

BMJ Open Pattern, correlates and implications of non-communicable disease multimorbidity among older adults in selected Indian states: a cross-sectional study

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ABSTRACT

Objectives: The objective of the present study was to estimate the proportion of older adults with non-communicable disease (NCD) multimorbidity, its correlates and implications in selected Indian states.

Methods: The study used data of 9852 older adults (≥60 years) (men 47%, mean age 68 years) collected by the United Nations Population Fund from seven selected Indian states. Multiple logistic regression analysis was used to assess the correlates of NCD multimorbidity and hospitalisation.

Results: NCD multimorbidity was reported by 30.7% (95% CI 29.8 to 31.7). Those in the highest wealth group, aged ≥70 years, alcohol users, women and tobacco users were more likely to report NCD multimorbidity compared to those without any NCD and single NCD. Those with multimorbidity, the wealthiest, ever tobacco users and those who had formal education were more likely to be hospitalised compared to their counterparts after adjusting for age, sex and ever use of alcohol.

Conclusions: Multimorbidity needs to be considered for planning NCD healthcare services provision particularly inpatient facilities focusing on alcohol users, tobacco users and women. Further studies are required to find out reasons for higher rates of multimorbidity among the wealthier group other than higher healthcare services usage and detection rates.

INTRODUCTION

The simultaneous occurrence of more than one health condition (multimorbidity) in the same individual especially in the older adults is increasingly becoming the norm.¹ Previous studies reported controversial results that multimorbidity was associated with the increased risk of mortality and vice versa.² A positive association between age and multimorbidity prevalence has also been reported.³ In most studies in the west,

Strengths and limitations of this study

- The findings of the study are from a large representative sample of 9852 older adults from selected Indian states.
- Non-communicable diseases in this study were self-reported, which is likely to be an underestimate of the actual prevalence in India although it was reported from developed countries that self-reports were reasonably accurate for certain chronic conditions.
- Even though sampling weights are used in the data analysis, there is a possibility of over-optimistic CIs (too narrow) in some cases due to cluster effect.

multimorbidity was reported to be higher among women.^{3–5} Multimorbidity was more prevalent among those with lower socio-economic status in developed countries,^{4 6–8} whereas in developing countries like India, multimorbidity tends to be more prevalent among the wealthier.^{9–12}

A few recent studies from different parts of India reported an increasing prevalence of multimorbidity with age.^{11–13} For example, the prevalence of multimorbidity in India increased from 1.3% in individuals aged 18–29 years to 30.6% in those aged 70 years and above. India had 104 million older adults population aged 60 years and above according to 2011 census and their number is projected to increase to 133 million by the year 2021.¹⁴ A recent study from India reported under-usage of healthcare services by the older adults due to various reasons including discrimination.¹⁵ However, there are only limited studies on the pattern and correlates of non-communicable diseases (NCDs) multimorbidity among older adults in India.^{10–13} The objective of the present study was to

estimate the proportion of older adults with multi morbidity, its correlates and implications in selected Indian states.

METHODS

We used data collected by the United Nations Population Fund (UNFPA) in the year 2011 on 'Building Knowledge Base on Population Ageing in India'. Using a multistage random sampling this national survey selected seven Indian states based on proportion of elderly aged 60 years and above (given in the bracket) and regional representation: Kerala (10.5%) and Tamil Nadu (8.8%) from the south, Punjab (9.0%) and Himachal Pradesh (9.0%) from the north, Maharashtra (8.7%) from the west and Orissa (8.3%) and West Bengal (7.1%) from the east. From each state 1280 households with older adults were selected. The primary sampling units (PSUs) were villages or urban wards. The PSUs were selected using the probability proportion to population size technique. Eighty PSUs were taken equally from rural and urban areas. The PSUs were then classified into different strata on the basis of population size. Since the list of households with older adults was not available, the details were gathered during the house listing and mapping process. From a list of households having at least one older adult, 16 households were selected randomly from each PSU and all the older adults in the selected households were approached for an interview. The response rate was 92.9%. Detailed methodology was published elsewhere.¹⁶

The sample was equally taken from rural and urban areas, irrespective of the distribution of older people across rural and urban areas and almost same sample size from all the selected states. We performed the analysis after applying sampling weights (We created sampling weights at the individual and household levels for urban and rural areas separately. Then we calculated design weight by adjusting for non-response at both the household and individual level. At the state level we normalised the sample weights in order to obtain standard state weights for the seven states in our study so that the total number of weighted cases was equal to the total number of unweighted cases) since the sampling scheme was distributed disproportionately.

'Has a doctor or nurse ever told you to have the disease?' was the question asked to assess chronic disease morbidity. However, this was not cross-checked with the prescription or any other clinical records. The chronic NCDs considered for the present study were: arthritis (including rheumatism, osteoarthritis and osteoporosis), high-blood pressure, cataract, diabetes, lung disease, heart disease, paralysis, depression, Alzheimer's disease, stroke (including cerebral embolism or thrombosis), dementia and cancer. Multimorbidity was defined as the coexistence of at least 2 of these 12 selected NCDs in the same person.

All the 12 NCDs considered were combined together with two NCDs as a cluster. Thus a total of 66 clusters were formed. This was used to determine the common clusters of conditions. Hospitalisation was defined as the medical treatment received as inpatient of a hospital at least for 1 day during the past 12 months due to the selected 12 NCDs. Hospitalisation rate was calculated for hospitalisation due to the aforementioned NCDs in the past 1 year.

For the current study, we used the data on demographic characteristics, wealth index, tobacco use, alcohol consumption, prevalence of NCDs and hospitalisation due to NCDs. Educational status was divided into two: no formal schooling (those who did not attend any school) and formal schooling (those who had completed a formal school level education). Ever smoking was defined as smoking at least one cigarette/bidi at some point in one's lifetime. Wealth index was calculated based on the asset holdings and amenities within the household and was generated as quintiles of wealth and has been published earlier.¹⁶ All these were based on self-reports.

From each state 1280 households with older adults were selected. The set of sample households had at least one older adult aged 60 years or above and all the older adults in the selected households were interviewed. The fieldwork was carried out during May to September, 2011 and a total of 8329 household interviews and 9852 individual interviews were conducted. The response rate was 93%.

The sample was equally taken from rural and urban areas and almost the same sample size from all the selected states. Data were analysed giving sampling weights at the individual and household level for rural and urban areas using SPSS V.17.0 (SPSS, Chicago, Illinois, USA). Separate analysis was performed to find the factors associated with multimorbidity compared to those without any NCD and multimorbidity compared to those with single NCD, using multiple logistic regression analysis. Among those who had at least one NCD, analyses were separately performed to find out the factors associated with hospitalisation due to NCD using multiple logistic regression analysis. The variables considered in the model to determine the factors associated with multimorbidity and hospitalisation were age, sex, educational level, wealth index, ever use of tobacco and ever use of alcohol. Since we used the data collected by UNFPA this study was exempted from ethics clearance by the Institute ethics committee of Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum.

RESULTS

The mean age of the study population was 68 years (SD ± 7.3) and 47% were men. More than half of the older adults (54%) were formally educated and 59% were currently married. Proportion of people living alone was

6%, 15% with spouse and the remaining 79% with others. More than half (52%) were rural residents. Nearly half (49.0%) of the older adults were formally educated. Ever use of tobacco was 45.5% and ever use of alcohol was also 45.5%. Nearly one-fourth (24.2%) of the sample were in the lowest, 61.0% were in the middle and 14.8% were in the highest wealth index group.

Sixty-three per cent of the older adults suffered from at least one NCD. Multimorbidity was seen among 30.7% of older adults. Of those with NCDs, 49% had multimorbidity. Among the elderly with multimorbidity, the most common clusters of conditions were arthritis and high-blood pressure (7.5%), arthritis and cataract (5.3%) and diabetes and high-blood pressure (4.7%).

Chronic NCD morbidity pattern is presented in table 1.

Factors associated with multimorbidity compared to those without NCD and compared to those with one NCD based on multiple logistic regression analysis are given in table 2.

Of those who were suffering from the selected NCDs, 5.6% were hospitalised due to the disease in the past 1 year. The mean number of hospitalisation was three for those with one NCD and nine for those with multimorbidity.

Among those who had at least one NCD, factors associated with hospitalisation due to NCD are given in table 3.

Those with multimorbidity (OR 2.32, CI 1.82 to 2.95), the wealthiest (OR 1.99, CI 1.33 to 2.98), those who had formal education (OR 1.33, CI 1.03 to 1.71) and ever users of tobacco (OR 1.48, CI 1.82 to 2.95) were more likely to be hospitalised compared to their counterparts after adjusting for age, sex and ever use of alcohol.

State wise prevalence (per 1000) of the selected chronic NCDs is presented in table 4. The top five conditions were arthritis (305), high-blood pressure (210), cataract (129), diabetes (101) and lung disease including asthma (91).

DISCUSSION

More than 60% of the older adults in our study had at least one NCD which is a huge challenge for the health-care system in India with limited capacity for managing NCDs. Among those with NCDs, 49% had multimorbidity which adds to this healthcare system's challenge. The present study showed a high level of NCD multimorbidity (30.7%) which was similar to the 30.6% reported among older adults aged 70 years and above and higher than the 21.3% among those aged 60–69 years from an earlier study in India.¹¹ Multimorbidity prevalence was reported as 45% among adults aged 65 years and above from Kosovo,¹⁸ 62% among adults aged ≥ 65 years from Germany¹⁹ and 55% among older adults aged 77 years and above from Sweden.⁷

Multimorbidity becomes progressively more common with age as reported in several studies.^{1 6 8 20} The lower proportion of multimorbidity in our study could be due to the limited access and usage of healthcare services in India compared to the above countries. Discrimination against older adults in healthcare seeking in India could also be another reason for under-usage of healthcare services resulting in not detecting NCDs many of which are asymptomatic.¹⁵

In our study, highest prevalence of most NCDs was reported from the state of Kerala which is the most advanced state in epidemiological and demographic transition.²¹ This could be due to the better access and use of healthcare in this state. In order to increase the access to healthcare, India will lead to increase the investments in public sector healthcare which is currently 1.4% of gross domestic product, one of the lowest in the world.²²

Hypertension (21%) and diabetes (10%) were two of the most common NCDs reported in this study. However, the prevalence of hypertension by measurement in the older adults in India ranged from 55% in

Table 1 Chronic NCD morbidity pattern in the sample population (N=9852)

Chronic disease	Percentage reported the disease	Percentage with comorbidity	Comorbidities (Mean \pm SD)
Arthritis (including rheumatism, osteoarthritis and osteoporosis)	30.6	15.7	1.8 \pm 0.9
High-blood pressure	21.0	14.0	2.1 \pm 1.0
Cataract	12.9	9.2	2.2 \pm 1.1
Diabetes	10.1	7.4	2.3 \pm 1.1
Lung disease including asthma	9.1	5.9	2.2 \pm 1.2
Heart disease	5.8	4.3	2.4 \pm 1.2
Paralysis	1.8	1.1	2.1 \pm 1.1
Depression	1.5	1.3	2.9 \pm 1.5
Alzheimer's disease	1.4	1.1	2.8 \pm 1.5
Stroke (including cerebral embolism or thrombosis)	1.0	0.8	2.7 \pm 1.3
Dementia	0.9	0.8	3.1 \pm 1.5
Cancer	0.4	0.3	2.4 \pm 1.4

NCD, non-communicable disease.

Table 2 Factors associated with multimorbidity: results of multivariate logistic regression analysis

Variable	Adjusted OR (95% CI)	
	Multimorbidity* N=3031 vs no NCD (N=3632)	Multimorbidity* (N=3031) vs one NCD (N=3189)
Age (years)		
60–70	Reference	Reference
70+	2.44 (2.19 to 2.71)	1.69 (1.52 to 1.87)
Sex		
Men	Reference	Reference
Women	1.51 (1.35 to 1.69)	1.13 (1.01 to 1.27)
Education		
No formal schooling	Reference	Reference
Formal schooling	0.91 (0.81 to 1.02)	1.16 (1.04 to 1.30)
Wealth index		
Lowest	Reference	Reference
Middle	2.03 (1.78 to 2.31)	1.35 (1.18 to 1.54)
Highest	4.68(3.90 to 5.62)	2.17 (1.81 to 2.59)
Ever use of tobacco		
No	Reference	Reference
Yes	1.22 (1.08 to 1.37)	0.85 (0.76 to 0.95)
Ever use of alcohol		
No	Reference	Reference
Yes	1.53 (1.25 to 1.89)	1.23 (1.01 to 1.50)

*Multimorbidity is \geq chronic NCDs.
NCD, non-communicable disease.

Table 3 Factors associated with hospitalisation: results of age-sex adjusted multiple logistic regression analysis among those with at least one NCD (N=6220)

Variable	Hospitalisation* (%)	Adjusted OR OR (95% CI)
Education		
No formal schooling	4.3	Reference
Formal schooling	6.6	1.33 (1.03 to 1.71)
Ever use of tobacco		
No	4.9	Reference
Yes	6.5	1.48 (1.15 to 1.90)
Wealth index		
Lowest	3.4	Reference
Middle	5.4	1.46 (1.04 to 2.06)
Highest	8.1	1.99 (1.33 to 2.98)
Morbidity Pattern		
Prevalence of one NCD	3.3	Reference
Multimorbidity	7.7	2.32 (1.82 to 2.95)

Variables included in the model but were not significant were age, sex and ever use of alcohol.

*Hospitalised within 1 year due to chronic NCD.
NCD, non-communicable disease.

rural to 72% in urban areas²³ and diabetes prevalence among older adults aged ≥ 65 years was 30.4%²⁴ indicating an underestimate of self-reports of these conditions. The current Indian national programme on the prevention and control of cancer, cardiovascular disease,

diabetes and stroke envisages detection and management of hypertension and diabetes among adults aged 30 years and above which is likely to increase the detection rate of these conditions even among older adults. The prevalence of cataract in our study (13%) was lower than the prevalence of unoperated cataract confirmed by doctors among people aged ≥ 60 years in India that ranged from 53% in south India to 58% in north India.²⁵ This indicates that the large proportion of cataract in India is undetected even after the implementation of the national programme for control of blindness in India since 1976. Hypertension and arthritis were the commonest combination of multimorbidity which was similar to that reported earlier.³

Various organisations such as the International Diabetes Federation (IDF), World Heart Foundation (WHF), Union for International Cancer Control (UICC) and World Lung Foundation (WLF) are focusing on individual chronic diseases such as diabetes, cardiovascular disease, cancer and chronic lung disease. Although the WHO has recommended integration of all the NCDs into a single national programme because of their common risk factors such as tobacco use, alcohol consumption, unhealthy diet and physical inactivity, only a few countries such as Brazil and China have such common NCD programmes at the national level.²⁶ For example, the national programme for prevention and control of cancer, cardiovascular disease, diabetes and stroke in India does not include chronic obstructive pulmonary disease. Integration of all these NCDs into a single national programme is important because of their

Table 4 Prevalence (per 1000) of chronic NCDs in older adults in selected Indian states

Diseases	Himachal Pradesh	Punjab	West Bengal	Orissa	Maharashtra	Kerala	Tamil Nadu	Combined
1 Arthritis (including rheumatism, osteoarthritis and osteoporosis)	423	481	222	253	361	175	215	305
2 High-blood pressure	147	329	238	147	130	397	106	210
3 Cataract	105	130	162	70	197	207	44	129
4 Diabetes	59	123	77	50	69	281	60	101
5 Lung disease including asthma	104	76	42	51	152	175	35	91
6 Heart disease	32	83	82	12	20	158	34	58
7 Paralysis	18	23	14	25	22	10	13	18
8 Depression	11	26	15	11	24	9	12	15
9 Alzheimer's disease	20	4	24	3	40	1	5	14
10 Stroke (including cerebral embolism or thrombosis)	9	3	29	1	6	22	3	10
11 Dementia	4	3	3	16	22	10	6	9
12 Cancer	4	6	1	1	3	7	4	7

Source: Mini.¹⁷

NCD, non-communicable disease.

common risk factors and because of the occurrence of multimorbidity among individuals. Recently WHO has recommended integrating mental health also into the common NCD programme.

Though the access and factors associated with hospitalisation varies between countries, more hospitalisation associated with multimorbidity seen in our study was similar to earlier findings from USA.²⁷ Hospitalisation is likely to increase the cost of healthcare. Many households are drawn below poverty line because of healthcare cost in India.²⁸ Owing to this cost factor the discrimination against the older adults, particularly women is likely to increase in India.

Our finding that older adults in the highest wealth index were more likely to be hospitalised than poorer their counterparts is contrary to the findings from the developed countries.³ This is probably because of the differences in the nature of epidemiological transition between developed and developing countries. In developing countries like India prevalence of NCDs in the upper socioeconomic strata was reported to be higher compared to those belonging to the lower socioeconomic strata²⁹ whereas in developed countries the reverse trend was reported.⁶⁻⁸ It was also reported that the measurement of socioeconomic status was challenging for older adults.³⁰ Moreover poor people cannot afford hospitalisation because of the high expenses involved. For example, expenditure for chronic diseases such as acute coronary syndrome was reported to be 15 times higher for poor people compared to non-poor in the Indian state of Kerala.³¹

Our study has several limitations. The self-reported multimorbidity has the limitation of recall bias. Along with the identification and selection bias of chronic illness using self-reports, design and methodological

restrictions of the original data apparently enforce limitations in our ability to establish more inferences as the original study was not mainly intended to address multimorbidity. However, our findings are consistent with other studies. Even though sampling weights are used in the data analysis, there is a possibility of over optimistic CIs (too narrow) in some cases due to cluster effect. We only studied selected states in India and hence the findings are not generalisable to the whole of India. We are also unable to provide any information on the time of episode of illness. For defining multimorbidity we simply summed up the number of diseases present by counting all diseases equally; however, the severity of diseases was not captured. The importance of presenting this big database representative of a large population in India is the limited availability of national level data on multimorbidity, which has implications to initiate more specific studies on multimorbidity.

In conclusion, our study on multimorbidity among older adults in India found that more than 30% had multimorbidity. Older age, women, those in higher socioeconomic status, tobacco users and alcohol users were more likely to have multimorbidity compared to those with no NCD. We also found that hospitalisation rates were significantly higher among those with multimorbidity and those who belonged to the wealthier group. The self-reported morbidity in our study was an underestimate of several chronic conditions such as hypertension, diabetes and cataract. This underestimation was probably due to poor access and under-usage of healthcare services. Further studies are required to find out reasons for higher rates of multimorbidity among the wealthier group other than higher healthcare services usage and detection rates. India needs to substantially increase the public sector investment in healthcare

in order to address the problem of multimorbidity and its related consequences such as higher hospitalisation. Social security of older adults in India also needs to be strengthened to address the challenge of multimorbidity.

To the best of our knowledge, none of the previous studies in India reported multimorbidity patterns and the associated determinants among older adults. NCDs in this study were self-reported, which is likely to be an underestimate of the actual prevalence in India although it was reported from developed countries that self-reports were reasonably accurate for certain chronic conditions.^{32 33}

Contributors The study was conceptualised by GKM and KRT. Data analysis was performed by GKM. Both authors contributed to writing and editing this paper, and have read and approved the final manuscript.

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Competing interests None declared.

Ethics approval The ethics clearance for the original study was obtained by the UNFPA.

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Data sharing statement No additional data are available.

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REFERENCES

- OECD. *Health reform: meeting the challenge of ageing and multiple morbidities*. OECD Publishing, 2011. (accessed 10 Jun 2016).
- Marengoni A, Angleman S, Melis R, *et al*. Aging with multimorbidity: a systematic review of the literature. *Ageing Res Rev* 2011;10:430–9.
- Violan C, Foguet-Boreu Q, Flores-Mateo G, *et al*. Prevalence, determinants and patterns of multimorbidity in primary care: a systematic review of observational studies. *PLoS ONE* 2014;9:e102149.
- Barnett K, Mercer SW, Norbury M, *et al*. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. *Lancet* 2012;380:37–43.
- Prados-Torres A, Poblador-Plou B, Calderón-Larrañaga A, *et al*. Multimorbidity patterns in primary care: interactions among chronic diseases using factor analysis. *PLoS ONE* 2012;7:e32190.
- van den Akker M, Buntinx F, Metsemakers JF, *et al*. Multimorbidity in general practice: prevalence, incidence, and determinants of co-occurring chronic and recurrent diseases. *J Clin Epidemiol* 1998;51:367–75.
- Marengoni A, Winblad B, Karp A, *et al*. Prevalence of chronic diseases and multimorbidity among the elderly population in Sweden. *Am J Public Health* 2008;98:1198–200.
- Salisbury C, Johnson L, Purdy S, *et al*. Epidemiology and impact of multimorbidity in primary care: a retrospective cohort study. *Br J Gen Pract* 2011;61:e12–21.
- Khanam MA, Streatfield PK, Kabir ZN, *et al*. Prevalence and patterns of multimorbidity among elderly people in rural Bangladesh: a cross-sectional study. *J Health Popul Nutr* 2011;29:406–14.
- Banjare P, Pradhan J. Socio-economic inequalities in the prevalence of multimorbidity among the rural elderly in Bargarh District of Odisha (India). *PLoS ONE* 2014;9:e97832.
- Pati S, Agrawal S, Swain S, *et al*. Non communicable disease multi morbidity and associated health care utilization and expenditures in India: cross-sectional study. *BMC Health Serv Res* 2014;14:451.
- Pati S, Swain S, Hussain MA, *et al*. Prevalence, correlates, and outcomes of multimorbidity among patients attending primary care in Odisha, India. *Ann Fam Med* 2015;13:446–50.
- Vadrevu L, Kumar V, Kanjilal B. Rising challenges of multiple morbidities among the rural poor in India—a case of the Sundarbans in West Bengal. *Int J Med Sci Public Health* 2016;5:343–50.
- Rajan SI. *Centre for enquiry into health and allied themes. Population Ageing and Health in India, 2006*. <http://www.cehat.org/humanrights/rajan.pdf> (accessed 17 Nov 2016).
- Joe W, Rudra S, Subramanian SV. Horizontal inequity in elderly health care utilization: evidence from India. *J Korean Med Sci* 2015;30:S155–66.
- United Nations Population Fund (UNFPA). *Report on the status of elderly in selected states of India 2011*. New Delhi, India: Building Knowledge Base on Ageing in India, United Nations Population Fund, 2012.
- Mini GK. *Pattern and correlates of chronic non-communicable diseases among older adults in selected states of India*. New Delhi, India: Building Knowledge Base on Population Ageing in India (BKPAI) Working Paper Series II No. 3, United Nations Population Fund (UNFPA), 2014. <http://www.isec.ac.in/BKPAI-WP-III.pdf> (accessed 2 Jan 2016).
- Jerliu N, Toçi E, Burazeri G, *et al*. Prevalence and socioeconomic correlates of chronic morbidity among elderly people in Kosovo: a population-based survey. *BMC Geriatr* 2013;13:22.
- van den Bussche H, Schön G, Kolonko T, *et al*. Patterns of ambulatory medical care utilization in elderly patients with special reference to chronic diseases and multimorbidity—results from a claims data based observational study in Germany. *BMC Geriatr* 2011;11:54.
- Walker A. Multiple chronic diseases and quality of life: patterns emerging from a large national sample, Australia. *Chronic Illn* 2007;3:202–18.
- Peters DH, Rao KS, Fryatt R. Lumping and splitting: the health policy agenda in India. *Health Policy Plan* 2003;18:249–60.
- World Bank. Health expenditure, public (% of GDP). <http://data.worldbank.org/indicator/SH.XPD.PUBL.ZS> (accessed 10 Jun 2016).
- Hypertension Study Group. Prevalence, awareness, treatment and control of hypertension among the elderly in Bangladesh and India: a multicentre study. *Bull World Health Organ* 2001;79:490–500.
- Jain A, Paranjape S. Prevalence of type 2 diabetes mellitus in elderly in a primary care facility: an ideal facility. *Indian J Endocrinol Metab* 2013;17:318–22.
- Vashist P, Talwar B, Gogoi M, *et al*. Prevalence of cataract in an older population in India: the India study of age-related eye disease. *Ophthalmology* 2011;118:272–8.e1–2.
- Bonita R, Magnusson R, Bovet P, *et al*. Lancet NCD Action Group. Country actions to meet UN commitments on non-communicable diseases: a stepwise approach. *Lancet* 2013;381:575–84.
- Creditor MC. Hazards of hospitalization of the elderly. *Ann Intern Med* 1993;118:219–23. http://apps.who.int/iris/bitstream/10665/94384/1/9789241506236_eng.pdf (accessed 24 Dec 2015).
- van Doorslaer E, O'Donnell O, Rannan-Eliya RP, *et al*. Effect of payments for health care on poverty estimates in 11 countries in Asia: an analysis of household survey data. *Lancet* 2006;368:1357–64.
- Reddy KS, Prabhakaran D, Jeemon P, *et al*. Educational status and cardiovascular risk profile in Indians. *Proc Natl Acad Sci* 2007;104:16263–8.
- Grundy E, Holt G. The socioeconomic status of older adults: how should we measure it in studies of health inequalities? *J Epidemiol Community Health* 2001;55:895–904.
- Daivadanam M, Thankappan KR, Sarma PS, *et al*. Catastrophic health expenditure & coping strategies associated with acute coronary syndrome in Kerala, India. *Indian J Med Res* 2012;136:585–92.
- Martin LM, Leff M, Calonge N, *et al*. Validation of self-reported chronic conditions and health services in a managed care population. *Am J Prev Med* 2000;18:215–18.
- Beltrán-Sánchez H, Jiménez MP, Subramanian SV. Assessing morbidity compression in two cohorts from the Health and Retirement Study. *J Epidemiol Community Health* 2016;70:1011–16.