36.8)
Sex						
Male	17,173	49.4 (48.5-50.4)	17,750	50.0 (49.3-50.8)	13,692	49.2 (47.8-50.6)
Female	16,817	50.6 (49.6-51.5)	17,081	50.0 (49.2-50.7)	13,553	50.8 (49.4-52.2)
Marital status						
Currently married	20,111	58.3 (57.3-59.2)	20,959	59.2 (58.5-60.0)	17,947	63.4 (62.1-64.7)
Single	13,852	41.7 (40.8-42.7)	13,872	40.8 (40.0-41.5)	9,298	36.6 (35.3-37.9)
Caste						
Non-SC/STs	26,089	76.4 (75.6-77.2)	26,291	76.0 (75.3-76.6)	20,823	76.8 (75.6-77.9)
SC/STs	7,880	23.6 (22.8-24.4)	8,531	24.0 (23.4-24.7)	6,422	23.2 (22.1-24.4)
Education						
Literate	12,406	29.5 (28.7-30.4)	13,514	34.2 (33.5-34.9)	13,362	42.6 (41.2-43.9)
Illiterate	21,543	70.5 (69.6-71.3)	21,301	65.8 (65.1-66.5)	13,883	57.4 (56.1-58.8)
Enabling variables						
Place of residence						
Urban	13,035	21.9 (21.3-22.5)	12,566	24.3 (23.7-24.9)	12,226	31.2 (30.0-32.4)
Rural	20,955	78.1 (77.5-78.7)	22,265	75.7 (75.1-76.3)	15,019	68.8 (67.6-70.0)
States						
More developed	17,389	53.7 (52.8-54.7)	17,019	55.2 (54.4-55.9)	14,466	56.3 (54.9-57.6)
Less developed	16,601	46.3 (45.3-47.2)	17,812	44.8 (44.1-45.6)	12,779	43.7 (42.4-45.1)
Economic dependency						
Economically independent	10,149	31.1 (30.2-32.0)	11,800	34.0 (33.3-34.7)	7,159	28.3 (27.0-29.6)
Economically dependent	23,061	68.9 (68.0-69.8)	22,429	66.0 (65.3-66.7)	20,075	71.7 (70.4-73.0)
Economic status						
Non-poor	15,407	35.8 (35.0-36.7)	14,372	34.8 (34.1-35.5)	11,738	36.1 (34.8-37.4)
Poor	18,583	64.2 (63.3-65.0)	20,459	65.2 (64.5-65.9)	15,507	63.9 (62.6-65.2)
Living arrangement						
With Family	32,482	95.6 (95.2-96.0)	32,595	94.8 (94.4-95.1)	26,659	95.9 (95.3-96.5)
Alone	1,174	4.4 (4.0-4.8)	1,509	5.2 (4.9-5.6)	586	4.1 (3.5-4.7)
Need variables						
Physical mobility status						
Mobile	29,697	89.5 (88.9-90.1)	30,821	91.9 (91.5-92.3)	24,499	92.0 (91.3-92.7)
Immobile	3,635	10.5 (9.9-11.1)	3,224	8.1 (7.7-8.5)	2,735	8.0 (7.3-8.7)
Current self-rated health (SRH)						
Good	27,263	80.8 (79.9-81.5)	24,965	76.4 (75.7-77.0)	20,143	77.6 (76.4-78.7)
Poor	6,217	19.2 (18.5-20.1)	8,216	23.6 (23.0-24.3)	7,091	22.4 (21.3-23.6)
SRH compared to previous year						
Better or same	25,018	74.3 (73.4-75.1)	25,971	79.3 (78.7-79.9)	19,590	75.0 (73.8-76.2)
Worse	8,430	25.7 (24.9-26.6)	7,210	20.7 (20.1-21.3)	7,644	25.0 (23.8-26.2)
N	33,990		34,831		27,245	

CI, confidence intervals; NSS, national sample survey; SC/STs, scheduled castes/scheduled tribes are officially designated disadvantaged groups in India.

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Determinants of hospitalization

Older population reporting poor SRH (AOR 2.42 95% CI 1.91-3.07) and living alone (AOR 2.13 95% CI 1.44-3.16) had the highest odds of hospitalization in 1995–96 and 2014, respectively (Table 6). Poor older population were 59% (95% CI 0.35-0.48) and 37% (95% CI 0.55-0.72) less likely to be hospitalized in 1995–96 and 2014, respectively. The economically dependent older population was 32% (95% CI 1.08-1.62) more likely to be hospitalized in 1995–96. Older population living in the less developed states had lower odds of hospitalization in 1995–96 (AOR 0.34 95% CI 0.29- 0.40) and 2014 (AOR 0.54 95% CI 0.47-0.61). In 1995–96, female and single older population were 30% (95% CI 0.60-0.83) and 34% (95% CI 0.57-0.77) less likely to be hospitalized, respectively. The older population belonging to SC/STs had lower odds of hospitalization (AOR 0.81, 95% CI 0.70-0.94) compared to non-SC/STs in 2014. In 2014, physically immobile and those reporting SRH worse than previous year had 85% (95% CI 1.15-2.27) and 67% (95% CI 1.44-1.94) higher odds of being hospitalized, respectively. After adjusting for the covariates, age and place of residence were not significantly associated with hospitalization.

Between 1995 and 2014, there was a modest increase in intercept for the outcome variable suggesting that when all the explanatory variables in the logit model were set equal to their reference categories, the probability of hospitalization was significantly higher in 2014 than in 1995–96 for the older population. Comparison of 1995–96 and 2014 coefficients showed the convergence of differentials in hospitalization by gender, marital status, economic status, living arrangement, and states (Table 6).

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Table 6 Determinants of hospitalization for the older population in NSS 1995–96 and NSS 2014, India

Background characteristics	Whether hospitalized							
	$\beta_{1995-96}$	Exp ($\beta_{1995-96}$)	95% CI for Exp ($\beta_{1995-96}$)	β_{2014}	Exp (β_{2014})	95% CI for Exp (β_{2014})	β_{2014} -$\beta_{1995-96}$	p-Value for Wald test (β_{2014} -$\beta_{1995-96}$)
Predisposing variables								
Age (years) (ref.=60 – 69)								
70 years or more	-0.028	0.97	[0.83 - 1.14]	0.124	1.13	[0.99 - 1.29]	0.152	0.147
Sex (ref.=male)								
Female	-0.352	0.70	[0.60 - 0.83]	-0.050	0.95	[0.83 - 1.10]	0.302	0.006
Marital Status (ref.=currently married)								
Single	-0.416	0.66	[0.57 - 0.77]	-0.130	0.88	[0.76 - 1.02]	0.286	0.009
Caste (ref.=non-SC/STs)								
SC/STs	0.017	1.02	[0.84 - 1.23]	-0.211	0.81	[0.70 - 0.94]	-0.229	0.060
Literacy status (ref.= literate)								
Illiterate	-0.278	0.76	[0.63 - 0.91]	-0.224	0.80	[0.70 - 0.92]	0.055	0.645
Enabling variables								
Place of residence (ref.= urban)								
Rural	-0.112	0.89	[0.76 - 1.04]	-0.032	0.97	[0.85 - 1.11]	0.080	0.446
States (ref.= more developed)								
Less developed	-1.070	0.34	[0.29 - 0.40]	-0.619	0.54	[0.47 - 0.61]	0.451	<0.001
Economic dependence (ref.= independent)								
Economically dependent	0.281	1.32	[1.08 - 1.62]	0.004	1.00	[0.85 - 1.18]	-0.277	0.035
Economic status (ref.=non-poor)								
Poor	-0.895	0.41	[0.35 - 0.48]	-0.462	0.63	[0.55 - 0.72]	0.432	<0.001
Living arrangement (ref.= living with family)								
Living alone	0.197	1.22	[0.85 - 1.74]	0.757	2.13	[1.44 - 3.16]	0.560	0.039
Need variables								
Physical mobility status (ref.= mobile)								
Immobile	0.400	1.49	[1.21 - 1.84]	0.617	1.85	[1.51 - 2.27]	0.217	0.149
Current self-rated health (ref.= good SRH)								
Poor SRH	0.884	2.42	[1.91 - 3.07]	0.736	2.09	[1.78 - 2.44]	-0.149	0.306
SRH compared to last year (ref.= better or nearly the same)								
Worse SRH	0.475	1.61	[1.31 - 1.98]	0.515	1.67	[1.44 - 1.94]	0.039	0.763
Constant	-2.466	0.08	[0.07 - 0.10]	-2.238	0.11	[0.09 - 0.12]	0.228	0.037
F-adjusted test statistic	1.61			0.81				
p-Value	0.106			0.611				
N	32,780			27,234				

CI, confidence intervals; NSS, national sample survey; SC/STs, scheduled castes/scheduled tribes are officially designated disadvantaged groups in India.

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Decomposition of increase in hospitalization rate

For the older population in India, the propensity change explained 86.6% of the increase in hospitalization rate between 1995 and 2014 (Table 7). The improved propensity to use hospital care by economically poor, residents of the less developed states, females, and singles contributed 16.4%, 12.3%, 9.0%, and 7.1% of the increase in hospitalization rate, respectively, regardless of the change in their composition. The change in intercept accounted for 13.5% of the increase in hospitalization rate. Change in the composition of the characteristics of older population had a modest influence on the level of hospitalization; contributing 9.2% of the increase in hospitalization. Many of the changes in the population structure during the inter-survey period favoured increased hospitalization, except gender and physical mobility status. The increase in the proportion of literates, those reporting poor SRH, economically dependent, and single contributed 2.1%, 1.7%, 1.6%, and 1.3% of the increase in hospitalization rate, respectively between 1995 and 2014, regardless of the change in the likelihood of hospitalization by the subgroups.

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Table 7 Decomposition of increase in hospitalization for the older population between 1995 and 2014, India

	Contribution to the increase in hospitalization (%)*		
Background characteristics	**Propensity**	**Composition**	**Interaction**
70 years or more	0.06 (3.4)	0.00 (0.0)	0.00 (-0.2)
Female	0.15 (9.0)	0.00 (-0.1)	0.00 (0.0)
Single	0.12 (7.1)	0.02 (1.3)	-0.01 (-0.9)
SC/STs	-0.05 (-3.2)	0.00 (0.0)	0.00 (0.0)
Illiterate	0.04 (2.3)	0.04 (2.1)	-0.01 (-0.4)
Rural	0.06 (3.7)	0.01 (0.6)	-0.01 (-0.4)
Less developed states	0.21 (12.3)	0.03 (1.6)	-0.01 (-0.7)
Economically dependent	-0.19 (-11.3)	0.01 (0.5)	-0.01 (-0.5)
Economically poor	0.28 (16.4)	0.00 (0.1)	0.00 (-0.1)
Living alone	0.02 (1.4)	0.00 (0.0)	0.00 (-0.1)
Physically immobile	0.02 (1.3)	-0.01 (-0.6)	-0.01 (-0.3)
Poor SRH	-0.03 (-1.7)	0.03 (1.7)	0.00 (-0.3)
Worse SRH than previous year	0.01 (0.6)	0.00 (-0.2)	0.00 (0.0)
Intercept	0.23 (13.5)		
% contribution to the overall increase	86.6	9.2	4.2

*Percent contribution has been calculated as the ratio of the contribution of the covariate and the sum of the absolute contribution of covariates under the propensity, composition and interaction components multiplied by 100; SC/STs, scheduled castes/scheduled tribes are officially designated disadvantaged groups in India.

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DISCUSSION

This report provides evidence on trends in hospitalization rates in India over two decades up to 2014, and compares the older population with population under 60 years. Five key findings relating to hospitalization trends and differentials emerge from this study. First, the hospitalization rate increased two-fold between 1995 and 2014; the increase was higher for NCDs and in less developed states. Second, poor people used more public hospitals; this differential was higher in the more developed than the less developed states. Third, the older population had higher hospitalization rates and greater proportion of hospitalization for NCDs than the population under 60 years. Fourth, amongst the older population, the hospitalization rate was comparatively lower for females, poor, and rural residents. Fifth, propensity change was largely responsible for the increase in hospitalization among the older population in India over these two decades.

Hospitalization is an important indicator of the demand for curative care and is an integral part of any health system. The increase in hospitalization rate found in our study could be due to the growing awareness about the health prevention and other precautionary measures along with proper diagnosis of the health conditions. The evidence on increasing hospitalization is vital for planning of resources to meet the growing demand for inpatient care and for formulating viable publicly funded financial risk protection mechanism. To provide targeted financial protective intervention it would also be useful to know whether the increase in hospitalization was due to higher hospitalizations for preventive care among the rich or emergency inpatient care among the poor. Data from the global burden of disease study suggests that of the total disease burden, measured as disability-adjusted life years lost in India, the contribution of noncommunicable disease and injuries has increased from 38.4% in 1990 to 64.2% in 2013.[33] The higher increase in hospitalization for NCDs over two decades is consistent with the shifting disease burden trends in India.

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The developed states in India with good health indicators are usually found to report higher use of healthcare.[10 22] Higher hospitalization rate in the more developed states of India may indicate a higher volume of health services provided by health sector, rather than reflect higher morbidity prevalence. Interestingly, we found that the increase in hospitalization rate between 1995 and 2014 was more pronounced in the less developed than the more developed states. A plausible reason for this could be the increased burden of chronic, degenerative, and lifestyle diseases in the less developed states because of their advancement through the health transition process. Other factors contributing to this could be the greater availability of health services, better access to healthcare, or the increased propensity to use healthcare.

The increase in the use of private hospitals over two decades in India is a matter of concern from the equity point of view and has cost implications for the poor. The continuing inadequacies of the public health system and the unrestricted growth of private providers are possible reasons for the decline in the use of public hospitals. The decline in the use of public hospitals was found to be higher for the non-poor in the less developed states, which implies that in spite of decline, the poor in the less developed states still largely use public hospitals. The increasing provision of inpatient care in private hospitals and the consequent decline in the utilization of public hospitals is likely to impose a higher financial risk on individuals and households.[34 35] Strengthening the public funding model of service delivery in India would increase the ability of public facilities to meet the increasing demand for healthcare and thereby improve the utilization of inpatient care by the poor.

Our results indicated clear distinction in levels and differentials in hospitalization rate between older population and population under 60 years. The older population had more than three times higher hospitalization than any other age groups. Contributing 8.6% to India's population, older population accounted for nearly one-fourth of all hospital stays in 2014. The improved longevity coupled by the increased years of poor health at older ages is

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predominantly responsible for the difference between the hospitalization rates of the two age groups. Data from the global burden of disease study suggest that in India in 1990, disease burden among the older population accounted for 11.8% of the total disease burden. In 2013, this burden had increased to 22.3% of the total disease burden, and noncommunicable diseases and injuries made up 82.3% of the total disease burden.[33] Our results showed that the contribution of the older population in total hospitalization increased over two decades, and they had higher hospitalization rates for NCDs in any given year. However, the hospitalizations in absolute number and their contribution in total hospitalizations remain higher for the population under 60 years. Evidence suggests that over the past 25 years the burden of premature death and health loss from NCDs such as heart disease, stroke, chronic obstructive pulmonary disease, and road traffic injuries has increased substantially, while the burden due to lower respiratory infections, tuberculosis, diarrhea and neonatal disorders remains high in India.[33] For the purpose of planning of the resources for universal health coverage and reducing premature mortality it is important to continue focusing on the child and adult population which account for majority of India's population. At the same time, given the increasing proportion of older population it is equally important to allocate resources and provide healthcare services to cater to their specific healthcare needs.

In the population under 60 years, there was no evidence for gender differential, while, in the older population, a higher proportion of males were hospitalized. Studies from the developed nations have also found that the older women have less hospital stays than their male counterparts.[15 36-39] Greater economic dependency among females at older ages is a major driver of the gender differential in healthcare use in India.[20] On a positive note, we found that the improved likelihood of using hospital care by female older population contributed to the decline in gender differential among the older population.

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In the absence of a health financing system, low level of health insurance coverage and high out of pocket cost of healthcare, economic status becomes an important factor affecting healthcare use. We found that the non-poor had higher hospitalization rates than the poor; this differential was higher for the older population than the other ages. Based on the Andersen's model of healthcare use, we found that the poor older population had significantly less likelihood of using hospital care even after controlling for health profiles. The economic inequality in hospitalization among the older population is evident in India.[16] Older population rely more on family and other social structures for financial support, and therefore, they might not have adequate resources for hospital care. Financial empowerment of the poor older population can be one way of effectively improving the healthcare utilization.

An important finding of this study is that the propensity change has contributed most to the two-fold increase in hospitalization of the older population in India between 1995 and 2014. A plausible explanation could be better awareness of the medical conditions and health among the population.[40] A relatively higher increase in hospitalization among the poor compared to the non-poor older population has contributed most to the increase in hospitalization rate attributed to propensity change. This indicates a decline in the differentials in healthcare use by economic status over two decades. It has been argued that lowering of inequality will not make the situation more equitable for the poor if there is a high increase in the rate of hospitalization, a decline in dependence on government hospitals, and a steep hike in the cost of hospital care.[22]

The increase in hospitalization rate was moderately influenced by the factors not explicitly considered in the model. The supply side factors like the expansion of private healthcare market and consequent improvement in the availability of health services could have propelled the use of healthcare.[22] The expansion of morbidity, with a heavier and

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cumulated concentration of chronic diseases at older ages, could be another potential driver of the increase in hospitalization.[41 42] Compositional change contributed marginally to the increase in hospitalization of the older population over the past two decades. It would be interesting to see how the anticipated compositional change influences the future demand for hospitalization.

The findings of this report must be interpreted in the light of some limitations. First, we used individual determinants and did not examine the full array of determinants of healthcare use as suggested by the Andersen's model of healthcare use. Data on the supply side of healthcare provision were not available from the national sample surveys, nor were comparable data available from other secondary sources corresponding to the survey time points. Second, the use of self-reported data on diseases from the national sample surveys may be associated with biases. However, we report hospitalization trends for broad groups of diseases which may be reasonable. Even with these limitations, this study uses large-scale data from the nationwide surveys in India over two decades to provide insights into the changing hospitalization rate by age groups, and the reasons behind the increased hospitalization of the older population. Given the anticipated further increase of the older population and their higher demand for healthcare, it is time for the policy makers to pay particular attention to planning how adequate resources and mechanisms can be put in place for the provision of geriatric healthcare in India.

FIGURE LEGEND

Fig 1. Socioeconomic and demographic differentials in hospitalization rates in NSS 1995–96, NSS 2004 and NSS 2014, India

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AUTHORS' CONTRIBUTIONS

AP extracted the data, conducted statistical analysis, interpreted the findings, and wrote the first draft of the manuscript. GBP contributed to the initial concept of the paper and guided the statistical analysis. LC provided critical comments on the manuscript for intellectual content. LD provided detailed guidance on the study design, analysis, interpretation of findings and drafting of the manuscript. All authors approved the final version of the manuscript.

COMPETING INTERESTS

There are no competing interests

DATA SHARING STATEMENT

The authors confirm that all data underlying the findings are fully available without restriction. Data are publicly available and can be obtained from the Ministry of Statistics and Programme Implementation, Government of India, New Delhi: http://mospiold.nic.in/Mospi_New/site/inner.aspx?status=3&menu_id=37

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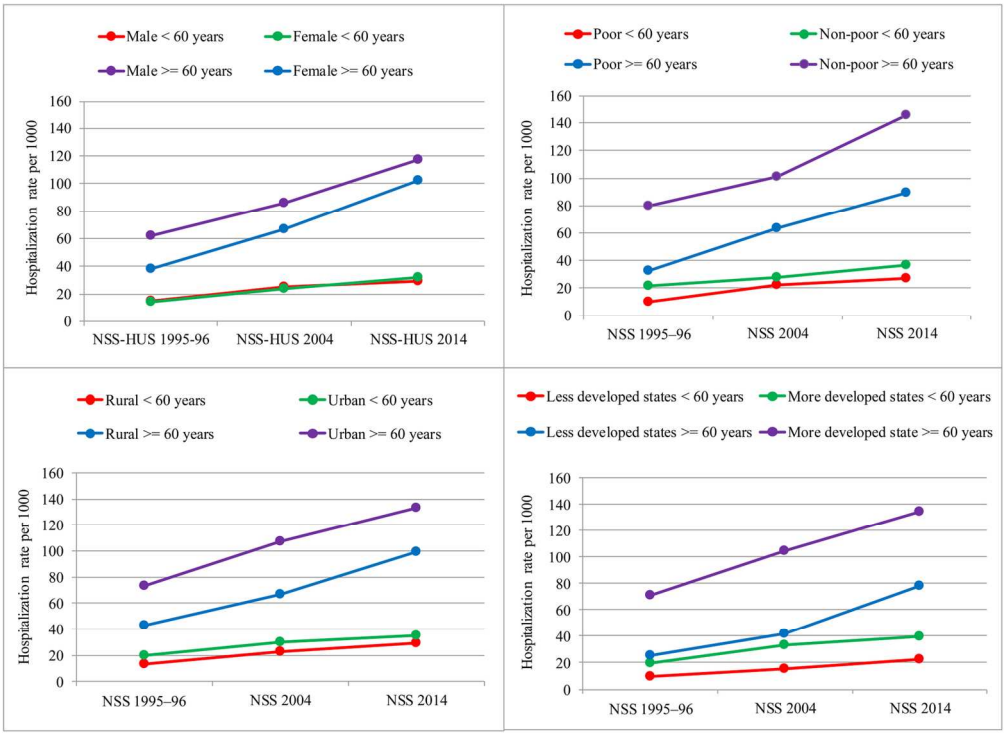

Fig 1. Socioeconomic and demographic differentials in hospitalization rates in NSS 1995–96, NSS 2004 and NSS 2014, India

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Table S1 Percent distribution of missing and deceased samples in NSS 1995–96, NSS 2004 and NSS 2014, India

Background characteristics	NSS 1995–96		NSS 2004		NSS 2014	
	N	%	N	%	N	%
	All ages					
Age	55	0.00	38	0.01	0	0.00
Sex	2	0.00	0.00	0.00	0	0.00
Place of residence	0	0.00	0.00	0.00	0	0.00
States	0	0.00	0.00	0.00	0	0.00
Economic status	0	0.00	0.00	0.00	0	0.00
N (including deceased persons)	633,405		385,055		335,499	
	60 years or more					
Marital status	27	0.12	0	0.00	0	0.00
Caste	21	0.05	9	0.01	0	0.00
Education	41	0.12	16	0.04	0	0.00
Economic dependency	780	2.29	602	1.45	11	0.01
Living arrangement	334	0.85	727	1.72	0	0.00
Physical mobility status	658	1.93	786	1.93	11	0.01
Self-rated health (SRH)	510	1.52	1,650	3.95	11	0.01
SRH compared to previous year	542	1.58	1,650	3.94	11	0.01
N (excluding deceased persons)	33,990		34,831		27,245	
% of hospitalized persons who died in 365 days reference period	1,284	3.05	736	2.32	1,152	2.18
N (including deceased persons)	35,274		35,567		28,397	

NSS, national sample survey; Caste in India is a social stratification of communities into 4 groups, namely scheduled castes (SCs), scheduled tribes (STs), other backward castes, and other castes. SC/STs are officially designated disadvantaged groups in India.

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Table S2 List of diseases grouped according to Global Burden of Disease (GBD) study categorization of diseases, 2013

Communicable diseases and nutritional disorders (CDs)	Non-communicable diseases and injuries (NCDs)
Tuberculosis	Neoplasms
STDs including HIV/AIDs	○ Cancer and other tumours
Diarrhoeal diseases	Cardiovascular and circulatory diseases
○ Cholera	○ Heart disease, Hypertension
○ Diarrhoea/dysentery/gastro-enteritis	○ Rheumatic fever
○ Amoebiosis	Chronic respiratory diseases
Respiratory infections and other common infectious disease	○ Bronchial Asthma and related conditions
○ Dengue/Influenza	Digestive diseases
○ Pneumonia	○ Gastrointestinal bleeding/piles
○ Respiratory (including ear/nose/throat) ailments	○ Gastritis/gastric/peptic ulcer
○ Cough and acute bronchitis	○ Cirrhosis/hydrocele
○ Pleurisy	○ Food poisoning
○ Meningitis and viral encephalitis	Neurological disorder:
○ Diptheria	○ Cerebral stroke
○ Pertussis/whooping cough	○ Other diseases of nerves
○ Tetanus	○ Epilepsy/headache
○ Measles/chicken pox/mumps/eruptive	○ Nervous and general debility
Neglected tropical diseases and malaria	○ Cerebral haemorrhage, thrombosis
○ Filariasis	Mental and behavioural disorders
○ Trachoma	Diabetes, urogenital, blood and endocrine diseases
○ Worm infestation/Guinea worm	○ Diabetes
○ Leprosy	○ Disease of kidney/urinary system/prostrate disorders
Neonatal and maternal disorders	○ Gynaecological disorders
Nutritional deficiencies:	○ Goiter/Thyroid disorders
○ Anemia/bleeding disorders	Musculoskeletal disorders
○ Under-nutrition	○ Disorders of joints and bones
○ Scurvy	○ Locomotor disability
○ Other malnutrition diseases (Beri-Beri , Ricket)	Other non-communicable diseases
Other communicable diseases and nutrition disorders:	Skin and subcutaneous diseases
○ Hepatitis/Jaundice/diseases of liver	Sense organ diseases
○ Fever of unknown origin/fever of short duration/malaria/typhoid	○ Glucoma
	○ Cataracts
	○ Hearing loss, adult onset
	○ Vision disorders, age related
	○ Diseases of ear/nose/throat
	○ Speech disability
	Oral disorders
	Accidents/injury/burns/fractures/poisoning
	Congenital anomalies

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Table S3 Hospitalization rates per 1000 (95% CI) for the older population by disease groups in the major states in NSS 1995–96, NSS 2004 and NSS 2014, India

States	Hospitalization rates per 1000 (95% CI)								
	NSS 1995–96			NSS 2004			NSS 2014		
	All diseases	NCDs	CDs	All diseases	NCDs	CDs	All diseases	NCDs	CDs
Less developed	25.1 (22.3-27.9)	13.6 (12.1-15.1)	5.8 (4.0-7.6)	41.6 (38.4-44.9)	28.6 (25.8-31.4)	7.3 (6.2-8.4)	78.4 (71.3-85.5)	61.2 (54.6-67.8)	15.0 (12.7-17.2)
Assam	28.9 (20.4-37.3)	16.3 (10.1-22.4)	6.2 (2.2-10.2)	35.7 (24.0-47.5)	26.6 (15.4-37.7)	5.3 (3.0-7.7)	37.0 (24.0-50.0)	29.3 (16.6-42.0)	5.9 (3.3-8.5)
Bihar	15.4 (10.7-20.1)	8.1 (5.2-11.0)	4.4 (1.0-7.9)	28.1 (24.1-32.2)	19.4 (16.2-22.7)	4.7 (3.1-6.4)	52.6 (37.2-68.1)	44.9 (29.9-59.9)	6.5 (2.9-10.1)
Madhya Pradesh	29.7 (24.4-35.0)	16.7 (12.8-20.5)	7.4 (4.6-10.2)	47.2 (39.2-55.3)	34.7 (27.3-42.2)	9.4 (6.6-12.3)	101.2 (72.9-129.5)	80.0 (53.0-106.9)	18.9 (10.4-27.4)
Odisha	44.1 (21.2-66.9)	12.0 (7.9-16.1)	14.8 (-1.0-30.5)	42.0 (32.2-51.9)	21.0 (15.7-26.4)	14.6 (6.8-22.4)	79.6 (63.3-95.8)	57.7 (42.7-72.8)	20.2 (14.3-26.2)
Rajasthan	34.3 (25.6-43.1)	21.6 (14.5-28.8)	4.6 (2.5-6.7)	56.7 (45.9-67.5)	37.0 (30.0-44.0)	6.4 (3.5-9.3)	101.9 (88.6-115.2)	75.4 (64.0-86.8)	25.2 (18.5-31.9)
Uttar Pradesh	18.6 (15.1-22.0)	11.8 (9.5-14.2)	3.4 (1.2-5.6)	38.6 (32.0-45.2)	27.7 (21.6-33.8)	5.5 (4.1-6.9)	78.5 (65.5-91.4)	62.5 (50.8-74.2)	12.7 (8.6-16.7)
Jammu & Kashmir	34.3 (15.8-52.9)	19.4 (4.6-34.1)	8.7 (-1.8-19.3)	48.5 (36.4-60.6)	39.0 (28.0-50.0)	6.3 (1.9-10.7)	68.5 (50.4-86.7)	55.9 (39.8-71.9)	11.2 (2.9-19.6)

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States	Hospitalization rates per 1000 (95% CI)								
	NSS 1995–96			NSS 2004			NSS 2014		
	All diseases	NCDs	CDs	All diseases	NCDs	CDs	All diseases	NCDs	CDs
More developed	70.9 (66.1-75.8)	41.7 (37.7-45.8)	12.7 (10.8-14.6)	104.6 (99.8-109.4)	74.6 (70.4-78.7)	17.1 (15.1-19.1)	134.3 (128.0-140.7)	109.7 (103.9-115.5)	21.1 (18.8-23.5)
Andhra Pradesh	47.0 (36.5-57.6)	30.8 (21.7-40.0)	6.2 (3.2-9.2)	65.9 (57.2-74.5)	54.4 (46.3-62.5)	5.8 (3.6-8.0)	111.2 (96.4-126.0)	94.1 (80.6-107.6)	12.9 (8.1-17.7)
Gujarat	45.9 (36.2-55.6)	18.4 (13.9-22.9)	19.3 (11.3-27.3)	102.5 (86.7-118.2)	64.6 (52.5-76.8)	27.3 (18.4-36.2)	123.7 (105.8-141.7)	98.0 (83.4-112.5)	24.9 (14.4-35.3)
Haryana	79.6 (57.0-102.1)	51.5 (33.4-69.6)	20.9 (9.1-32.7)	81.8 (57.2-106.5)	61.0 (38.5-83.5)	13.7 (5.4-22.0)	89.2 (71.5-106.8)	75.3 (58.7-91.9)	13.1 (7.1-19.1)
Karnataka	52.5 (37.8-67.2)	30.5 (18.4-42.6)	8.0 (2.6-13.3)	80.4 (68.2-92.6)	54.0 (44.7-63.3)	10.5 (5.7-15.3)	110.3 (96.9-123.7)	89.2 (76.9-101.4)	19.8 (14.6-25.1)
Kerala	200.5 (175.8-225.1)	110.5 (94.2-128.6)	39.0 (27.9-50.2)	279.1 (251.7-306.5)	190.5 (168.3-212.6)	47.0 (34.9-59.0)	281.3 (249.1-313.5)	216.2 (189.5-243.0)	51.5 (36.2-66.7)
Maharashtra	70.4 (60.3-80.5)	42.9 (3.5-618.2)	10.9 (7.6-14.2)	96.6 (85.0-108.2)	76.0 (65.1-86.8)	11.1 (8.0-14.1)	119.9 (103.1-136.7)	103.0 (86.5-119.4)	14.4 (11.1-17.7)
Punjab	45.6 (34.0-57.2)	21.7 (14.0-29.3)	4.7 (1.7-7.7)	80.7 (63.2-98.2)	58.8 (43.7-73.8)	12.5 (5.1-19.8)	103.7 (80.0-127.5)	89.5 (66.6-112.5)	12.7 (6.8-18.6)
Tamil Nadu	72.7 (52.7-92.7)	52.3 (32.8-71.89)	7.7 (5.2-10.2)	105.6 (92.0-119.2)	71.9 (60.9-82.9)	23.1 (15.8-30.4)	138.1 (118.5-157.7)	115.3 (96.6-134.0)	22.1 (16.3-27.8)
West Bengal	41.5 (33.0-50.1)	22.1 (17.4-26.9)	8.0 (2.3-13.7)	68.5 (59.5-77.4)	46.7 (38.8-54.6)	11.5 (8.4-14.6)	109.4 (98.1-120.7)	86.3 (76.0-96.6)	18.7 (14.3-23.1)
India	49.7 (46.8-52.6)	28.7 (26.5-31.0)	9.5 (8.2-10.8)	76.4 (73.4-79.4)	54.0 (51.4-56.5)	12.7 (11.5-13.9)	109.9 (105.2-114.5)	88.5 (84.2-92.8)	18.4 (16.8-20.1)

CI, confidence intervals; NSS, national sample survey.

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Table S4 Hospitalization rates per 1000 (95% CI) in public hospitals among the older population in the major states in NSS 1995–96, NSS 2004 and NSS 2014, India

	Hospitalization rates per 1000 (95% CI) in public hospitals								
	NSS 1995–96			NSS 2004			NSS 2014		
States	Non-poor	Poor	Total	Non-poor	Poor	Total	Non-poor	Poor	Total
Less developed	53.3 (45.6-60.8)	64.8 (56.0-72.7)	57.1 (51.3-62.6)	38.7 (33.6-44.2)	59.5 (54.9-63.9)	48.9 (45.0-52.9)	36.0 (30.4-41.9)	55.0 (48.9-60.9)	45.2 (40.9-49.6)
Assam	78.8 (61.2-89.8)	67.2 (33.3-89.4)	76.0 (60.1-86.9)	47.7 (25.4-70.9)	83.8 (66.7-93.0)	64.4 (44.9-80.1)	78.3 (65.3-87.4)	86.6 (72.0-94.2)	82.3 (72.3-89.2)
Bihar	35.5 (19.6-55.4)	22.9 (9.1-46.7)	31.3 (18.4-48.0)	14.3 (9.5-20.9)	27.5 (19.2-37.7)	21.3 (16.0-27.6)	20.5 (11.9-33.0)	42.8 (32.6-53.6)	28.8 (20.3-39.1)
Madhya Pradesh	43.6 (33.3-54.4)	72.0 (56.5-83.6)	51.4 (42.2-60.5)	35.1 (26.8-44.4)	67.0 (53.1-78.4)	51.6 (43.1-60.0)	24.5 (14.8-37.7)	48.1 (31.3-65.3)	37.2 (26.2-49.8)
Odisha	92.6 (81.6-97.3)	93.4 (84.5-97.3)	92.9 (85.5-96.6)	74.6 (61.2-84.6)	86.9 (76.3-93.2)	81.1 (72.6-87.5)	71.0 (58.8-80.8)	85.8 (76.9-91.6)	79.2 (72.5-84.7)
Rajasthan	60.7 (44.1-75.1)	44.7 (23.7-67.7)	55.6 (42.1-68.4)	52.7 (39.0-66.0)	70.9 (60.3-79.7)	59.9 (50.0-69.1)	48.8 (40.5-57.2)	66.5 (57.2-74.7)	58.9 (52.4-65.0)
Uttar Pradesh	30.9 (22.8-40.4)	54.2 (38.2-69.4)	38.6 (30.2-47.8)	24.7 (17.4-33.9)	44.7 (36.7-53.0)	34.3 (27.7-41.5)	26.8 (18.5-37.0)	30.8 (23.0-39.9)	28.4 (22.4-35.3)
Jammu & Kashmir	94.5 (82.7-98.4)	99.6 (97.1-100.0)	97.7 (93.6-99.2)	92.6 (84.6-96.6)	85.9 (71.3-93.8)	89.1 (80.7-94.0)	87.1 (73.9-94.1)	94.9 (86.7-98.1)	92.6 (86.2-96.1)

(....continues)

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(....continued)

States	Hospitalization rates per 1000 (95% CI) in public hospitals								
	NSS 1995–96			NSS 2004			NSS 2014		
	Non-poor	Poor	Total	Non-poor	Poor	Total	Non-poor	Poor	Total
More developed	27.2 (23.6-31.1)	52.4 (46.9-57.8)	38.5 (35.0-42.1)	28.1 (25.0-31.3)	42.6 (39.4-45.8)	36.1 (33.9-38.4)	20.7 (18.0-23.6)	41.1 (38.2-44.1)	31.6 (29.5-33.8)
Andhra Pradesh	16.3 (10.0-25.5)	42.2 (27.9-57.9)	24.6 (17.6-33.2)	24.1 (15.9-34.7)	38.8 (30.8-47.4)	32.0 (26.2-38.5)	14.6 (8.7-23.3)	29.9 (22.8-38.0)	22.6 (17.7-28.3)
Gujarat	27.2 (15.9-42.5)	64.9 (47.1-79.3)	40.6 (30.0-52.2)	17.7 (11.2-26.8)	33.6 (24.4-44.3)	25.4 (19.5-32.3)	16.7 (10.3-26.0)	33.6 (26.0-42.0)	24.9 (19.5-31.2)
Haryana	39.8 (24.7-57.0)	25.2 (10.8-48.4)	33.3 (22.0-46.8)	20.8 (11.5-34.6)	18.2 (9.2-33.0)	19.6 (12.5-29.2)	6.9 (3.8-12.4)	52.9 (39.0-66.3)	29.7 (21.3-39.8)
Karnataka	33.0 (19.6-49.9)	46.3 (27.5-66.3)	35.1 (23.1-49.5)	20.8 (12.9-31.6)	51.4 (40.6-62.0)	35.4 (28.3-43.2)	26.5 (16.3-40.1)	28.5 (22.4-35.5)	27.8 (22.1-34.2)
Kerala	21.1 (14.4-29.9)	55.1 (47.2-62.8)	42.0 (35.9-48.4)	26.9 (20.2-34.9)	41.0 (35.0-47.3)	35.6 (31.0-40.5)	20.3 (14.4-27.8)	49.5 (42.3-56.7)	33.8 (28.8-39.3)
Maharashtra	15.2 (9.9-22.8)	35.8 (26.3-46.5)	25.1 (19.4-31.9)	22.7 (15.6-31.7)	36.2 (29.0-44.1)	30.7 (25.4-36.5)	9.3 (6.2-13.7)	29.7 (22.3-38.2)	20.5 (15.7-26.3)
Punjab	35.8 (22.9-51.1)	41.8 (22.7-63.7)	38.3 (27.0-51.0)	32.4 (20.0-47.9)	25.2 (14.4-40.2)	29.4 (20.4-40.3)	22.3 (7.5-50.6)	24.8 (16.1-36.2)	23.6 (13.8-37.3)
Tamil Nadu	21.5 (14.1-31.5)	69.4 (49.7-83.9)	43.2 (29.3-58.2)	16.7 (11.6-23.3)	43.5 (34.8-52.6)	33.6 (27.7-40.1)	13.6 (9.2-19.7)	40.7 (32.9-49.1)	30.8 (25.7-36.4)
West Bengal	62.3 (51.5-72.0)	83.0 (65.1-92.7)	69.0 (59.6-77.1)	60.2 (51.6-68.3)	82.1 (75.0-87.5)	69.0 (63.2-74.2)	49.8 (43.2-56.4)	72.1 (63.4-79.4)	61.0 (55.9-65.9)
India	34.1 (30.4-37.9)	54.6 (49.9-59.2)	42.7 (39.7-45.8)	30.9 (28.3-33.6)	46.3 (43.6-49.1)	39.2 (37.3-41.2)	25.8 (23.2-28.4)	45.2 (42.5-47.9)	35.9 (33.9-37.8)

CI, confidence intervals; NSS, national sample survey.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1-2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-6
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	-
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	8
		(*e*) Describe any sensitivity analyses	-
Results			

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Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	-
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	15-18
		(b) Indicate number of participants with missing data for each variable of interest	Appendix Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	15-16
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	19-20
		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-14 and 21-22
Discussion			
Key results	18	Summarise key results with reference to study objectives	23
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	27
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	23-26
Generalisability	21	Discuss the generalisability (external validity) of the study results	23-26
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	28

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Hospitalization trends in India from serial cross-sectional nationwide surveys: 1995 to 2014

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Hospitalization trends in India from serial cross-sectional nationwide surveys: 1995 to 2014

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ABSTRACT

Objectives: We report hospitalization trends for different age groups across the states of India and for various disease groups, compare the hospitalization trends among the older (60 years or more) and the younger (under 60 years) population, and quantify the factors that contribute to the change in hospitalization rates of the older population over two decades.

Design: Serial cross-sectional study.

Setting: Nationally representative sample, India.

Data sources: 3 consecutive National Sample Surveys (NSS) on healthcare utilization in 1995–96, 2004, and 2014.

Participants: 633,405 individuals in NSS 1995–96, 385,055 in NSS 2004, and 335,499 in NSS 2014.

Methods: Descriptive statistics, multivariate analyses, and a regression decomposition technique were used to attain the study objectives.

Result: The annual hospitalization rate per 1000 increased from 16.6 to 37.0 in India from 1995–96 to 2014. The hospitalization rate was about half in the less developed than the more developed states in 2014 (26.1 vs 48.6 per 1000). Poor people used more public than private hospitals; this differential was higher in the more developed (40.7% vs 22.9%) than the less developed (54.3% vs 40.1%) states in 2014. When compared to the younger population, the older population had a 3.6 times higher hospitalization rate (109.9 vs 30.7) and a greater proportion of hospitalization for non-communicable diseases (80.5% vs 56.7%) in 2014. Amongst the older population, hospitalization rates were comparatively lower for females, poor, and rural residents. Propensity change contributed to 86.5% of the increase in hospitalization among the older population and compositional change contributed 9.3%.

Conclusion: The older population in India has a much higher hospitalization rate and has continuing greater socioeconomic differentials in hospitalization rates. Specific policy focus

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on the requirements of the older population for hospital care in India is needed in light of the anticipated increase in their proportion in the population.

Keywords Ageing, decomposition, hospitalization, non-communicable diseases, older population, propensity

Stregths and limitations of this study

- The use of large scale data from nationwide surveys in India over two decades provides the most updated trends for hospitalization.
- The evidence on the changing hospitalization rate by age groups and the reasons behind the increased hospitalization of the older population is timely for policy formulation given the population ageing and shifting disease burden.
- It was not possible for us to study the contribution of the supply side factors in the increased hospitalization.
- Self-reported data and the nature of cross-sectional data may lead to recall and reporting biases, which may have affected the accuracy of the results.

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INTRODUCTION

The improvement in life expectancy in India has not been matched by the improvements in levels of health of the population.[1 2] The older population in India suffer from a higher burden of disease at older ages, particularly chronic diseases and disabilities.[3-11] The ageing population in India will continue to be one of the major determinants of the change in disease burden over the next two decades.[5] Higher disease burden rates at older ages result in greater demand for healthcare, particularly hospitalization.[12-15] Hospital care is an important aspect of any health system, especially regarding the treatment of the more vulnerable older segment of the population.[16 17]

Monitoring change in hospitalization rates is important to highlight the necessity for health policies to allocate resources and services to respond to the diverse healthcare needs of different segments of the population. Studies in India have analyzed hospitalization, but they are restricted in their approach and lack comprehensive assessment of rate over time.[16 18-22] The purpose of this study was to analyze hospitalization trends from nationally representative data between 1995 and 2014 for different age groups across the less and more developed states of India, and for various disease groups. In addition to this, we aimed to compare the hospitalization trends of the older population with the population under 60 years, and quantify the propensity and compositional change that may contribute to the change in hospitalization rates of the older population.

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METHODS

Ethics statement

The study is based on secondary data from the National Sample Surveys with no identifiable information on the survey participants. Exemption from ethics approval for analysis of the National Sample Surveys data was obtained from the institutional ethics committees of the Public Health Foundation of India and the London School of Hygiene and Tropical Medicine.

Data sources and participants

We used individual level data from National Sample Survey (NSS) on healthcare utilization conducted in all Indian states in 1995–96, 2004, and 2014.[23-25] These surveys record the utilization of healthcare for both inpatient and outpatient care, with hospitalization episodes in 365 days reference period recorded in detail. In addition, information of certain aspects of the condition of the older population was also collected. Individual level data was collected for a nationally representative sample of 633,405 in NSS 1995–96, 385,055 in NSS 2004, and 335,499 in NSS 2014. The sample of the older population in these surveys was: 35,274 in NSS 1995–96, 35,567 in NSS 2004, and 28,397 in NSS 2014. Samples with missing values for the independent variables were dropped, meaning that we did a complete case analysis. The proportion of missing cases on any independent variable across the three surveys was less than 4% of the total sample (Table S1). Though there was variation in sample size; the sample design was uniform across the three surveys. This permits the construction of comparable variables which could be used to make statistical inferences about change in parameter estimates.

Initial analyses of trends and differentials in hospitalization rates were performed on all persons surveyed including deceased members. However, for the subsequent descriptive, multivariate, and decomposition analyses performed on the older population, the deceased was excluded because the questions on several important background variables were only

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asked to the older persons who were alive on the date of survey. The sample of deceased older population is reported in Table S1.

Measures

Our outcome variable was hospitalization rate defined as the number of episodes of hospitalization in 365 days reference period per 1000 of the population exposed to the risk. The cause of hospitalization was categorized into non-communicable diseases and injuries (NCDs), and communicable diseases and nutritional disorders (CDs) using the Global Burden of Disease 2013 classification.[2] The diseases included in the two broad categories are listed in Table S2.

We used monthly per capita consumption expenditure (MPCE) adjusted to the household size and composition as a proxy for economic status. The equivalence scale used was $e_h = (A_h + 0.5K_h)^{0.75}$, where A_h was the number of adults in the household, and K_h was the number of children 0–14 years. Parameters were set on the basis of estimates summarized by Deaton.[26] The state-specific adult equivalent mean MPCE was used as a cut-off to categorize households into poor and non-poor.

We present analyses at the state level for the 35 states and union territories in India by classifying them into two groups –less developed and more developed states. The less developed states include the 18 states namely, eight empowered action group states (Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Uttar Pradesh, Uttaranchal, Odisha and Rajasthan), 8 north-eastern states (Assam, Arunachal Pradesh, Manipur, Mizoram, Meghalaya, Nagaland, Sikkim and Tripura), Himachal Pradesh, and Jammu and Kashmir.[27] State-specific rates were estimated for the 19 major states of India, with a population over 10 million in 2011 census, accounting for 97% of India's population. For comparison Bihar, Madhya Pradesh, Uttar Pradesh, and Andhra Pradesh were considered as undivided states at all survey points.

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The Andersen's model of healthcare utilization was used to study the association of individuals' predisposing, enabling, and need variables with hospitalization.[28] Based on the availability of data age, sex, marital status, caste[1], and education were identified as predisposing variables; place of residence, states, economic independence, economic status, and living arrangement as enabling factors; and physical mobility status, current self-rated health (SRH), and SRH compared to previous year as the need variables, which are likely to affect hospitalization in the older population. These variables were dichotomized for all analyses.

Statistical methods

Descriptive analyses were used to examine the change in hospitalization rate for all diseases, NCDs, and CDs at both aggregate and subgroup levels for all ages, and the change in the composition of the older population in India between 1995 and 2014.

A logit model was used to evaluate the effect of covariates on the probability of hospitalization in the older population. The model employed was of the form:

$$Ln[P_i/(1- P_i)]= \sum \beta_i X_i \qquad (1)$$

where $Ln[P_i/(1- P_i)]$ was the log odds of hospitalization, X_i was a vector of explanatory variables, and β_i was a vector of regression coefficients. The model was checked for multicollinearity. Fit of the model was assessed using the p-value of the F-adjusted mean residual goodness-of-fit statistic. A p-value below 0.05 was not considered a good fit.

A regression decomposition technique was used to decompose the change in hospitalization rate into its constituent parts.[29-31] A multivariate logit model was estimated for each period. For example, the equation for the period 1995–96 was

$$Ln[P_i/(1-P_i)]_{(1995–96)} = \beta_0 + \beta_i X_{i(1995–96)} + \cdots\cdots\cdots\cdots + \beta_n X_{n(1995–96)}$$

[1] Caste in India is a social stratification of communities into 4 groups, namely scheduled castes (SCs), scheduled tribes (STs), other backward castes, and other castes. SC/STs are officially designated disadvantaged groups in India.

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$$i=1,2,3,4\cdots\cdots\cdots\cdots n \qquad (2)$$

while the equation for the period 2014 was

$$Ln[P_i/(1\text{-}P_i)]_{(2014)} = \beta_0 + \beta_i X_{i(2014)} + \cdots\cdots\cdots\cdots + \beta_n X_{n(2014)}$$

$$i=1,2,3,4\cdots\cdots\cdots\cdots n \qquad (3)$$

The difference $Ln[P_i/(1\text{-}P_i)]_{(2014)} - Ln[P_i/(1\text{-}P_i)]_{(1995\text{–}96)}$ was decomposed using equation (4), which considered 1995–96 as the base period.

$$Logit_{(2014)} - Logit_{(1995\text{–}96)} = [(\beta_{0(2014)} - \beta_{0(1995\text{–}96)}) + \sum P_{ij(1995\text{–}96)} (\beta_{ij(2014)} - \beta_{ij(1995\text{–}96)})] + \sum \beta_{ij(1995\text{–}96)} (P_{ij(2014)} - P_{ij(1995\text{–}96)}) + \cdots\cdots\cdots\cdots + \sum (\beta_{ij(2014)} - \beta_{ij(1995\text{–}96)}) (P_{ij(2014)} - P_{ij(1995\text{–}96)}) \qquad (4)$$

Where,

$P_{ij(2014)}$ = Proportion of j^{th} category of the i^{th} covariate in NSS 2014

$P_{ij(1995\text{–}96)}$ = Proportion of j^{th} category of the i^{th} covariate in NSS 1995–96

$\beta_{ij(2014)}$ = Coefficient for the j^{th} category of the i^{th} covariate in NSS 2014

$\beta_{ij(1995\text{–}96)}$ = Coefficient for the j^{th} category of the i^{th} covariate in NSS 1995–96

$\beta_{0(2014)}$ = Regression constant in NSS 2014

$\beta_{0(1995\text{–}96)}$ = Regression constant in NSS 1995–96

This procedure yields three components: 1) propensity defined as the change brought by variation in the impact of determinants; 2) composition defined as the change due to variation in the proportion of determinants, and 3) interaction which reflects the change as a result of the interplay between compositional and propensity change.[32] We used p-values for the Wald test to assess the difference between the coefficients from the two logit models. The estimates were generated using survey sampling weights, and the survey design features including the cluster design effect were taken into account to calculate the 95% confidence intervals (95% CI). This was done using the "svyset" command in STATA version 13.1 (StataCorp LP, Texas).

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RESULTS

Hospitalization trends and differentials

The annual hospitalization rate per 1000 increased 2.23 times between 1995 and 2014; the increase was higher for NCDs than CDs (3.61 vs 2.25 times) (Table 1). The contribution of NCDs to total hospitalization increased from 38.6% in 1995–96 to 62.2% in 2014. The hospitalization rate increased with age, and was highest for the population aged 70 years or more. The hospitalization rate increased 2.21 times for older population, and 2.01 times for population under 60 years between 1995 and 2014. When compared to younger population, the older population had more than three times higher hospitalization rates, and a greater proportion of hospitalizations for NCDs.

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Table 1 Hospitalization rate per 1000 (95% CI) by age and disease groups in NSS 1995–96, NSS 2004 and NSS 2014, India

	Hospitalization rates per 1000 (95% CI)			Estimated hospitalized cases (in millions) (%)
Age (years)	NCDs	CDs	All diseases	
	NSS 1995–96			
0-4	2.2 (1.8-2.6)	7.8 (7.0-8.6)	14.1 (12.9-15.3)	1.4 (9.7)
5-14	2.0 (1.8-2.3)	3.0 (2.7-3.3)	6.8 (6.3-7.2)	1.4 (10.3)
15-29	3.6 (3.3-3.9)	6.0 (5.5-6.4)	13.9 (13.2-14.7)	3.1 (22.0)
30-44	6.8 (6.3-7.3)	6.0 (5.5-6.5)	17.8 (17.0-18.6)	2.9 (20.5)
45-59	14.1 (12.9-15.2)	6.4 (5.7-7.2)	28.0 (26.4-29.5)	2.9 (20.5)
60-69	24.4 (22.0-26.8)	8.6 (7.2-10.0)	42.2 (39.2-45.2)	1.2 (8.9)
70 or more	35.7 (31.1-40.3)	11.1 (8.5-13.7)	61.8 (55.9-67.7)	1.1 (8.1)
Under 60 years	5.0 (4.8-5.2)	5.5 (5.2-5.7)	14.6 (14.2-15.0)	11.6 (83.0)
60 years or more	28.7 (26.4-31.0)	9.5 (8.2-10.8)	49.7 (46.8-52.7)	2.4 (17.0)
All ages	6.4 (6.1-6.6)	5.7 (5.5-5.9)	16.6 (16.2-17.0)	14.0 (1.7)
	NSS 2004			
0-4	4.4 (3.8-4.9)	15.0 (13.8-16.1)	23.9 (22.5-25.4)	2.6 (9.5)
5-14	4.0 (3.6-0.5)	5.6 (5.2-6.1)	11.8 (11.1-12.5)	2.7 (9.9)
15-29	10.3 (9.7-10.9)	5.9 (5.5-6.4)	21.4 (20.5-22.2)	5.4 (19.9)
30-44	15.8 (15.0-16.6)	7.5 (6.8-8.2)	29.7 (28.5-30.9)	5.7 (21.0)
45-59	30.1 (28.6-31.6)	10.5 (9.6-11.3)	47.8 (45.9-49.6)	5.6 (20.5)
60-69	45.2 (42.1-48.2)	12.2 (10.7-13.8)	65.7 (62.1-69.3)	2.9 (10.6)
70 or more	70.0 (65.0-74.9)	13.7 (11.7-15.6)	95.9 (90.3-101.6)	2.3 (8.5)
Under 60 years	11.7 (11.4-12.1)	7.9 (7.6-8.2)	24.5 (24.0-24.9)	21.9 (80.8)
60 years or more	54.0 (51.3-56.6)	12.7 (11.5-14.0)	76.4 (73.3-79.5)	5.2 (19.2)
All ages	14.7 (14.4-15.1)	8.3 (8.0-8.6)	28.2 (27.7-28.7)	27.2 (2.8)
	NSS 2014			
0-4	8.3 (7.3-9.3)	25.0 (23.3-26.7)	34.2 (32.3-36.2)	3.4 (8.2)
5-14	6.6 (5.8-7.3)	7.6 (7.0-8.1)	14.4 (13.5-15.4)	3.3 (7.8)
15-29	11.6 (10.8-12.4)	12.2 (11.5-12.9)	24.6 (23.5-25.7)	7.5 (17.9)
30-44	22.1 (20.9-23.3)	11.1 (10.2-12.1)	34.6 (33.0-36.1)	8.4 (20.2)
45-59	41.7 (39.7-43.7)	13.1 (11.8-14.3)	56.5 (54.2-58.9)	9.2 (22.2)
60-69	72.8 (68.0-77.7)	17.1 (15.0-19.3)	92.2 (86.8-97.5)	5.3 (12.7)
70 or more	116.2 (107.4-124.9)	20.8 (18.2-23.4)	141.2 (131.9-150.5)	4.6 (11.0)
Under 60 years	17.4 (16.9-17.9)	12.3 (11.9-12.7)	30.7 (30.0-31.4)	31.8 (76.4)
60 years or more	88.5 (84.1-92.9)	18.4 (16.8-20.1)	109.9 (105.1-114.7)	9.8 (23.6)
All ages	23.1 (22.5-23.7)	12.8 (12.4-13.2)	37.0 (36.3-37.7)	41.6 (3.7)

CI, confidence intervals; NSS, national sample survey.

Males and females under 60 years had similar hospitalization rates, while the older males had 64% higher hospitalization rate than the older females in 1995–96 (Fig.1). The gender gap reduced for the older population by 2014 because of the higher increase in hospitalization rate for the females compared to the males (2.71 vs 1.89 times). As compared to poor, amongst older population, the non-poor had 62% higher hospitalization rate, while amongst population under 60 years, the non-poor had 36% higher hospitalization rate in 2014. In 1995–96, the urban residents aged 60 years or more had 71% higher hospitalization rate than the rural residents, which declined to 34% higher in 2014. As compared to the less

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developed states, the hospitalization rate in the more developed states was 2.82 times higher for the older population and 2.07 times higher for those under 60 years; however, the differential become similar by 2014.

The more developed states had 2.21 times and 1.86 times higher hospitalization rate than the less developed states in 1995–96 and 2014, respectively (Table 2). Between 1995 and 2014, the increase in hospitalization rate was higher in the less developed compared to the more developed states, more so for the older population for all diseases (3.12 vs 1.89 times), NCDs (4.50 vs 2.63 times), and CDs (2.59 vs 1.66 times). The hospitalization rate for older population by disease groups in the major states of India is shown for 1995–96, 2004 and 2014 in Table S3.

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Table 2 Hospitalization rates per 1000 (95% CI) by disease groups in the less and more developed states in NSS 1995–96, NSS 2004 and NSS 2014, India

	Hospitalization rates per 1000 (95% CI)								
	60 years or more								
	NSS 1995–96			NSS 2004			NSS 2014		
States	All hospitalizations	NCDs	CDs	All hospitalizations	NCDs	CDs	All hospitalizations	NCDs	CDs
Less developed	25.1 (22.3-27.9)	13.6 (12.1-15.1)	5.8 (4.0-7.6)	41.6 (38.4-44.9)	28.6 (25.8-31.4)	7.3 (6.2-8.4)	78.4 (71.3-85.5)	61.2 (54.6-67.8)	15.0 (12.7-17.2)
More developed	70.9 (66.1-75.8)	41.7 (37.7-45.8)	12.7 (10.8-14.6)	104.6 (99.8-109.4)	74.6 (70.4-78.7)	17.1 (15.1-19.1)	134.3 (128.0-140.7)	109.7 (103.9-115.5)	21.1 (18.8-23.5)
India	49.7 (46.8-52.6)	28.7 (26.5-31.0)	9.5 (8.2-10.8)	76.4 (73.4-79.4)	54.0 (51.4-56.5)	12.7 (11.5-13.9)	109.9 (105.2-114.5)	88.5 (84.2-92.8)	18.4 (16.8-20.1)
	Under 60 years								
	NSS 1995–96			NSS 2004			NSS 2014		
States	All hospitalizations	NCDs	CDs	All hospitalizations	NCDs	CDs	All hospitalizations	NCDs	CDs
Less developed	9.4 (8.9-9.8)	2.9 (2.7-3.1)	3.7 (3.4-4.0)	15.7 (15.2-16.1)	7.3 (7.0-7.6)	5.2 (4.9-5.4)	22.3 (21.5-23.1)	11.8 (11.2-12.4)	9.9 (9.4-10.4)
More developed	19.5 (18.9-20.1)	7.0 (6.6-7.3)	7.1 (6.7-7.4)	33.1 (32.3-34.0)	16.1 (15.5-16.7)	10.5 (10.0-11.1)	39.9 (38.8-40.9)	23.5 (22.6-24.4)	15.0 (14.3-15.6)
India	14.6 (14.2-15.0)	5.0 (4.8-5.2)	5.5 (5.2-5.7)	24.5 (24.0-24.9)	11.7 (11.4-12.1)	7.9 (7.6-8.2)	30.7 (30.0-31.4)	17.4 (16.9-17.9)	12.3 (11.9-12.7)
	All ages								
	NSS 1995–96			NSS 2004			NSS 2014		
States	All hospitalizations	NCDs	CDs	All hospitalizations	NCDs	CDs	All hospitalizations	NCDs	CDs
Less developed	10.2 (9.8-10.6)	3.5 (3.3-3.7)	3.8 (3.6-4.1)	17.5 (17.0-18.0)	8.7 (8.4-9.0)	5.4 (5.1-5.6)	26.1 (25.2-27.0)	15.2 (14.4-15.9)	10.2 (9.7-10.7)
More developed	22.5 (21.9-23.1)	9.0 (8.6-9.4)	7.4 (7.0-7.7)	38.7 (37.8-39.6)	20.6 (20.0-21.3)	11.1 (10.6-11.6)	48.6 (47.5-49.8)	31.5 (30.5-32.4)	15.6 (14.9-16.2)
India	16.6 (16.2-17.0)	6.4 (6.1-6.6)	5.7 (5.5-5.9)	28.2 (27.7-28.7)	14.7 (14.4-15.1)	8.3 (8.0-8.6)	37.0 (36.3-37.7)	23.1 (22.5-23.7)	12.8 (12.4-13.2)

CI, confidence intervals, NSS, national sample survey.

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Between 1995 and 2014, the hospitalization in public hospitals declined from 44.9% to 38.4% (Table 3). The use of public hospitals was higher in the less developed than the more developed states in 2014 (47.6% vs 33.2%). Poor were hospitalized more in public hospitals; this differential was higher in the more developed (40.7% vs 22.9%) compared to the less developed states (54.3% vs 40.1%) in 2014. In less developed states, the decline in the use of public hospitals was higher for the non-poor than the poor (-25.3% vs -16.7%), while in the more developed states, both non-poor and poor showed a similar decline. The hospitalization in public hospitals for the older population in the major states of India for 1995–96, 2004 and 2014 is presented in Table S4.

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Table 3 Hospitalization rates per 1000 (95% CI) in public hospitals by economic status in the less and more developed states in NSS 1995–96, NSS 2004 and NSS 2014, India

	Hospitalization rates per 1000 (95% CI) in public hospitals								
	60 years or more								
	NSS 1995–96			NSS 2004			NSS 2014		
States	Non-poor	Poor	Total	Non-poor	Poor	Total	Non-poor	Poor	Total
Less developed	53.3 (45.6-60.8)	64.8 (56.0-72.7)	57.1 (51.3-62.6)	38.7 (33.6-44.2)	59.5 (54.9-63.9)	48.9 (45.0-52.9)	36.0 (30.4-41.9)	55.0 (48.9-60.9)	45.2 (40.9-49.6)
More developed	27.2 (23.6-31.1)	52.4 (46.9-57.8)	38.5 (35.0-42.1)	28.1 (25.0-31.3)	42.6 (39.4-45.8)	36.1 (33.9-38.4)	20.7 (18.0-23.6)	41.1 (38.2-44.1)	31.6 (29.5-33.8)
India	34.1 (30.4-37.9)	54.6 (49.9-59.2)	42.7 (39.7-45.8)	30.9 (28.3-33.6)	46.3 (43.6-49.1)	39.2 (37.3-41.2)	25.8 (23.2-28.4)	45.2 (42.5-47.9)	35.9 (33.9-37.8)
	Under 60 years								
	NSS 1995–96			NSS 2004			NSS 2014		
States	Non-poor	Poor	Total	Non-poor	Poor	Total	Non-poor	Poor	Total
Less developed	53.8 (51.1-56.4)	65.3 (60.6-69.7)	58.0 (55.6-60.4)	43.5 (41.4-45.6)	51.7 (49.6-53.8)	47.8 (46.3-49.3)	41.3 (38.7-43.9)	54.2 (51.7-56.7)	48.2 (46.4-50.0)
More developed	30.0 (28.3-31.9)	51.9 (49.6-54.2)	40.0 (38.5-41.5)	28.1 (26.4-29.9)	44.1 (42.4-45.8)	38.0 (36.7-39.2)	23.7 (21.8-25.6)	40.6 (38.9-42.3)	33.7 (32.4-35.1)
India	37.9 (36.3-39.4)	55.3 (53.2-57.4)	45.4 (44.1-46.7)	33.8 (32.4-35.1)	46.2 (44.9-47.6)	41.1 (40.1-42.1)	30.9 (29.4-32.5)	45.4 (44.0-46.9)	39.2 (38.2-40.3)
	All ages								
	NSS 1995–96			NSS 2004			NSS 2014		
States	Non-poor	Poor	Total	Non-poor	Poor	Total	Non-poor	Poor	Total
Less developed	53.7 (51.2-56.2)	65.2 (61.0-69.2)	57.9 (55.7-60.0)	42.5 (40.5-44.5)	52.5 (50.6-54.5)	47.7 (46.3-49.1)	40.1 (37.7-42.6)	54.3 (52.0-56.6)	47.6 (45.9-49.3)
More developed	29.5 (27.9-31.1)	52.0 (49.8-54.1)	39.7 (38.3-41.1)	28.0 (26.5-29.6)	43.7 (42.3-45.3)	37.5 (36.4-38.6)	22.9 (21.3-24.5)	40.7 (57.8-60.7)	33.2 (32.1-34.3)
India	37.2 (35.8-38.7)	55.2 (53.3-57.1)	44.9 (43.7-46.1)	33.1 (31.9-34.3)	46.2 (44.9-47.4)	40.6 (39.8-41.5)	29.6 (28.3-31.0)	45.4 (44.1-46.6)	38.4 (37.5-39.4)

CI, confidence intervals, NSS, national sample survey.

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All subgroups of the older population showed a significant increase in hospitalization rates, but there was considerable variation in the amount of change (Table 4). Between 1995 and 2014, the increase in hospitalization rate was higher for females (2.82 vs 1.87 times), single (3.04 vs 1.89 times), poor (2.72 vs 1.87 times), illiterate (2.45 vs 1.77 times), rural residents (2.32 vs 1.88 times), and those living in the less developed states (3.07 vs 1.95 times) compared to their respective counterparts. This reduced the differential in hospitalization rate by gender, marital status, economic status, place of residence, and states.

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Table 4 Hospitalization rate per 1000 (95% CI) for older population by background characteristics in NSS 1995–96, NSS 2004 and NSS 2014, India

Background characteristics	Hospitalization rates per 1000 (95% CI)		
Predisposing variables	**NSS 1995–96**	**NSS 2004**	**NSS 2014**
Age (years)			
60-69	37.6 (34.8-40.5)	62.2 (58.8-65.6)	82.6 (77.6-87.6)
70 or more	53.1 (47.8-58.4)	90.6 (85.3-96.0)	124.4 (116.4-132.4)
Sex			
Male	53.9 (49.3-58.4)	80.3 (76.3-84.2)	101.0 (95.5-106.6)
Female	33.3 (30.4-36.1)	63.7 (59.5-67.9)	94.0 (87.5-100.5)
Marital status			
Currently married	50.8 (46.8-54.9)	75.6 (72.0-79.1)	95.9 (91.2-100.7)
Single	32.9 (29.8-36.0)	66.8 (61.9-71.6)	100.1 (91.8-108.4)
Caste			
Non-SC/STs	46.7 (43.5-50.0)	78.8 (75.3-82.2)	105.2 (100.0-110.4)
SC/STs	32.9 (28.4-37.3)	50.7 (45.8-55.5)	71.8 (65.8-77.9)
Education			
Literate	65.9 (60.7-71.1)	106.3 (100.6-112.0)	116.7 (110.2-123.2)
Illiterate	34.0 (30.9-37.2)	54.2 (50.9-57.5)	83.2 (77.5-88.8)
Enabling variables			
Place of residence			
Urban	63.1 (58.7-67.4)	99.5 (92.8-106.3)	118.6 (111.2-126.0)
Rural	37.9 (34.7-41.1)	63.2 (60.0-66.3)	87.8 (82.6-93.1)
States			
More developed	62.1 (57.8-66.5)	98.4 (93.8-103.0)	121.0 (114.9-127.1)
Less developed	21.8 (19.0-24.5)	39.5 (36.4-42.6)	67.0 (61.2-72.9)
Economic dependency			
Economically independent	35.8 (30.9-40.8)	63.2 (58.9-67.5)	89.2 (80.2-98.2)
Economically dependent	47.2 (44.0-50.4)	77.9 (74.1-81.7)	100.7 (96.0-105.5)
Economic status			
Non-poor	68.6 (62.6-74.6)	94.9 (89.2-100.6)	128.2 (119.1-137.4)
Poor	29.4 (26.9-31.9)	59.8 (56.5-63.0)	80.1 (75.8-84.3)
Living arrangement			
With family	44.2 (41.4-47.0)	74.1 (71.1-77.1)	95.3 (91.4-99.3)
Alone	31.1 (22.2-40.0)	54.0 (41.1-67.0)	146.2 (99.3-193.2)
Need variables			
Physical mobility status			
Mobile	38.0 (35.4-40.7)	62.5 (59.8-65.3)	84.3 (80.3-88.3)
Immobile	91.3 (78.8-103.7)	193.9 (175.0-212.8)	249.4 (222.3-276.5)
Current self-rated health (SRH)			
Good	31.2 (28.9-33.4)	54.3 (51.5-57.1)	67.8 (63.8-71.7)
Poor	96.9 (86.4-107.4)	138.3 (129.5-147.1)	200.2 (186.8-213.7)
SRH compared to previous year			
Better or same	31.9 (29.4-34.5)	57.4 (54.6-60.1)	70.1 (66.0-74.3)
Worse	78.3 (70.7-85.9)	138.9 (128.9-148.9)	179.5 (167.8-191.2)
Total	43.4 (40.8-46.1)	72.0 (69.1-74.8)	97.5 (93.2-101.7)

CI, confidence intervals; NSS, national sample survey; SC/STs, scheduled castes/scheduled tribes are officially designated disadvantaged groups in India.

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Compositional change

Most of the older population lived in rural areas, but their proportion decreased by 9.3 percentage points (78.1 % to 68.8%) between 1995 and 2014 (Table 5). There was 5.2 percentage points (58.3% in 1995–96 to 63.4% in 2014) increase in the proportion of currently married older population. Literacy in the older population increased by 13.0 percentage points by 2014. In 1995–96, most of the older population were physically mobile (89.5%), less than 70 years of age (62.5%), resident of the more developed states (53.7%), economically dependent (68.9%), and reported good SRH (80.8%), with only marginal change in their proportions. The majority of the older population were non-SC/STs (76.4%), poor (64.2%), living with family (95.6%), and reporting better or nearly same SRH compared to past year (74.3%) in 1995–96 and their proportion remained unchanged in 2014.

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Table 5 Background characteristics of the older population in NSS 1995–96, NSS 2004 and NSS 2014, India

Background characteristics	NSS 1995–96		NSS 2004		NSS 2014	
Predisposing variables	**N**	**% (95% CI)**	**N**	**% (95% CI)**	**N**	**% (95% CI)**
Age (years)						
60-69	21,124	62.5 (61.6-63.4)	22,546	65.3 (64.6-66.0)	17,160	64.5 (63.2-65.8)
70 years or more	12,866	37.5 (36.6-38.4)	12,264	34.7 (34.0-35.4)	10,085	35.5 (34.2-36.8)
Sex						
Male	17,173	49.4 (48.5-50.4)	17,750	50.0 (49.3-50.8)	13,692	49.2 (47.8-50.6)
Female	16,817	50.6 (49.6-51.5)	17,081	50.0 (49.2-50.7)	13,553	50.8 (49.4-52.2)
Marital status						
Currently married	20,111	58.3 (57.3-59.2)	20,959	59.2 (58.5-60.0)	17,947	63.4 (62.1-64.7)
Single	13,852	41.7 (40.8-42.7)	13,872	40.8 (40.0-41.5)	9,298	36.6 (35.3-37.9)
Caste						
Non-SC/STs	26,089	76.4 (75.6-77.2)	26,291	76.0 (75.3-76.6)	20,823	76.8 (75.6-77.9)
SC/STs	7,880	23.6 (22.8-24.4)	8,531	24.0 (23.4-24.7)	6,422	23.2 (22.1-24.4)
Education						
Literate	12,406	29.5 (28.7-30.4)	13,514	34.2 (33.5-34.9)	13,362	42.6 (41.2-43.9)
Illiterate	21,543	70.5 (69.6-71.3)	21,301	65.8 (65.1-66.5)	13,883	57.4 (56.1-58.8)
Enabling variables						
Place of residence						
Urban	13,035	21.9 (21.3-22.5)	12,566	24.3 (23.7-24.9)	12,226	31.2 (30.0-32.4)
Rural	20,955	78.1 (77.5-78.7)	22,265	75.7 (75.1-76.3)	15,019	68.8 (67.6-70.0)
States						
More developed	17,389	53.7 (52.8-54.7)	17,019	55.2 (54.4-55.9)	14,466	56.3 (54.9-57.6)
Less developed	16,601	46.3 (45.3-47.2)	17,812	44.8 (44.1-45.6)	12,779	43.7 (42.4-45.1)
Economic dependency						
Economically independent	10,149	31.1 (30.2-32.0)	11,800	34.0 (33.3-34.7)	7,159	28.3 (27.0-29.6)
Economically dependent	23,061	68.9 (68.0-69.8)	22,429	66.0 (65.3-66.7)	20,075	71.7 (70.4-73.0)
Economic status						
Non-poor	15,407	35.8 (35.0-36.7)	14,372	34.8 (34.1-35.5)	11,738	36.1 (34.8-37.4)
Poor	18,583	64.2 (63.3-65.0)	20,459	65.2 (64.5-65.9)	15,507	63.9 (62.6-65.2)
Living arrangement						
With Family	32,482	95.6 (95.2-96.0)	32,595	94.8 (94.4-95.1)	26,659	95.9 (95.3-96.5)
Alone	1,174	4.4 (4.0-4.8)	1,509	5.2 (4.9-5.6)	586	4.1 (3.5-4.7)
Need variables						
Physical mobility status						
Mobile	29,697	89.5 (88.9-90.1)	30,821	91.9 (91.5-92.3)	24,499	92.0 (91.3-92.7)
Immobile	3,635	10.5 (9.9-11.1)	3,224	8.1 (7.7-8.5)	2,735	8.0 (7.3-8.7)
Current self-rated health (SRH)						
Good	27,263	80.8 (79.9-81.5)	24,965	76.4 (75.7-77.0)	20,143	77.6 (76.4-78.7)
Poor	6,217	19.2 (18.5-20.1)	8,216	23.6 (23.0-24.3)	7,091	22.4 (21.3-23.6)
SRH compared to previous year						
Better or same	25,018	74.3 (73.4-75.1)	25,971	79.3 (78.7-79.9)	19,590	75.0 (73.8-76.2)
Worse	8,430	25.7 (24.9-26.6)	7,210	20.7 (20.1-21.3)	7,644	25.0 (23.8-26.2)
N	33,990		34,831		27,245	

CI, confidence intervals; NSS, national sample survey; SC/STs, scheduled castes/scheduled tribes are officially designated disadvantaged groups in India.

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Determinants of hospitalization

Older population reporting poor SRH (AOR 2.42 95% CI 1.91-3.07) and living alone (AOR 2.13 95% CI 1.44-3.16) had the highest odds of hospitalization in 1995–96 and 2014, respectively (Table 6). Poor older population were 59% (95% CI 0.35-0.48) and 37% (95% CI 0.55-0.72) less likely to be hospitalized in 1995–96 and 2014, respectively. The economically dependent older population was 32% (95% CI 1.08-1.62) more likely to be hospitalized in 1995–96. Older population living in the less developed states had lower odds of hospitalization in 1995–96 (AOR 0.34 95% CI 0.29- 0.40) and 2014 (AOR 0.54 95% CI 0.47-0.61). In 1995–96, female and single older population were 30% (95% CI 0.60-0.83) and 34% (95% CI 0.57-0.77) less likely to be hospitalized, respectively. The older population belonging to SC/STs had lower odds of hospitalization (AOR 0.81, 95% CI 0.70-0.94) compared to non-SC/STs in 2014. In 2014, physically immobile and those reporting SRH worse than previous year had 85% (95% CI 1.15-2.27) and 67% (95% CI 1.44-1.94) higher odds of being hospitalized, respectively. After adjusting for the covariates, age and place of residence were not significantly associated with hospitalization.

Between 1995 and 2014, there was a modest increase in intercept for the outcome variable suggesting that when all the explanatory variables in the logit model were set equal to their reference categories, the probability of hospitalization was significantly higher in 2014 than in 1995–96 for the older population. Comparison of 1995–96 and 2014 coefficients showed the convergence of differentials in hospitalization by gender, marital status, economic status, living arrangement, and states (Table 6).

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Table 6 Determinants of hospitalization for the older population in NSS 1995–96 and NSS 2014, India

Background characteristics	Whether hospitalized							
	$\beta_{1995-96}$	Exp ($\beta_{1995-96}$)	95% CI for Exp ($\beta_{1995-96}$)	β_{2014}	Exp (β_{2014})	95% CI for Exp (β_{2014})	β_{2014} -$\beta_{1995-96}$	p-Value for Wald test (β_{2014} -$\beta_{1995-96}$)
Predisposing variables								
Age (years) (ref.=60 – 69)								
70 years or more	-0.028	0.97	[0.83 - 1.14]	0.124	1.13	[0.99 - 1.29]	0.152	0.147
Sex (ref.=male)								
Female	-0.352	0.70	[0.60 - 0.83]	-0.050	0.95	[0.83 - 1.10]	0.302	0.006
Marital Status (ref.=currently married)								
Single	-0.416	0.66	[0.57 - 0.77]	-0.130	0.88	[0.76 - 1.02]	0.286	0.009
Caste (ref.=non-SC/STs)								
SC/STs	0.017	1.02	[0.84 - 1.23]	-0.211	0.81	[0.70 - 0.94]	-0.229	0.060
Literacy status (ref.= literate)								
Illiterate	-0.278	0.76	[0.63 - 0.91]	-0.224	0.80	[0.70 - 0.92]	0.055	0.645
Enabling variables								
Place of residence (ref.= urban)								
Rural	-0.112	0.89	[0.76 - 1.04]	-0.032	0.97	[0.85 - 1.11]	0.080	0.446
States (ref.= more developed)								
Less developed	-1.070	0.34	[0.29 - 0.40]	-0.619	0.54	[0.47 - 0.61]	0.451	<0.001
Economic dependence (ref.= independent)								
Economically dependent	0.281	1.32	[1.08 - 1.62]	0.004	1.00	[0.85 - 1.18]	-0.277	0.035
Economic status (ref.=non-poor)								
Poor	-0.895	0.41	[0.35 - 0.48]	-0.462	0.63	[0.55 - 0.72]	0.432	<0.001
Living arrangement (ref.= living with family)								
Living alone	0.197	1.22	[0.85 - 1.74]	0.757	2.13	[1.44 - 3.16]	0.560	0.039
Need variables								
Physical mobility status (ref.= mobile)								
Immobile	0.400	1.49	[1.21 - 1.84]	0.617	1.85	[1.51 - 2.27]	0.217	0.149
Current self-rated health (ref.= good SRH)								
Poor SRH	0.884	2.42	[1.91 - 3.07]	0.736	2.09	[1.78 - 2.44]	-0.149	0.306
SRH compared to last year (ref.= better or nearly the same)								
Worse SRH	0.475	1.61	[1.31 - 1.98]	0.515	1.67	[1.44 - 1.94]	0.039	0.763
Constant	-2.466	0.08	[0.07 - 0.10]	-2.238	0.11	[0.09 - 0.12]	0.228	0.037
F-adjusted test statistic	1.61			0.81				
p-Value	0.106			0.611				
N	32,780			27,234				

CI, confidence intervals; NSS, national sample survey; SC/STs, scheduled castes/scheduled tribes are officially designated disadvantaged groups in India.

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Decomposition of increase in hospitalization rate

For the older population in India, the propensity change explained 86.6% of the increase in hospitalization rate between 1995 and 2014 (Table 7). The improved propensity to use hospital care by economically poor, residents of the less developed states, females, and singles contributed 16.4%, 12.3%, 9.0%, and 7.1% of the increase in hospitalization rate, respectively, regardless of the change in their composition. The change in intercept accounted for 13.5% of the increase in hospitalization rate. Change in the composition of the characteristics of older population had a modest influence on the level of hospitalization; contributing 9.2% of the increase in hospitalization. Many of the changes in the population structure during the inter-survey period favoured increased hospitalization, except gender and physical mobility status. The increase in the proportion of literates, those reporting poor SRH, economically dependent, and single contributed 2.1%, 1.7%, 1.6%, and 1.3% of the increase in hospitalization rate, respectively between 1995 and 2014, regardless of the change in the likelihood of hospitalization by the subgroups.

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Table 7 Decomposition of increase in hospitalization for the older population between 1995 and 2014, India

	Contribution to the increase in hospitalization (%)*		
Background characteristics	**Propensity**	**Composition**	**Interaction**
70 years or more	0.06 (3.4)	0.00 (0.0)	0.00 (-0.2)
Female	0.15 (9.0)	0.00 (-0.1)	0.00 (0.0)
Single	0.12 (7.1)	0.02 (1.3)	-0.01 (-0.9)
SC/STs	-0.05 (-3.2)	0.00 (0.0)	0.00 (0.0)
Illiterate	0.04 (2.3)	0.04 (2.1)	-0.01 (-0.4)
Rural	0.06 (3.7)	0.01 (0.6)	-0.01 (-0.4)
Less developed states	0.21 (12.3)	0.03 (1.6)	-0.01 (-0.7)
Economically dependent	-0.19 (-11.3)	0.01 (0.5)	-0.01 (-0.5)
Economically poor	0.28 (16.4)	0.00 (0.1)	0.00 (-0.1)
Living alone	0.02 (1.4)	0.00 (0.0)	0.00 (-0.1)
Physically immobile	0.02 (1.3)	-0.01 (-0.6)	-0.01 (-0.3)
Poor SRH	-0.03 (-1.7)	0.03 (1.7)	0.00 (-0.3)
Worse SRH than previous year	0.01 (0.6)	0.00 (-0.2)	0.00 (0.0)
Intercept	0.23 (13.5)		
% contribution to the overall increase	86.6	9.2	4.2

*Percent contribution has been calculated as the ratio of the contribution of the covariate and the sum of the absolute contribution of covariates under the propensity, composition and interaction components multiplied by 100; SC/STs, scheduled castes/scheduled tribes are officially designated disadvantaged groups in India.

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DISCUSSION

This report provides evidence on trends in hospitalization rates in India over two decades up to 2014, and compares the older population with population under 60 years. Five key findings relating to hospitalization trends and differentials emerge from this study. First, the hospitalization rate increased two-fold between 1995 and 2014; the increase was higher for NCDs and in less developed states. Second, poor people used more public hospitals; this differential was higher in the more developed than the less developed states. Third, the older population had higher hospitalization rates and greater proportion of hospitalization for NCDs than the population under 60 years. Fourth, amongst the older population, the hospitalization rate was comparatively lower for females, poor, and rural residents. Fifth, propensity change was largely responsible for the increase in hospitalization among the older population in India over these two decades.

Hospitalization is an important indicator of the demand for curative care and is an integral part of any health system. The increase in hospitalization rate found in our study could be due to the growing awareness about the health prevention and other precautionary measures along with proper diagnosis of the health conditions. The evidence on increasing hospitalization is vital for planning of resources to meet the growing demand for inpatient care and for formulating viable publicly funded financial risk protection mechanism. To provide targeted financial protective intervention it would also be useful to know whether the increase in hospitalization was due to higher hospitalizations for preventive care among the rich or emergency inpatient care among the poor. Data from the global burden of disease study suggests that of the total disease burden, measured as disability-adjusted life years lost in India, the contribution of noncommunicable disease and injuries has increased from 38.4% in 1990 to 64.2% in 2013.[33] The higher increase in hospitalization for NCDs over two decades is consistent with the shifting disease burden trends in India.

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The developed states in India with good health indicators are usually found to report higher use of healthcare.[10 22] Higher hospitalization rate in the more developed states of India may indicate a higher volume of health services provided by health sector, rather than reflect higher morbidity prevalence. Interestingly, we found that the increase in hospitalization rate between 1995 and 2014 was more pronounced in the less developed than the more developed states. A plausible reason for this could be the increased burden of chronic, degenerative, and lifestyle diseases in the less developed states because of their advancement through the health transition process. Other factors contributing to this could be the greater availability of health services, better access to healthcare, or the increased propensity to use healthcare.

The increase in the use of private hospitals over two decades in India is a matter of concern from the equity point of view and has cost implications for the poor. The continuing inadequacies of the public health system and the unrestricted growth of private providers are possible reasons for the decline in the use of public hospitals. The decline in the use of public hospitals was found to be higher for the non-poor in the less developed states, which implies that in spite of decline, the poor in the less developed states still largely use public hospitals. The increasing provision of inpatient care in private hospitals and the consequent decline in the utilization of public hospitals is likely to impose a higher financial risk on individuals and households.[34 35] Strengthening the public funding model of service delivery in India would increase the ability of public facilities to meet the increasing demand for healthcare and thereby improve the utilization of inpatient care by the poor.

Our results indicated clear distinction in levels and differentials in hospitalization rate between older population and population under 60 years. The older population had more than three times higher hospitalization than any other age groups. Contributing 8.6% to India's population, older population accounted for nearly one-fourth of all hospital stays in 2014. The improved longevity coupled by the increased years of poor health at older ages is

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predominantly responsible for the difference between the hospitalization rates of the two age groups. Data from the global burden of disease study suggest that in India in 1990, disease burden among the older population accounted for 11.8% of the total disease burden. In 2013, this burden had increased to 22.3% of the total disease burden, and noncommunicable diseases and injuries made up 82.3% of the total disease burden.[33] Our results showed that the contribution of the older population in total hospitalization increased over two decades, and they had higher hospitalization rates for NCDs in any given year. However, the hospitalizations in absolute number and their contribution in total hospitalizations remain higher for the population under 60 years. Evidence suggests that over the past 25 years the burden of premature death and health loss from NCDs such as heart disease, stroke, chronic obstructive pulmonary disease, and road traffic injuries has increased substantially, while the burden due to lower respiratory infections, tuberculosis, diarrhea and neonatal disorders remains high in India.[33] For the purpose of planning of the resources for universal health coverage and reducing premature mortality it is important to continue focusing on the child and adult population which account for majority of India's population. At the same time, given the increasing proportion of older population it is equally important to allocate resources and provide healthcare services to cater to their specific healthcare needs.

In the population under 60 years, there was no evidence for gender differential, while, in the older population, a higher proportion of males were hospitalized. Studies from the developed nations have also found that the older women have less hospital stays than their male counterparts.[15 36-39] Greater economic dependency among females at older ages is a major driver of the gender differential in healthcare use in India.[20] On a positive note, we found that the improved likelihood of using hospital care by female older population contributed to the decline in gender differential among the older population.

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In the absence of a health financing system, low level of health insurance coverage and high out of pocket cost of healthcare, economic status becomes an important factor affecting healthcare use. We found that the non-poor had higher hospitalization rates than the poor; this differential was higher for the older population than the other ages. Based on the Andersen's model of healthcare use, we found that the poor older population had significantly less likelihood of using hospital care even after controlling for health profiles. The economic inequality in hospitalization among the older population is evident in India.[16] Older population rely more on family and other social structures for financial support, and therefore, they might not have adequate resources for hospital care. Financial empowerment of the poor older population can be one way of effectively improving the healthcare utilization.

An important finding of this study is that the propensity change has contributed most to the two-fold increase in hospitalization of the older population in India between 1995 and 2014. A plausible explanation could be better awareness of the medical conditions and health among the population.[40] A relatively higher increase in hospitalization among the poor compared to the non-poor older population has contributed most to the increase in hospitalization rate attributed to propensity change. This indicates a decline in the differentials in healthcare use by economic status over two decades. It has been argued that lowering of inequality will not make the situation more equitable for the poor if there is a high increase in the rate of hospitalization, a decline in dependence on government hospitals, and a steep hike in the cost of hospital care.[22]

The increase in hospitalization rate was moderately influenced by the factors not explicitly considered in the model. The supply side factors like the expansion of private healthcare market and consequent improvement in the availability of health services could have propelled the use of healthcare.[22] The expansion of morbidity, with a heavier and

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cumulated concentration of chronic diseases at older ages, could be another potential driver of the increase in hospitalization.[41 42] Compositional change contributed marginally to the increase in hospitalization of the older population over the past two decades. It would be interesting to see how the anticipated compositional change influences the future demand for hospitalization.

The findings of this report must be interpreted in the light of some limitations. First, we used individual determinants and did not examine the full array of determinants of healthcare use as suggested by the Andersen's model of healthcare use. Data on the supply side of healthcare provision were not available from the national sample surveys, nor were comparable data available from other secondary sources corresponding to the survey time points. Second, the use of self-reported data on diseases from the national sample surveys may be associated with biases. However, we report hospitalization trends for broad groups of diseases which may be reasonable. Even with these limitations, this study uses large-scale data from the nationwide surveys in India over two decades to provide insights into the changing hospitalization rate by age groups, and the reasons behind the increased hospitalization of the older population. Given the anticipated further increase of the older population and their higher demand for healthcare, it is time for the policy makers to pay particular attention to planning how adequate resources and mechanisms can be put in place for the provision of geriatric healthcare in India.

FIGURE LEGEND

Fig 1. Socioeconomic and demographic differentials in hospitalization rates in NSS 1995–96, NSS 2004 and NSS 2014, India

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AUTHORS' CONTRIBUTIONS

AP extracted the data, conducted statistical analysis, interpreted the findings, and wrote the first draft of the manuscript. GBP contributed to the initial concept of the paper and guided the statistical analysis. LC provided critical comments on the manuscript for intellectual content. LD provided detailed guidance on the study design, analysis, interpretation of findings and drafting of the manuscript. All authors approved the final version of the manuscript.

COMPETING INTERESTS

There are no competing interests

DATA SHARING STATEMENT

The authors confirm that all data underlying the findings are fully available without restriction. Data are publicly available and can be obtained from the Ministry of Statistics and Programme Implementation, Government of India, New Delhi: http://mospiold.nic.in/Mospi_New/site/inner.aspx?status=3&menu_id=37

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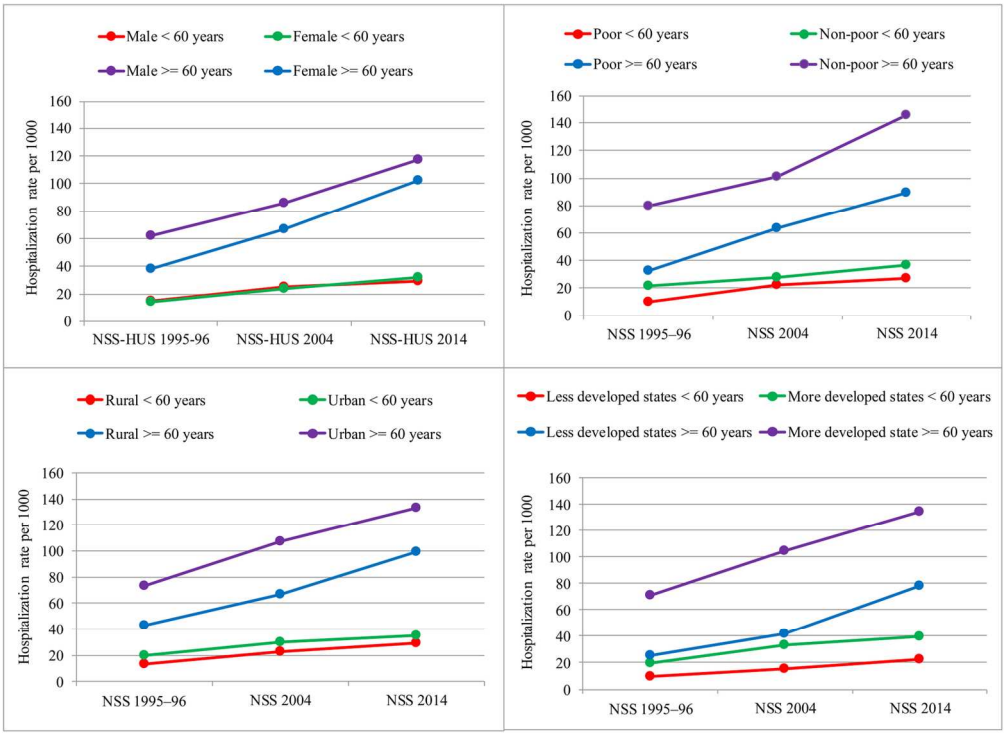

Fig 1. Socioeconomic and demographic differentials in hospitalization rates in NSS 1995–96, NSS 2004 and NSS 2014, India

147x107mm (300 x 300 DPI)

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Table S1 Percent distribution of missing and deceased samples in NSS 1995–96, NSS 2004 and NSS 2014, India

	NSS 1995–96		NSS 2004		NSS 2014	
Background characteristics	N	%	N	%	N	%
			All ages			
Age	55	0.00	38	0.01	0	0.00
Sex	2	0.00	0	0.00	0	0.00
Place of residence	0	0.00	0	0.00	0	0.00
States	0	0.00	0	0.00	0	0.00
Economic status	0	0.00	0	0.00	0	0.00
N (including deceased persons)	633,405		385,055		335,499	
			60 years or more			
Marital status	27	0.12	0	0.00	0	0.00
Caste	21	0.05	9	0.01	0	0.00
Education	41	0.12	16	0.04	0	0.00
Economic dependency	780	2.29	602	1.45	11	0.01
Living arrangement	334	0.85	727	1.72	0	0.00
Physical mobility status	658	1.93	786	1.93	11	0.01
Self-rated health (SRH)	510	1.52	1,650	3.95	11	0.01
SRH compared to previous year	542	1.58	1,650	3.94	11	0.01
N (excluding deceased persons)	33,990		34,831		27,245	
% of hospitalized persons who died in 365 days reference period	1,284	3.05	736	2.32	1,152	2.18
N (including deceased persons)	35,274		35,567		28,397	

NSS, national sample survey; Caste in India is a social stratification of communities into 4 groups, namely scheduled castes (SCs), scheduled tribes (STs), other backward castes, and other castes. SC/STs are officially designated disadvantaged groups in India.

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Table S2 List of diseases grouped according to Global Burden of Disease (GBD) study categorization of diseases, 2013

Communicable diseases and nutritional disorders (CDs)	Non-communicable diseases and injuries (NCDs)
Tuberculosis	Neoplasms
STDs including HIV/AIDs	○ Cancer and other tumours
Diarrhoeal diseases	Cardiovascular and circulatory diseases
○ Cholera	○ Heart disease, Hypertension
○ Diarrhoea/dysentery/gastro-enteritis	○ Rheumatic fever
○ Amoebiosis	Chronic respiratory diseases
Respiratory infections and other common infectious disease	○ Bronchial Asthma and related conditions
○ Dengue/Influenza	Digestive diseases
○ Pneumonia	○ Gastrointestinal bleeding/piles
○ Respiratory (including ear/nose/throat) ailments	○ Gastritis/gastric/peptic ulcer
○ Cough and acute bronchitis	○ Cirrhosis/hydrocele
○ Pleurisy	○ Food poisoning
○ Meningitis and viral encephalitis	Neurological disorder:
○ Diptheria	○ Cerebral stroke
○ Pertussis/whooping cough	○ Other diseases of nerves
○ Tetanus	○ Epilepsy/headache
○ Measles/chicken pox/mumps/eruptive	○ Nervous and general debility
Neglected tropical diseases and malaria	○ Cerebral haemorrhage, thrombosis
○ Filariasis	Mental and behavioural disorders
○ Trachoma	Diabetes, urogenital, blood and endocrine diseases
○ Worm infestation/Guinea worm	○ Diabetes
○ Leprosy	○ Disease of kidney/urinary system/prostrate disorders
Neonatal and maternal disorders	○ Gynaecological disorders
Nutritional deficiencies:	○ Goiter/Thyroid disorders
○ Anemia/bleeding disorders	Musculoskeletal disorders
○ Under-nutrition	○ Disorders of joints and bones
○ Scurvy	○ Locomotor disability
○ Other malnutrition diseases (Beri-Beri , Ricket)	Other non-communicable diseases
Other communicable diseases and nutrition disorders:	Skin and subcutaneous diseases
○ Hepatitis/Jaundice/diseases of liver	Sense organ diseases
○ Fever of unknown origin/fever of short duration/malaria/typhoid	○ Glucoma
	○ Cataracts
	○ Hearing loss, adult onset
	○ Vision disorders, age related
	○ Diseases of ear/nose/throat
	○ Speech disability
	Oral disorders
	Accidents/injury/burns/fractures/poisoning
	Congenital anomalies

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Table S3 Hospitalization rates per 1000 (95% CI) for the older population by disease groups in the major states in NSS 1995–96, NSS 2004 and NSS 2014, India

States	Hospitalization rates per 1000 (95% CI)								
	NSS 1995–96			NSS 2004			NSS 2014		
	All diseases	NCDs	CDs	All diseases	NCDs	CDs	All diseases	NCDs	CDs
Less developed	25.1 (22.3-27.9)	13.6 (12.1-15.1)	5.8 (4.0-7.6)	41.6 (38.4-44.9)	28.6 (25.8-31.4)	7.3 (6.2-8.4)	78.4 (71.3-85.5)	61.2 (54.6-67.8)	15.0 (12.7-17.2)
Assam	28.9 (20.4-37.3)	16.3 (10.1-22.4)	6.2 (2.2-10.2)	35.7 (24.0-47.5)	26.6 (15.4-37.7)	5.3 (3.0-7.7)	37.0 (24.0-50.0)	29.3 (16.6-42.0)	5.9 (3.3-8.5)
Bihar	15.4 (10.7-20.1)	8.1 (5.2-11.0)	4.4 (1.0-7.9)	28.1 (24.1-32.2)	19.4 (16.2-22.7)	4.7 (3.1-6.4)	52.6 (37.2-68.1)	44.9 (29.9-59.9)	6.5 (2.9-10.1)
Madhya Pradesh	29.7 (24.4-35.0)	16.7 (12.8-20.5)	7.4 (4.6-10.2)	47.2 (39.2-55.3)	34.7 (27.3-42.2)	9.4 (6.6-12.3)	101.2 (72.9-129.5)	80.0 (53.0-106.9)	18.9 (10.4-27.4)
Odisha	44.1 (21.2-66.9)	12.0 (7.9-16.1)	14.8 (-1.0-30.5)	42.0 (32.2-51.9)	21.0 (15.7-26.4)	14.6 (6.8-22.4)	79.6 (63.3-95.8)	57.7 (42.7-72.8)	20.2 (14.3-26.2)
Rajasthan	34.3 (25.6-43.1)	21.6 (14.5-28.8)	4.6 (2.5-6.7)	56.7 (45.9-67.5)	37.0 (30.0-44.0)	6.4 (3.5-9.3)	101.9 (88.6-115.2)	75.4 (64.0-86.8)	25.2 (18.5-31.9)
Uttar Pradesh	18.6 (15.1-22.0)	11.8 (9.5-14.2)	3.4 (1.2-5.6)	38.6 (32.0-45.2)	27.7 (21.6-33.8)	5.5 (4.1-6.9)	78.5 (65.5-91.4)	62.5 (50.8-74.2)	12.7 (8.6-16.7)
Jammu & Kashmir	34.3 (15.8-52.9)	19.4 (4.6-34.1)	8.7 (-1.8-19.3)	48.5 (36.4-60.6)	39.0 (28.0-50.0)	6.3 (1.9-10.7)	68.5 (50.4-86.7)	55.9 (39.8-71.9)	11.2 (2.9-19.6)

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(...continued)

States	Hospitalization rates per 1000 (95% CI)								
	NSS 1995–96			NSS 2004			NSS 2014		
	All diseases	NCDs	CDs	All diseases	NCDs	CDs	All diseases	NCDs	CDs
More developed	70.9 (66.1-75.8)	41.7 (37.7-45.8)	12.7 (10.8-14.6)	104.6 (99.8-109.4)	74.6 (70.4-78.7)	17.1 (15.1-19.1)	134.3 (128.0-140.7)	109.7 (103.9-115.5)	21.1 (18.8-23.5)
Andhra Pradesh	47.0 (36.5-57.6)	30.8 (21.7-40.0)	6.2 (3.2-9.2)	65.9 (57.2-74.5)	54.4 (46.3-62.5)	5.8 (3.6-8.0)	111.2 (96.4-126.0)	94.1 (80.6-107.6)	12.9 (8.1-17.7)
Gujarat	45.9 (36.2-55.6)	18.4 (13.9-22.9)	19.3 (11.3-27.3)	102.5 (86.7-118.2)	64.6 (52.5-76.8)	27.3 (18.4-36.2)	123.7 (105.8-141.7)	98.0 (83.4-112.5)	24.9 (14.4-35.3)
Haryana	79.6 (57.0-102.1)	51.5 (33.4-69.6)	20.9 (9.1-32.7)	81.8 (57.2-106.5)	61.0 (38.5-83.5)	13.7 (5.4-22.0)	89.2 (71.5-106.8)	75.3 (58.7-91.9)	13.1 (7.1-19.1)
Karnataka	52.5 (37.8-67.2)	30.5 (18.4-42.6)	8.0 (2.6-13.3)	80.4 (68.2-92.6)	54.0 (44.7-63.3)	10.5 (5.7-15.3)	110.3 (96.9-123.7)	89.2 (76.9-101.4)	19.8 (14.6-25.1)
Kerala	200.5 (175.8-225.1)	110.5 (94.2-128.6)	39.0 (27.9-50.2)	279.1 (251.7-306.5)	190.5 (168.3-212.6)	47.0 (34.9-59.0)	281.3 (249.1-313.5)	216.2 (189.5-243.0)	51.5 (36.2-66.7)
Maharashtra	70.4 (60.3-80.5)	42.9 (3.5-618.2)	10.9 (7.6-14.2)	96.6 (85.0-108.2)	76.0 (65.1-86.8)	11.1 (8.0-14.1)	119.9 (103.1-136.7)	103.0 (86.5-119.4)	14.4 (11.1-17.7)
Punjab	45.6 (34.0-57.2)	21.7 (14.0-29.3)	4.7 (1.7-7.7)	80.7 (63.2-98.2)	58.8 (43.7-73.8)	12.5 (5.1-19.8)	103.7 (80.0-127.5)	89.5 (66.6-112.5)	12.7 (6.8-18.6)
Tamil Nadu	72.7 (52.7-92.7)	52.3 (32.8-71.89)	7.7 (5.2-10.2)	105.6 (92.0-119.2)	71.9 (60.9-82.9)	23.1 (15.8-30.4)	138.1 (118.5-157.7)	115.3 (96.6-134.0)	22.1 (16.3-27.8)
West Bengal	41.5 (33.0-50.1)	22.1 (17.4-26.9)	8.0 (2.3-13.7)	68.5 (59.5-77.4)	46.7 (38.8-54.6)	11.5 (8.4-14.6)	109.4 (98.1-120.7)	86.3 (76.0-96.6)	18.7 (14.3-23.1)
India	49.7 (46.8-52.6)	28.7 (26.5-31.0)	9.5 (8.2-10.8)	76.4 (73.4-79.4)	54.0 (51.4-56.5)	12.7 (11.5-13.9)	109.9 (105.2-114.5)	88.5 (84.2-92.8)	18.4 (16.8-20.1)

CI, confidence intervals; NSS, national sample survey.

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Table S4 Hospitalization rates per 1000 (95% CI) in public hospitals among the older population in the major states in NSS 1995–96, NSS 2004 and NSS 2014, India

	Hospitalization rates per 1000 (95% CI) in public hospitals								
	NSS 1995–96			NSS 2004			NSS 2014		
States	Non-poor	Poor	Total	Non-poor	Poor	Total	Non-poor	Poor	Total
Less developed	53.3 (45.6-60.8)	64.8 (56.0-72.7)	57.1 (51.3-62.6)	38.7 (33.6-44.2)	59.5 (54.9-63.9)	48.9 (45.0-52.9)	36.0 (30.4-41.9)	55.0 (48.9-60.9)	45.2 (40.9-49.6)
Assam	78.8 (61.2-89.8)	67.2 (33.3-89.4)	76.0 (60.1-86.9)	47.7 (25.4-70.9)	83.8 (66.7-93.0)	64.4 (44.9-80.1)	78.3 (65.3-87.4)	86.6 (72.0-94.2)	82.3 (72.3-89.2)
Bihar	35.5 (19.6-55.4)	22.9 (9.1-46.7)	31.3 (18.4-48.0)	14.3 (9.5-20.9)	27.5 (19.2-37.7)	21.3 (16.0-27.6)	20.5 (11.9-33.0)	42.8 (32.6-53.6)	28.8 (20.3-39.1)
Madhya Pradesh	43.6 (33.3-54.4)	72.0 (56.5-83.6)	51.4 (42.2-60.5)	35.1 (26.8-44.4)	67.0 (53.1-78.4)	51.6 (43.1-60.0)	24.5 (14.8-37.7)	48.1 (31.3-65.3)	37.2 (26.2-49.8)
Odisha	92.6 (81.6-97.3)	93.4 (84.5-97.3)	92.9 (85.5-96.6)	74.6 (61.2-84.6)	86.9 (76.3-93.2)	81.1 (72.6-87.5)	71.0 (58.8-80.8)	85.8 (76.9-91.6)	79.2 (72.5-84.7)
Rajasthan	60.7 (44.1-75.1)	44.7 (23.7-67.7)	55.6 (42.1-68.4)	52.7 (39.0-66.0)	70.9 (60.3-79.7)	59.9 (50.0-69.1)	48.8 (40.5-57.2)	66.5 (57.2-74.7)	58.9 (52.4-65.0)
Uttar Pradesh	30.9 (22.8-40.4)	54.2 (38.2-69.4)	38.6 (30.2-47.8)	24.7 (17.4-33.9)	44.7 (36.7-53.0)	34.3 (27.7-41.5)	26.8 (18.5-37.0)	30.8 (23.0-39.9)	28.4 (22.4-35.3)
Jammu & Kashmir	94.5 (82.7-98.4)	99.6 (97.1-100.0)	97.7 (93.6-99.2)	92.6 (84.6-96.6)	85.9 (71.3-93.8)	89.1 (80.7-94.0)	87.1 (73.9-94.1)	94.9 (86.7-98.1)	92.6 (86.2-96.1)

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States	Hospitalization rates per 1000 (95% CI) in public hospitals								
	NSS 1995–96			NSS 2004			NSS 2014		
	Non-poor	Poor	Total	Non-poor	Poor	Total	Non-poor	Poor	Total
More developed	27.2 (23.6-31.1)	52.4 (46.9-57.8)	38.5 (35.0-42.1)	28.1 (25.0-31.3)	42.6 (39.4-45.8)	36.1 (33.9-38.4)	20.7 (18.0-23.6)	41.1 (38.2-44.1)	31.6 (29.5-33.8)
Andhra Pradesh	16.3 (10.0-25.5)	42.2 (27.9-57.9)	24.6 (17.6-33.2)	24.1 (15.9-34.7)	38.8 (30.8-47.4)	32.0 (26.2-38.5)	14.6 (8.7-23.3)	29.9 (22.8-38.0)	22.6 (17.7-28.3)
Gujarat	27.2 (15.9-42.5)	64.9 (47.1-79.3)	40.6 (30.0-52.2)	17.7 (11.2-26.8)	33.6 (24.4-44.3)	25.4 (19.5-32.3)	16.7 (10.3-26.0)	33.6 (26.0-42.0)	24.9 (19.5-31.2)
Haryana	39.8 (24.7-57.0)	25.2 (10.8-48.4)	33.3 (22.0-46.8)	20.8 (11.5-34.6)	18.2 (9.2-33.0)	19.6 (12.5-29.2)	6.9 (3.8-12.4)	52.9 (39.0-66.3)	29.7 (21.3-39.8)
Karnataka	33.0 (19.6-49.9)	46.3 (27.5-66.3)	35.1 (23.1-49.5)	20.8 (12.9-31.6)	51.4 (40.6-62.0)	35.4 (28.3-43.2)	26.5 (16.3-40.1)	28.5 (22.4-35.5)	27.8 (22.1-34.2)
Kerala	21.1 (14.4-29.9)	55.1 (47.2-62.8)	42.0 (35.9-48.4)	26.9 (20.2-34.9)	41.0 (35.0-47.3)	35.6 (31.0-40.5)	20.3 (14.4-27.8)	49.5 (42.3-56.7)	33.8 (28.8-39.3)
Maharashtra	15.2 (9.9-22.8)	35.8 (26.3-46.5)	25.1 (19.4-31.9)	22.7 (15.6-31.7)	36.2 (29.0-44.1)	30.7 (25.4-36.5)	9.3 (6.2-13.7)	29.7 (22.3-38.2)	20.5 (15.7-26.3)
Punjab	35.8 (22.9-51.1)	41.8 (22.7-63.7)	38.3 (27.0-51.0)	32.4 (20.0-47.9)	25.2 (14.4-40.2)	29.4 (20.4-40.3)	22.3 (7.5-50.6)	24.8 (16.1-36.2)	23.6 (13.8-37.3)
Tamil Nadu	21.5 (14.1-31.5)	69.4 (49.7-83.9)	43.2 (29.3-58.2)	16.7 (11.6-23.3)	43.5 (34.8-52.6)	33.6 (27.7-40.1)	13.6 (9.2-19.7)	40.7 (32.9-49.1)	30.8 (25.7-36.4)
West Bengal	62.3 (51.5-72.0)	83.0 (65.1-92.7)	69.0 (59.6-77.1)	60.2 (51.6-68.3)	82.1 (75.0-87.5)	69.0 (63.2-74.2)	49.8 (43.2-56.4)	72.1 (63.4-79.4)	61.0 (55.9-65.9)
India	34.1 (30.4-37.9)	54.6 (49.9-59.2)	42.7 (39.7-45.8)	30.9 (28.3-33.6)	46.3 (43.6-49.1)	39.2 (37.3-41.2)	25.8 (23.2-28.4)	45.2 (42.5-47.9)	35.9 (33.9-37.8)

CI, confidence intervals; NSS, national sample survey.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1-2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-6
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	-
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	8
		(*e*) Describe any sensitivity analyses	-
Results			

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Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	-
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	15-18
		(b) Indicate number of participants with missing data for each variable of interest	Appendix Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	15-16
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	19-20
		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-14 and 21-22
Discussion			
Key results	18	Summarise key results with reference to study objectives	23
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	27
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	23-26
Generalisability	21	Discuss the generalisability (external validity) of the study results	23-26
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	28

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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