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Economic Status and Adult Mortality in India: Is the Relationship Sensitive to Choice of Indicators?

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SUMMARY

Research on economic status and adult mortality is often stymied by the reciprocity of this relationship and lack of clarity on which aspect of economic status matters. While financial resources increase access to healthcare and nutrition and reduce mortality, sickness also reduces labor force participation, thereby reducing income. Without longitudinal data, it is difficult to study the linkage between economic status and mortality. Using data from a national sample of 132,116 Indian adults aged 15 years and above, this paper examines their likelihood of death between wave 1 of the India Human Development Survey (IHDS), conducted in 2004–05 and wave 2, conducted in 2011–12. The results show that mortality between the two waves is strongly linked to the economic status of the household at wave 1 regardless of the choice of indicator for economic status. However, negative relationship between economic status and mortality for individuals already suffering from cardiovascular and metabolic conditions varies between three markers of economic status—income, consumption, and ownership of consumer durables—reflecting two-way relationship between short- and long-term markers of economic status and morbidity.

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1. Introduction

The correlation between economic status and health has been extensively documented at both macro and micro levels (Deaton, 2002; Kitagawa, 1973; Preston, 1975). However, research seeking to understand the causal relationship between the economic status of individuals and mortality faces three serious challenges: (1) Economic status tends to be a loosely defined term that is variously operationalized as income, occupation, wealth, ownership of assets, and consumption by different studies, frequently because data availability dictates the choice of measures (Bollen, Glanville, & Stecklov, 2001). However, as we discuss below, these distinctions are conceptually meaningful, but little attention has been paid to whether the relationship between economic status and mortality is sensitive to choice of indicators (2) Economic status and health do not have a unidirectional relationship, making it difficult to model these relationships with cross-sectional data. Poverty may lead to poor health, but illness may also reduce income. Thus, longitudinal studies can help to untangle this relationship. (3) Economic status may affect health outcomes both positively and negatively. Much of the research in this area has tended to focus on the beneficial impact of economic status on health outcomes, while overlooking potentially negative influences. This issue is particularly relevant in transitional societies where health limitations associated with obesity and lack of physical activity tend to disproportionately affect the rich, creating what has been called "double burden" of malnutrition (Ramachandran, 2016).

In this paper we examine the link between the economic status of 132,116 Indian adults ages 15 and above in 2004–05 and the likelihood of their death by 2011–12. Using prospective data from a unique household survey, the India Human Development Survey (IHDS) allows us to address some of the challenges described above in order to examine the extent to which economic status offers protection against death for Indian adults. The IHDS data are particularly well-suited to this analysis because they collect information at an earlier point in time on both different markers of economic status and whether individuals suffer from major diseases. The second interview, conducted seven years later, provides the information about the survival status of these individuals.

2. Conceptual challenges

Studies linking economic status to mortality must address three crucial questions in order to develop appropriate analytical strategies:

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(a) What constitutes economic status?

Although economic status forms the core of demographic research on individual well-being, few studies critically reflect on indicators of economic status they use and what these indicators measure (Bollen *et al.*, 2001). Data limitations often force researchers to make choices that provide good approximations of the relative economic ranking of households suitable for studies where economic status is simply a control variable. However, this strategy is inadequate when economic status is the primary variable of interest. Three commonly used markers of economic status—income, consumption expenditure, and wealth or asset ownership—tap into three different dimensions of economic status.

(i) Income

Income from wages, self-employment, government transfers, and rents or dividends, forms the core on which households build their lifestyles. In societies where most of these incomes are received in cash, data on income are routinely collected and feature prominently as independent or control variables in studies of individual well-being. However, as we consider income fluctuations within a life cycle perspective, limitations of focusing on cross-sectional measures of income become quickly apparent (Modigliani & Brumberg, 1954). Income is rarely stable across the life course with most income being concentrated in adulthood while children are supported by their parents and older individuals rely on savings or support from other family members or government (Lee & Mason, 2011). Moreover, income also tends to fluctuate considerably from year to year, particularly in agricultural societies where vagaries of weather lead to substantial crop variations.

Income data may also contain considerable measurement error (Deaton, 1997). In societies characterized by high degree of self-employed (e.g. agriculture or petty business), it is necessary to obtain detailed data on inputs and outputs to calculate net income. It is also possible, that high income households may understate their incomes.

(ii) Consumption

Potential discrepancy between short-term fluctuations in income and longer term needs of families for a stable life-style led Friedman (1957) to distinguish between permanent and transient components of income. This distinction led to arguments that household consumption is more closely related to permanent income and less susceptible to income volatility (Friedman, 1957) so that consumption expenditures have become the favored indicator of household economic status in research on developing countries (Grosh & Glewwe, 2000). Although less volatile than income, consumption expenditures also could easily spike in a given year, for example when large medical emergencies take place. Moreover, research in India has shown that consumption data are sensitive to reference period for data collection (Sen, 2000).

(iii) Assets

Wealth is a third measure often used to measure household economic status (OECD, 2013). Households that own large amounts of wealth but have low current income can easily borrow against this wealth to finance day-to-day living. Real estate, savings, stocks, and bonds typically get counted as wealth in rich societies. However, in poor countries, non-liquid wealth in the form of ownership of consumer durables and housing has been used quite profitably as a measure of household economic status by many researchers (Bollen *et al.*, 2001; Filmer & Pritchett, 2001; Montgomery, Gragnolati, Burke, & Paredes, 2000). Montgomery *et al.* (2000) find that while the standard of living measured by ownership of household assets is weakly correlated with consumption expenditure per adult in any given year, assets are strong enough "proxies" when it comes to predicting outcomes of demographic interest. However, a number of weaknesses of these asset-based measures should be noted. First, asset indices are sensitive to household size and do not take into account economies of scale. Second, in some settings, many items in this index may be acquired through gifts or major life transitions, e.g. in India it is common to give a TV as dowry. Thus, they may reflect income or consumption from own resources poorly but nonetheless provide assets that households may use to finance expenditures. Finally, as Montgomery *et al.* note, some of the items often included in these indices may have an effect on mortality independent of their significance for economic status (e.g., clean tap water, toilets, electricity, transportation).

Each of these three markers of economic status reflects a different life-cycle process. Income is most vulnerable to short-term fluctuations of the three while assets, often treated as markers of wealth, are the most long-term since they are accumulated over a lifetime. Consumption expenditures form a medium-term measure of economic status—households may save during periods of unexpected windfall income to spend during periods of economic stress, but over time if the windfall or shortfall in income becomes more or less stable, life-styles may be adjusted to incorporate these into permanent incomes. Thus, selection of an indicator to measure economic status must depend on whether we see the relationship between economic status and mortality operating in short, medium or long term.

(b) How can we address potential biases due to reverse causality?

It has long been recognized that poverty is associated with ill-health (Deaton, 2002). In England and Wales, the systematic documentation of mortality by occupational class began as early as 1851, with the publication of Decennial Supplements to the Annual Report of the Registrar General. Social class differentials in mortality became the focus of systematic study in the United States only in the latter half of the twentieth century, with the publication of Kitagawa and Hauser's path-breaking study of demographic and socio-economic mortality differentials. This study was based on the 1960 Census matched to death certificates filed in May–August of the same year (Hummer, Rogers, & Eberstein, 1998; Kitagawa, 1973). Although there exists ample literature on the nexus between socio-economic status and health and mortality in Western societies, research on this issue in an Asian context gained prominence only in the 1990s (Chen, Yang, & Liu, 2010; Liang *et al.*, 2000; Liu, Hermalin, & Chuang, 1998; Saikia & Ram, 2010; Zimmer, 2008; Zimmer & Amornsirisomboon, 2001; Zimmer, Kaneda, & Spess, 2007; Zimmer, Martin, Ofstedal, & Chuang, 2007).

One of the challenges faced by literature in this area emerges from the possibility of reverse causation. Poor health may restrict an individual's capacity to earn income and accumulate assets by limiting work or by raising medical expenses. In his pioneering article titled *Healthy Bodies and Thick Wallets*, James P. Smith (1999) concluded that the causal direction of the relationship between income and health is not uniform across the life-cycle. During the pre-retirement period, health affects income, whereas for older individuals, income affects health. In recent decades, several studies have tried to address challenges of reverse causality in research located in developed countries (Case & Paxson, 2011).

However, in extending this work to developing countries, we encounter an additional challenge. Economic status may be measured via a variety of indicators such as income, consumption expenditure, and ownership of assets (Deaton, 1997). Several studies have tried to find ways to find easy measures of economic status without having to engage in extensive data collection (Filmer &

Pritchett, 2001; Montgomery *et al.*, 2000). However, when it comes to studying the link between mortality and economic status, it is not clear which indicator to use since each may be associated with underlying health conditions with varying degrees of immediacy. Onset of illness may increase expenditure on medicines and physician costs immediately; it may reduce ability to work and consequently reduce income in medium term and may reduce purchasing power for larger items in longer term. Thus, the results may be sensitive to a choice of indicators.

(c) Does economic status have a consistently positive impact on health outcomes?

While literature in developed countries associates rising incomes with healthy lifestyles, consumption of more diverse foods, and lower obesity, emerging literature from India suggests that growing income may be associated with negative as well as positive influences on health. Higher income individuals in India typically tend to engage in non-manual work (Desai *et al.*, 2010), reducing physical activity, which, in turn, reduces caloric needs; but their food intake rises due to growing income. Moreover, greater incomes may lead to a preference for "superior foods", which in the case of India, include refined cereals, and the consumption of rice and wheat instead of small millets as also the higher consumption of fats. All of these may be linked to rising rates of diabetes rather than improving health (Mohan, Radhika, Vijayalakshmi, & Sudha, 2010). Increasing consumption of restaurant food by higher income Indians (National Sample Survey Organisation, 2012) may also be linked to poor diets.

This is a distinctly different scenario from that prevalent in industrial societies where the proportion of individuals involved in manual labor is smaller and the consumption of organic and unrefined food is more expensive than mass-produced and processed but less healthy foods. Consequently, obesity is associated with poverty rather than wealth. This has been particularly documented in the United States where the rates of obesity and of associated chronic disease are higher among the poor than among the rich (Levine, 2011).

This sedentary lifestyle in conjunction with well-documented risks of cardio-vascular diseases and diabetes among South Asian populations places higher income Indians at a greater risk. Research suggests that there is some possibility that either genetic factors or their traditional carbohydrate-based diets make Indians more susceptible to cardio-vascular diseases and diabetes. South Asian populations living abroad, particularly in Europe and the United States, have shown very high rates of diabetes, high blood pressure and heart conditions (Gunarathne *et al.*, 2009; Gupta, Wu, Young, & Perlman, 2011). The rates of coronary heart disease have been reported to be unusually high in several parts of the world among people originating from the Indian subcontinent (McKeigue, Miller, & Marmot, 1989). A UK study showed that men and women from India had the highest standardized mortality rates due to cardiovascular diseases, and that young Indian men were at particularly high risk of contracting these diseases (Balarajan, Bulusu, Adelstein, & Shukla, 1984). The cardiovascular mortality of South Asian migrants was also seen to increase with the duration of residence in England and Wales, presumably as these migrants became richer (Harding, 2003). Indian immigrants in the United States show a higher prevalence of diabetes and a number of related chronic diseases such as hypertension and cardiac conditions (Bhopal, 2000; Shah *et al.*, 2015). Since Indians form the ethnic group with the highest income and education levels in the United States (Migration Policy Institute, 2014), this is a surprising finding that deserves to be studied for the population residing in India where comparison across income levels within the same population is feasible.

At the same time, however, higher economic status may make it easier to obtain effective treatment for these diseases. While in theory, the Indian public health system comprises a vast array of primary health centers located throughout the country (Gangolli, Duggal, & Shukla, 2005), in practice nearly 3 out of 4 Indians use private health services and have to incur large out-of-pocket expenditures (Barik & Desai, 2014). Higher economic status may also be associated with living in households with better water and sanitation facilities which may also reduce morbidity and increase survival (Spears, 2013). Thus, the extent to which an income-mortality nexus exists in India is an open question.

3. Limited research on adult mortality in India

Most of the research on mortality in India has focused on infant and child mortality (Ghosh, 2012; Kumar, Singh, Rai, & Singh, 2013; Morris *et al.*, 2013; Ram, Jha, Ram, & Kumar, 2010; Ram *et al.*, 2013; Singh, Pathak, Chauhan, & Pan, 2011); and research on adult mortality is limited at best. Earlier studies of adult mortality in India concentrated more on the levels and trends (Clark, 1987; Dandekar, 1972; Dyson, 1984) rather than underlying processes. In a recent study, Ram *et al.* (2015) explored the regional variation in the risk of adult mortality among Indian districts and identified the eastern Indian districts to be more susceptible to the risk of adult death.

Unfortunately, India has lacked comprehensive data for the analysis of individual and household-level predictors of adult mortality. India has a vital registration system to record vital statistics like birth, deaths, and marriage, but it is poorly organized, and frequently incomplete, particularly in rural areas. Adult mortality statistics come mainly from the Sample Registration System (SRS), which is fairly complete but lacks socio-economic information about individuals.

Using retrospective data from the National Family Health Survey (NFHS), Saikia and Ram (2010) have tried to explore the factors associated with adult death (among persons aged 15–59 years). Since the NFHS focused mainly on maternal and child health, information on adult mortality in NFHS is somewhat limited and subject to recall bias. Defining the universe for which retrospective data are to be obtained is difficult since households may restructure themselves after the death of a patriarch or a young widow may move in with her parents after being widowed. In both cases, deceased individuals may not be included in the retrospective data for the sample household. Additionally, with retrospective recall, it is not possible to obtain data on the socio-economic status of a household before the individual's death (Saikia & Ram, 2010). Since both household structure and household income are affected by death, particularly the death of income-earning adults, it is difficult to develop an analytical model using retrospective data. It is this niche that the present paper seeks to fill.

4. Data and methods

(a) IHDS: Advantages of panel data

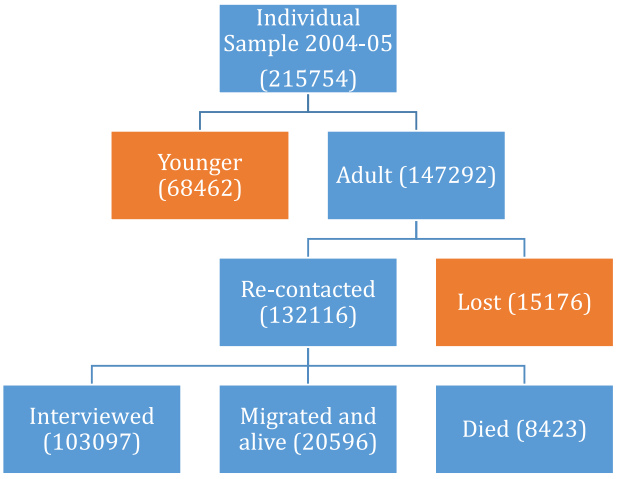
In this paper, we use prospective data from the India Human Development Surveys (IHDS) of 2004–05 and 2011–12. The IHDS is the first Indian nationwide panel survey with a sample that is sufficiently large to study rare events like mortality. IHDS began as a multi-topic panel study of 41,554 households from 33 states and union territories across India. The first wave of IHDS collected socio-economic and health data for over 215,754 individuals across 1503 villages and 971 urban neighborhoods. The survey was designed to be nationally representative at its inception.

In 2011–12, all of the 2004–05 households as well as any households separating from the root household but residing in the same area were selected for re-interviews. The re-contact rate for IHDS was 83–90% in rural areas and 72% in urban areas. For each of the original household members in 2004–05, a tracking sheet was filled out identifying their current whereabouts and survival status. For individuals who had migrated, their current occupation, marital status, and survival status were obtained from the household members still residing in the original households. Where the whole household had migrated or died, basic demographic information and survival was collected from closest relatives or friends identified by the household in wave 1 as being the persons most likely to stay in touch with them. For about 95% of the migrants, family members left behind were able to provide information about their survival status, in about 5% of the cases, the whole household had migrated and close relatives or friends provided information about the survival status of the migrants.

Figure 1 provides a detailed description of attrition of the IHDS 2004–05. IHDS 2004–05 collected information from 215,754 individuals on various aspects like health status, education, employment, and activities of daily life, among others. Out of the entire sample, 147,292 were adults of age 15 years and above in IHDS 2004–05—our target sample. Among them 15,176 (close to 10%) were lost to re-interview for the IHDS 2011–12 survey and no information about their whereabouts is available. Of those successfully re-contacted either in person or via proxy information (132,116)—8423 died.

The biggest challenge to this analysis comes from sample attrition—individuals or households that could not be re-contacted at all—about 9.2% of the eligible sample. The loss of sample was higher among the rich and those living in the urban areas. Sample losses usually occurred due to migration—mostly for work. While attrition biases our results, given that attrition is disproportionately concentrated in richer households living in urban areas and studies in other parts of the world have shown that sick individuals are the least likely to migrate (White, 2016), we expect that while attrition may bias our results, it may provide a lower bound estimate of the relationship between household economic status and probability of survival.

Comparison of IHDS data with other reputable data sources such as the Census, National Sample Surveys (NSS) and National Family Health Survey (NFHS) shows that the IHDS compares well with these sources on common items (Desai *et al.*, 2010). For example, the NSS estimates poverty rate to be 37% in 2004–05 and 22% in 2011–12; IHDS estimates are similar at 38% in 2004–05 and 21% in 2011–12.



Source: India Human Development Survey 2004-2005 and 2011-2012.

Figure 1. Description of IHDS sample used for analyses.

(b) Methodology

In this paper, we analyze the log odds that individuals aged 15 years and above who were interviewed in the 2004–05 survey died before the second survey was conducted in 2011–12, with sample losses being treated as censoring. This prospective panel allows us to explore the link between economic and health status at wave 1 and the probability of death by wave 2.

As noted earlier, poverty may be the result rather than the determinant of ill-health and mortality (Smith, 1999) if ill-health leads to lower incomes. In order to address this potential bias, we use data on economic status in 2004–05 and relate these to subsequent mortality between 2004–05 and 2011–12. This does not totally eliminate potential endogeneity since even in 2004–05 income may well be depressed due to ill health that later leads to death. However, the IHDS also contains data on major morbidity and we use these data to model the mechanisms through which economic status may affect mortality. The IHDS contains information on a range of major illnesses and we focus on three major illnesses—heart conditions, diabetes, and high blood pressure. In analyses not presented here we also explore other conditions such as tuberculosis, cancer, and asthma with similar findings but present the three conditions noted above in this paper since literature has identified these as particular risk factors associated with rising incomes as well as South Asian heritage.

(c) Measurement of economic status

The IHDS data contain three major indicators of economic status:

1. *Income:* Income is measured for the 12 months preceding the survey using monetary income from wage and salary, government transfers, remittances as well as agricultural and business income received by household members. For agricultural products that are consumed by the household, their market value is added to generate total household income. For some households, annual income from all sources translated to negative income. When agricultural expenses are subtracted from the value of the output, some households suffered net loss. These households, including those with income less than a thousand annually were not necessarily poor as revealed by other economic indicators (e.g. asset score), but experienced a bad year like crop failure, or loss in business etc. This could also be due to cyclical incomes, particularly for orchard owners whose crops may be biannual. So, we choose to analyze them separately than combining with the poor.
2. *Consumption expenditure:* The IHDS administered an abbreviated consumption module for 49 items that has been well tested in the Employment and Unemployment portion of National Sample Surveys. This module collects data on food expenditure, educational expenditure, health expenditure, housing, and transportation expenditure among others. The reference period for more frequently collected items is 30 days while that for rarely purchased items is 12 months. We have combined these create a consumption measure for 30 days.
3. *Asset index:* The household wealth or asset index was constructed using a set of 23 dichotomous variables measuring the household possession of basic and durable assets (Figure 2). The weighted mean number of assets owned by households was 7.97 with a standard deviation of 4.29. The wealth index was created using a simple sum of the assets; the unweighted Cronbach's reliability coefficient alpha of the wealth scale was

0.89. The values of the wealth index used in this analysis vary from 0 to 23, where a value of "0" denotes that the household possesses none of the 23 assets, and a value of "23" indicates the ownership of all 23 assets by the household. It has become common in research based on Demographic and Health Surveys to create a wealth index using Principal Component Analysis that allow for different items to be weighted differently. When a similar index was constructed with the IHDS data, the correlation between PCA based index and simple summative index was 0.99. Hence for simplicity and ease of interpretation we use the summative index. In results not reported here, all analyses were repeated using PCA with similar results—not surprising given the high correlation between two indices.

Income and consumption expenditure are continuous variables and we standardize them for household size by dividing the value of income/expenditure by square root of household size and taking a log of this term. This allows us to take into account economies of scale as well as household size (Gornick & Jantti, 2013). It is not easy to standardize an asset index by household size; however, it may also not be conceptually meaningful to undertake this standardization. Most of these items, e.g. electric fan or television, are shared by different household members.

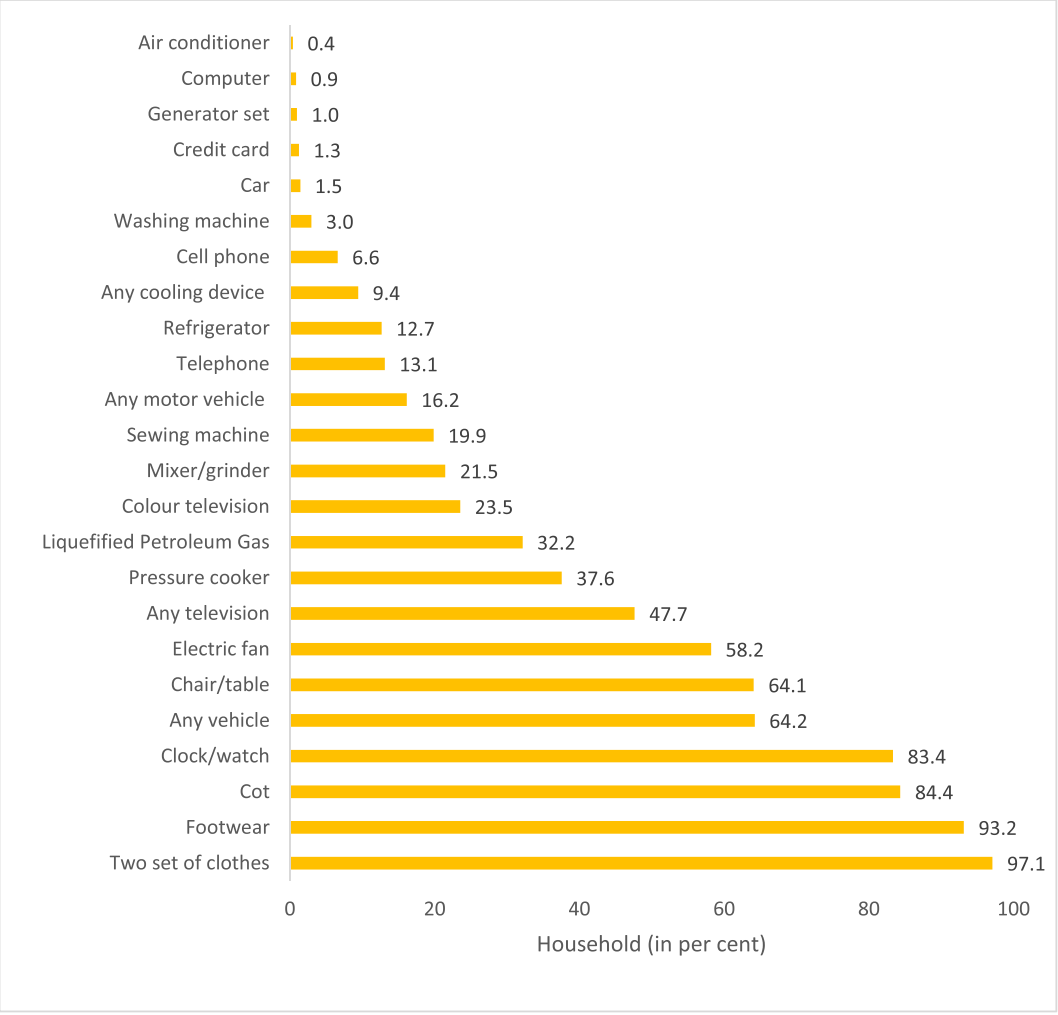
5. Research questions

This paper seeks to answer the following research questions:

1. Is household economic status associated with the probability of adult death in the subsequent seven years? If so, is this relationship sensitive to choice of indicators used to measure economic status?
2. Are individuals from higher economic strata more likely to suffer from chronic conditions that may reduce the probability of their survival?
3. Is the relationship between chronic health conditions and mortality similar for the rich and the poor?

Our approach to addressing these question is through estimating a series of logistic regressions, first with morbidity as a dependent variable and then with mortality as a dependent variable with morbidity as an intervening variable.

We control for age, gender, marital status, education, employment status, caste/religion, place of residence, and state of residence in our analyses. Descriptive statistics for mortality, morbidity, income, consumption expenditure, wealth index, and other background factors are presented in Table 1.



Source: India Human Development Survey 2004-2005.

Figure 2. Possessions of various assets in selected sample households in India, 2004–05.

6. Results

(a) Higher economic status is associated with higher morbidity

This paper began by identifying both positive and negative impacts of economic status. While higher economic resources allow for better medical care, they may also lead to greater likelihood of contracting diseases like diabetes, heart conditions, and high blood pressure. Table 2 estimates logistic regressions with likelihood of experiencing any one of these diseases as a dependent variable.

The results show that ceteris paribus, individuals living in households with higher economic status face higher odds of suffering from high blood pressure, cardiac condition, or diabetes. This relationship is positive and statistically significant for each of the three indicators of economic status. Because these data are contemporaneous—both morbidity information and economic status information are collected in wave 1 of the IHDS survey—they suffer from reverse causality discussed above. However, if the causal direction is of concern with morbidity reducing income or wealth, the fact that we see a positive relationship between the two in spite of this potentially negative feedback loop suggests that this is a strong relationship indeed and actual relationship may be even larger than we estimate.

One economic indicator for which this argument does not hold is for consumption expenditure. Presence of these illnesses may lead to higher expenditure for diagnostic tests and medication and may result in individuals drawing down on their savings to increase total overall expenditure. The coefficient for expenditures in morbidity regression is far larger than that for the income, suggesting a strong possibility that reverse causation is operating for this indicator.

However, the strong positive relationship between economic status and morbidity suggests that, at least in India, it is important to examine both positive and negative impacts of higher economic status on mortality. It is also reasonable to wonder if higher economic status may be associated with greater access to medical care, resulting in the quicker diagnosis of illnesses like high blood pressure that may well go undetected in the case of poorer individuals. This remains a valid concern to which we return in the discussion section.

Table 1
Description of the individual sample followed in India Human Development Survey 2011–12 from 2004–05 wave

	Surviving	Died	Sample
Three major morbidity condition			
No	94.00	6.00	127,809
Yes	81.44	18.56	4307
Sex			
Male	92.74	7.26	66,232
Female	94.44	5.56	65,884
Age			
15–29 years	98.58	1.42	53,169
30–44 years	97.48	2.52	37,982
45–59 years	92.58	7.42	24,629
60 years or more	69.78	30.22	16,335
Marital status			
Unmarried/no Gauna	98.36	1.64	31,336
Married	94.11	5.89	90,264
Widowed	73.54	26.46	9711
Divorced/separated	90.56	9.44	805
Education			
Illiterate	89.78	10.22	48,363
Up to 5th standard	93.22	6.78	21,110
Secondary level	96.51	3.49	42,615
Metric but non graduate	98.00	2.00	11,584
Graduate & above	97.56	2.44	7439
Social groups			
Forward caste	93.73	6.27	27,863
OBC	93.71	6.29	47,638
Dalit	93.34	6.66	28,508
Adivasis	91.92	8.08	9542
Muslims	94.61	5.39	15,115
Christian, Sikh & other minority religion	93.03	6.97	3450
Income quintile			
Poorest	91.89	8.11	21,086
Second	93.16	6.84	23,813
Middle	93.63	6.37	26,783
Fourth	93.93	6.07	28,795
Richest	94.70	5.30	31,638
Consumption quintile			
Poorest	91.51	8.49	18,980
Second	93.09	6.91	23,223
Middle	93.57	6.43	26,305
Fourth	94.32	5.68	29,762
Richest	94.46	5.54	33,847
Asset quintile			
Poorest	91.83	8.17	25,485
Second	93.46	6.54	27,698
Middle	93.64	6.36	24,015
Fourth	94.27	5.73	31,152
Richest	94.66	5.34	23,767
Place of residence			
Rural	93.29	6.71	97,579
Urban	94.42	5.58	34,537
Work status			
Not working	91.06	8.94	51,289
Working	95.19	4.81	80,827
Total	**93.59**	**6.41**	**132,116**

Notes: *Morbidity refers to any of the three conditions—Diabetes, Cardiac Condition, or Hypertension.
Source: India Human Development Survey 2004–05 and 2011–12, age 15 or greater in 2004–05.

(b) Net effect of economic status on mortality is negative

In Table 3 we examine the relationships of log equivalent income, log equivalent consumption, and the household asset index in 2004–05 with the probability of dying between 2004–05 and 2011–12. Models are estimated separately for each indicator of economic status. For each indicator we also present two models: the first model only contains economic status and the second contains both the economic status indicator and morbidity at wave 1. For each model we control for age, gender, marital status, employment status, education, caste/ethnicity/religion, place of residence, and state of residence. For parsimony we do not discuss control variables here except to note that their effect on mortality appears to be in the expected directions with older, less educated, and rural individuals more likely to suffer from both morbidity and mortality.

Consistent with earlier research in the Asian context (Liang *et al.*, 2000, 2002; Saikia & Ram, 2010), these results confirm a strong inverse relationship between household economic status and adult mortality. If age, sex, education, and the place and state of residence are held constant, the risk of mortality declines as household economic status increases in Model 1 for income, consumption expenditure, and household asset index respectively.

The second model adds a control for the presence of chronic morbidity at wave 1. Not surprisingly, experiencing diabetes, cardiac conditions, or high blood pressure is strongly associated with the risk of subsequent mortality. And in each model the impact of economic status on mortality becomes even larger in magnitude because of the positive relationship between economic status and morbidity that we saw in Table 2. Model 1 shows an estimate of the total impact of economic status on mortality, while Model 2 shows the negative impact net of its positive impact via morbidity,

Table 2
Log odds of three major morbidities by household income, consumption, wealth, and other socio-economic characteristics in India

	Model 1		Model 2		Model 3	
	Coef	SE	Coef	SE	Coef	SE
Log equivalent income pc	0.070*	0.03				
Log equivalent consumption pc			0.612**	0.05		
Asset					0.089**	0.01
Sex (male omitted)						
Female	0.300**	0.10	0.255**	0.10	0.252**	0.09
Age (15–29 years omitted)						
30–44 years	1.799**	0.12	1.770**	0.12	1.753**	0.12
45–59 years	2.840**	0.11	2.738**	0.12	2.739**	0.12
60 years & above	3.308**	0.12	3.215**	0.13	3.186**	0.13
Education level (illiterate omitted)						
Upto 5th standard	0.403**	0.08	0.318**	0.08	0.293**	0.08
Secondary level	0.428**	0.09	0.241**	0.09	0.199*	0.10
Metric but non graduate	0.603**	0.14	0.317*	0.14	0.254	0.15
Graduate & above	0.612**	0.12	0.200	0.12	0.158	0.13
Missing values	−0.321	0.25	−0.359	0.25	−0.356	0.25
Marital status (married omitted)						
Unmarried/married no gauna	−0.842**	0.15	−0.841**	0.15	−0.813**	0.15
Widowed	0.080	0.10	0.115	0.10	0.110	0.10
Divorced/separated	−0.329	0.33	−0.223	0.33	−0.235	0.33
Social group (forward caste omitted)						
OBC	−0.224**	0.07	−0.161*	0.07	−0.142*	0.07
Dalit	−0.385**	0.08	−0.242**	0.08	−0.214**	0.08
Adivasi	−0.941**	0.23	−0.717**	0.22	−0.723**	0.23
Muslim	−0.108	0.09	−0.026	0.09	−0.013	0.09
Christian, Sikh & other minority religion	0.114	0.11	0.105	0.10	0.125	0.10
Negative income (no omitted)						
Yes	−0.193	0.25				
Place of residence (rural omitted)						
Urban	0.447**	0.07	0.367**	0.07	0.266**	0.07
Whether working (no omitted)						
Yes	−0.262**	0.08	−0.227**	0.08	−0.189**	0.07
Constant	−5.499**	0.32	−11.162**	0.46	−5.522**	0.23
Observations	132,116		132,116		132,116	
Chi Square	2247.82		2589.47		2407.39	
DF	42		41		41	

Note: $^{**}p < 0.01$, $^{*}p < 0.05$. *Morbidity refers to any of the three conditions—Diabetes, Cardiac Condition, or Hypertension. All models include state dummy variables. The results are not shown for brevity. Standard errors are clustered at the PSU level in weighted regressions.
Source: India Human Development Survey 2004–05 and 2011–12.

increasing the size of the coefficient. This increase is especially large for the consumption coefficient compared to the income and asset coefficients, consistent with our argument of the reinforced association of expenditures and morbidity because of the likely impact of morbidity on increasing health expenditures. Model 2 shows that although richer individuals have a higher likelihood of contracting cardiovascular and metabolic diseases, this does not increase their overall mortality. Thus, the wealthy are living longer, albeit with poorer health.

(c) Individuals with pre-existing conditions experience lower mortality when living in households with more assets

Table 4 interacts economic status with pre-existing morbidity to see if individuals with pre-existing acute conditions like diabetes, cardiac conditions, and high blood pressure are especially likely to survive if they live in households with higher economic status. The results suggest that this relationship depends on the marker of economic status we are using. Only for the household asset index does this table show a statistically significant interaction effect. Living in a wealthier household reduces mortality for all individuals, but it is especially important for individuals suffering from chronic morbidity.

Predicted probability of death from Table 4 is plotted in Figure 3 for individuals with and without preexisting conditions. Results show that probability of death between two surveys in absence of morbidity is 7.7% for the poorest while it is 4.4% for the richest, nearly half. This difference is much wider for those with preexisting morbidity from the three listed conditions, a ratio of 3 to 1.

It seems likely that this is where greater susceptibility of income and consumption expenditure to reverse causal direction is relevant. Incomes are likely to be depressed with greater morbidity and consumption expenditure is likely to be greater for households that have to cope with health expenditures. Hence, for both of these indicators, our wave 1 measures are already affected by presence of morbidity. While it is also possible that wealth index at wave 1 may also be affected by the presence of morbidity at wave 1, this impact is likely to be smaller since wealth is acquired over a lifetime. This lower distortion may lead to lower standard errors and consequently the interaction term for wealth and morbidity is significant while that for consumption or income and morbidity are not.

7. Discussion

Factors leading to adult mortality in developing countries have received considerably less attention than those leading to child mortality, primarily due to data limitations. While data on infant and child mortality along with its socio-economic correlates are routinely collected in demographic and health surveys, data about

Table 3
Log odds of mortality for three indicators of household economic status

	Income				Consumption				Asset			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	Coefficients	*SE*	*Coefficients*	*SE*	*Coefficients*	*SE*	*Coefficients*	*SE*	*Coefficients*	*SE*	*Coefficients*	*SE*
Log equivalent income pc	−0.048**	0.02	−0.050**	0.02								
Log equivalent consumption pc					−0.062**	0.02	−0.080**	0.02				
Asset									−0.034**	0.01	−0.039**	0.01
Morbidity (no omitted)												
Yes			0.514**	0.10			0.527**	0.10			0.552**	0.10
Sex (male omitted)												
Female	−0.836**	0.05	−0.844**	0.05	−0.837**	0.05	−0.844**	0.05	−0.824**	0.05	−0.829**	0.05
Age (15–29 years omitted)												
30–44 years	0.602**	0.12	0.593**	0.12	0.606**	0.12	0.597**	0.12	0.615**	0.12	0.606**	0.12
45–59 years	1.601**	0.11	1.571**	0.11	1.603**	0.11	1.574**	0.11	1.625**	0.11	1.597**	0.11
60 years & above	2.879**	0.11	2.835**	0.11	2.882**	0.11	2.839**	0.11	2.912**	0.11	2.869**	0.11
Education level (illiterate omitted)												
Upto 5th standard	−0.216**	0.05	−0.231**	0.05	−0.213**	0.05	−0.226**	0.05	−0.182**	0.05	−0.193**	0.05
Secondary level	−0.469**	0.06	−0.485**	0.06	−0.468**	0.06	−0.479**	0.06	−0.400**	0.06	−0.407**	0.06
Metric but non graduate	−0.832**	0.10	−0.859**	0.10	−0.833**	0.10	−0.853**	0.10	−0.721**	0.11	−0.734**	0.11
Graduate & above	−0.948**	0.10	−0.980**	0.10	−0.949**	0.10	−0.970**	0.10	−0.804**	0.10	−0.818**	0.11
Missing values	0.298*	0.13	0.311*	0.13	0.300*	0.13	0.314*	0.13	0.305*	0.13	0.321*	0.13
Marital status (married omitted)												
Unmarried/married no gauna	−0.097	0.11	−0.082	0.12	−0.096	0.11	−0.080	0.12	−0.109	0.12	−0.094	0.12
Widowed	0.596**	0.05	0.594**	0.06	0.593**	0.05	0.591**	0.06	0.587**	0.05	0.584**	0.06
Divorced/separated	0.829*	0.34	0.843*	0.34	0.829*	0.34	0.841*	0.33	0.803*	0.33	0.813*	0.33
Social group (forward caste omitted)												
OBC	−0.020	0.05	−0.008	0.05	−0.018	0.05	−0.009	0.05	−0.049	0.05	−0.042	0.05
Dalit	0.094	0.06	0.113	0.06	0.089	0.06	0.104	0.06	0.035	0.06	0.047	0.06
Adivasi	0.383**	0.07	0.403**	0.07	0.376**	0.07	0.390**	0.07	0.310**	0.08	0.321**	0.08
Muslim	−0.107	0.06	−0.097	0.06	−0.104	0.06	−0.097	0.06	−0.137*	0.06	−0.131*	0.06
Christian, Sikh & other. minority religion	−0.028	0.10	−0.049	0.10	−0.032	0.10	−0.051	0.10	−0.022	0.10	−0.041	0.10
Negative income (no omitted)												
Yes	0.131	0.16	0.138	0.16								
Place of residence (rural omitted)												
Urban	0.025	0.05	0.004	0.05	0.014	0.04	−0.004	0.05	0.096*	0.05	0.085	0.05
Work status (not working omitted)												
Working	−0.656**	0.05	−0.647**	0.05	−0.664**	0.05	−0.655**	0.05	−0.685**	0.05	−0.678**	0.05
Constant	−2.845**	0.23	−2.865**	0.24	−2.664**	0.30	−2.520**	0.30	−3.041**	0.18	−3.057**	0.18
Observations	132,116		132,116		132,116		132,116		132,116		132,116	
Chi-Square	7395.08		7325.26		7233.29		7102.61		7235.2		7157.92	
DF	42		43		41		42		41		42	

Note: $^{**}p < 0.01$, $^{*}p < 0.05$. *Morbidity refers to any of the three conditions—Diabetes, Cardiac Condition, or Hypertension. All models include state dummy variables. Results are not shown for brevity. Standard errors are clustered at the PSU level in weighted regressions.
Source: India Human Development Survey 2004–05 and 2011–12.

Table 4
Log odds of mortality in interaction with morbidity and income, consumption, and wealth.

	Model 1		Model 2		Model 3	
	Coeff	SE	Coeff	SE	Coeff	SE
Log equivalent income pc	−0.05**	0.02				
Log equivalent consumption pc			−0.08**	0.02		
Asset					−0.03**	0.01
Morbidity * lneqincpc	−0.02	0.04				
Morbidity * lneqcopc			0.00	0.09		
Morbidity * Asset					−0.04*	0.02
Morbidity (no omitted)						
Yes	0.71	0.37	0.53	0.92	0.93**	0.20

Note: $^{**}p < 0.01$, $^{*}p < 0.05$. *Morbidity refers to any of the three conditions—Diabetes, Cardiac Condition, or Hypertension. All models include controls as of Table 3. Results are not shown for brevity. Standard errors are clustered at the PSU level in weighted regressions.
Source: India Human Development Survey 2004–05 and 2011–12.

adult mortality are harder to come by. Moreover, the conceptual limitations of mortality and economic status analyses are worse for adult mortality because of the greater potential for reverse causal effects of morbidity and mortality on adult incomes and expenditures.

Using data from the India Human Development Survey, a panel survey conducted in 2004–05 and then again in 2011–12, this paper analyzes the relationship between economic status and subsequent mortality for 132,116 adults ages 15 and above. Based on these results, this paper emphasizes three aspects of the

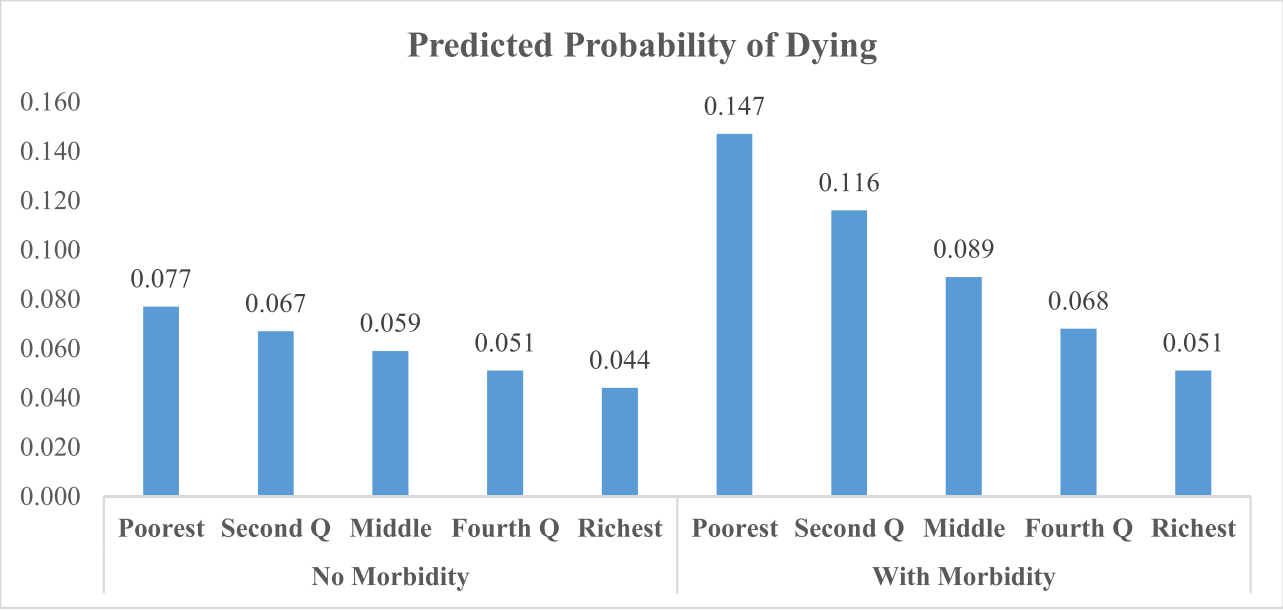


Figure 3. Predicted probability of death among adults from various asset groups by Morbidity Status in India, 2004–05.

relationship between household economic status and adult mortality:

(1) It distinguishes between three different indicators of economic status—income, consumption, and household wealth—and finds that each is related to reduced mortality among adults in the seven years following the initial measurement of economic status. This suggests that the relationship between higher economic status and lower mortality is robust to choice of indicators.
(2) It finds that individuals living in households with higher economic status have greater likelihood of suffering from diabetes, high blood pressure, and cardiac conditions. This observation is consistent with recent literature on double burden of malnutrition in India (Ramachandran, 2016) and supplements the emerging literature on South Asian immigrants which suggests that rising incomes may be associated with poor diet and life styles that increase the underlying susceptibility of these immigrants to cardiovascular and metabolic diseases. It also stands in direct contrast to the literature in developed countries which finds a higher prevalence of obesity and cardiovascular diseases in poorer sections of the society. This observation, combined with the literature on double burden of malnutrition in India (Ramachandran, 2016) suggests that in transitional societies increasing wealth may bring health risks that may need greater attention. Ceteris paribus, individuals suffering from one of these three conditions at Wave 1, are significantly more likely to die at wave 2. Thus, higher economic status has both positive and negative effects on mortality, although on balance the positive relationship dominates.
(3) It suggests that although having cardiac condition, diabetes, or high blood pressure increases mortality, this relationship is smaller for individuals from households with higher wealth. However, this interaction is statistically significant only for the economic indicator that taps into long-term wealth. Measures of short-term economic status like annual income and consumption expenditure are themselves affected by presence of morbidity and this measurement error increases the standard errors in the interaction term between economic status and morbidity in regressions predicting mortality.
A focus on both positive and negative consequences of higher income is a particular contribution of this paper. It is not possible to say unequivocally from our analysis that an increase in wealth leads to an increase in what have come to be termed as "lifestyle diseases". It is possible that the availability of wealth simply makes it easier to diagnose these illnesses earlier. However, addition of morbidity to regressions including indicators of economic status increases the negative impact of economic status on mortality strengthening our arguments (and observations from other studies) that increasing wealth is associated with higher rates of diabetes, heart condition, and hypertension.
(4) This paper uses unique data that contain measures of income, consumption, and assets to examine whether the relationship between mortality and economic status is sensitive to the choice of indicators. Each of these variables refers to a somewhat different aspect of economic status, moreover each is affected by measurement errors in different ways. Incomes may be understated, consumption may be highly sensitive to reference period and large expenses such as holidays or marriage, asset ownership may depend on geography (air coolers are not needed in mountains), access to reliable electric supply and household composition and needs (e.g. presence of elderly may make it necessary to have a toilet or a cot).

Each of these three may also be influenced by underlying health conditions with varying degrees of immediacy of impact. Onset of illness immediately increases consumption by imposing medical expenses. It also reduces earning ability but with a slightly longer time span of impact—particularly for individuals with access to some sick leave. Illness affects assets over a longer period since many items are accumulated over a lifetime and consequently there is minimal impact of health conditions on asset accumulation. Of the three indicators of economic conditions we examine, consumption seems to be most vulnerable to reverse causality. When we add controls for existence of diabetes, cardiac condition and high blood pressure, the coefficient for log consumption

expenditure on log odds of mortality becomes substantially larger—change from −0.06 in model 1 to −0.08 in model 2, a far greater change than observed in the coefficients for log income or number of consumer assets owned. This suggests that consumption expenditure is high for individuals with major illnesses but in this case, it overstates actual economic status and consequently has a weaker negative impact on mortality than in models where this error is reduced through introduction of controls for major illnesses.

However, the overarching message from this analyses is that that regardless of the indicator used, higher economic status is associated with lower mortality. This suggests that the relationship between economic status and mortality is highly robust.

Moreover, in case of the asset index—the indicator that taps into longer term economic status and is least likely to be affected by reverse causality—it appears that higher economic status is associated with lower mortality once individuals are diagnosed with major illnesses such as hypertension, diabetes and cardiac condition. These three conditions are easily manageable by individuals who are able to obtain regular care and comply with the prescribed medication regime. Early diagnosis leads to a better health outcome. Hence, it is not surprising that the greatest rate of mortality is observed among poor individuals afflicted with one of these conditions who may be less likely to comply with the prescribed medication regime and may well have arrived at this diagnosis at a more advanced level of the disease.

Indian public health policies suffer from a curious gap when it comes to adult health. The issue of maternal and child health has received substantial attention in the National Health Mission; diseases that lead to hospitalization are beginning to be addressed through highly subsidized insurance programs for the poor. However, few policies address the challenge of diagnosis and treatment of non-communicable diseases, especially chronic illnesses such as hypertension where well-established, long-term treatment can prove effective. Our results suggest that tackling this challenge, particularly for the poor, may have a substantial impact on adult mortality.

8. Limitations

While national panel survey data with a large sample of adults are able to overcome several conceptual and methodological challenges, data limitations continue to plague our ability to draw inference. First, it would be useful to have data for more than two waves so that it would be possible to see the progression of health using a life-cycle perspective with increasing prevalence of morbidity being observed at an intervening period between initial measurement of economic status and morbidity. Second, even though the IHDS has a re-contact rate of 83% and when proxy information for migrants is included, we have data on survival status of more than 94% of adults, attrition may not be independent of the survival status. This would suggest caution in interpreting these results. Third, only limited information about availability of medical services is available in the survey. Hence, while we assume that the negative relationship between economic status and mortality is via access to better medical care, this hypothesis cannot be empirically tested. Fourth, the measures of morbidity are based on self-reports; the results might be stronger with more direct measures, for high blood pressure, for instance. Fifth, it would strengthen this research and provide a fuller understanding of ways in which economic status may negatively or positively affect health if information about a variety of life-cycle changes associated with rising incomes could be included in the analyses. However, there is no information on factors such as physical activity. While there is some information about smoking and alcohol consumption available from the survey, we choose not to focus it since it was collected from the head of the household and subjected to considerable measurement error. Sixth, since death is a rare event, even a sample size of over 130,000 individuals does not allow to examine the variation in this relationship across different ages or regions of residence. Finally, any discussion of causality must acknowledge that although our modeling strategy allows us to look at economic status in 2004–05 and probability of death in the subsequent seven years, it does not solve the problem of reverse causality. It is possible that underlying health conditions may have already reduced income at the time of the first survey. This would lead us to underestimate the link between income and mortality.

While there is much work left to be done, we believe these results, the panel design, and our clearer focus on alternative measures of economic status represent an important step forward in the analysis of adult mortality in India and in better understanding the way in which this relationship is shaped by long-term and short-term measures of economic status. Results presented in this paper suggest a need for great care in interpreting studies on health outcomes and expenditures based on widely used Indian National Sample Surveys (NSS) which rely mainly on consumption expenditure as a marker of economic status. Since consumption expenditure appears to be the more susceptible to the endogeneity associated with health status than income or asset ownership, analyses based on studies which rely on consumption expenditure only should be treated with extreme caution.

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Appendix A

See Tables 5 and 6.

Table 5
Attrition in India Human Development Survey between 2004–05 and 2011–12 for adults ages 15 and above

	Analytical sample	Attrition
Three major morbidity condition		
No	90.89	9.11
Yes	88.22	11.78
Sex		
Male	90.80	9.20
Female	90.79	9.21
Age		
15–29 years	90.47	9.53
30–44 years	90.82	9.18
45–59 years	90.92	9.08
60 years or more	91.65	8.35
Marital status		
Unmarried/no gauna	89.50	10.50
Married	91.19	8.81
Widowed	91.28	8.72
Divorced/separated	92.06	7.94
Education		
Illiterate	93.41	6.59
Up to 5th standard	90.79	9.21
Secondary level	89.79	10.21
Metric but non graduate	88.40	11.60
Graduate & above	84.08	15.92
Missing values	94.15	5.85
Social groups		
Forward caste	89.59	10.41

(*continued on next page*)

Table 5 (*continued*)

	Analytical sample	Attrition
OBC	91.76	8.24
Dalit	92.89	7.11
Adivasis	88.87	11.13
Muslims	88.25	11.75
Christian, Sikh & other minority religion	87.63	12.37
Income quintile		
Poorest	93.23	6.77
Second	92.17	7.83
Middle	92.00	8.00
Fourth	90.13	9.87
Richest	87.89	12.11
Consumption quintile		
Poorest	90.59	9.41
Second	91.59	8.41
Middle	90.45	9.55
Fourth	92.11	7.89
Richest	89.53	10.47
Asset quintile		
Poorest	94.65	5.35
Second	91.92	8.08
Middle	90.89	9.11
Fourth	90.29	9.71
Richest	86.35	13.65
Place of residence		
Rural	93.57	6.43
Urban	83.78	16.22
All India	**90.80**	**9.20**

Source: India Human Development Survey 2004–05 and 2011–12.

Table 6
Prevalence of hypertension, heart disease, and diabetes among adults ages 15 and above by various economic class in India

Resource quintiles	Morbidity prevalence by		
	Income	Consumption	Asset
Negative income	2.84	–	–
Poorest	1.69	1.22	1.13
Second	1.73	1.32	1.31
Middle	1.94	2.07	1.86
Fourth	2.43	2.70	2.93
Richest	3.49	3.60	4.76

Source: India Human Development Survey 2004–05 and 2011–12, age 15 or greater in 2004–05.

Appendix B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.worlddev.2017.10.018.

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