Adult Mortality in India: The Health-wealth Nexus

Debasis Barik[1], Sonalde Desai[2], Reeve Vanneman[3]

Abstract

Recent economic research on relationship between health and wealth has noted that this relationship operates in both directions; higher incomes lead to greater access to healthcare while healthier individuals are likely to earn more. In societies like India that are in midst of epidemiological transition, a third factor may also be important. Higher income individuals may more likely be afflicted by life-style diseases that increase mortality. Using unique panel data from IHDS of 2004-5 and 2011-12, we examine the relationship between household wealth in 2004-5 and probability of dying in the subsequent seven years for adults ages 15 and above. The results show that although wealth is likely to be associated with slightly higher prevalence of non-communicable diseases, wealthier individuals are less likely to die even after controlling for these factors. Moreover, individuals in the top wealth quintile, even with diseases are less likely to die than their poorer peers.

Adult Mortality in India: The Health-wealth Nexus

Debasis Barik[1], Sonalde Desai[2], Reeve Vanneman[3]

Addressing Socioeconomic Gradient in Health Disparities

In most societies, people with higher social status enjoy good health and lower mortality. More schooling, higher incomes, prestigious jobs etc. provide knowledge and resources to live healthier and for a longer period. These disparities in health outcomes among various population sub-groups by their relative socio-economic position have increasingly drawn attention of researchers and policymakers alike (Deaton, 2002). Though education is widely perceived as the single most important socio-economic determinant of mortality (Antonovsky 1967, Kitagawa 1973, Preston and Taubman 1994, Elo and Preston 1996), Liu, Hermalin et al. (1998) found that the direct influence of education to lower mortality was very low and insignificant among the older Taiwanese. 83 percent of the total effect of education on mortality was indirect, mostly by means of health disparities. However, these disparities in health outcomes are neither consistent across countries, nor over time (Preston 1975) making it difficult to develop public policies to address these disparities.

Arguably the greatest challenge to understand the nature and causes of health disparities lies in the reciprocity of this relationship. While we can expect greater economic resources to translate into better nutrition and more access to health care, thereby reducing mortality, a large number of studies also document that poor health leads to unemployment and lower income (Grossman 1972, Smith 1999). For

individuals suffering from chronic illnesses, treatment costs will also reduce their disposable income and divert other family members from productive activity. Moreover, in low income countries like India, rising incomes have created a dual nutrition burden in which the poor continue to suffer from malnutrition but the rich are afflicted with obesity and a rising burden of cardio-vascular diseases (Ke-You and Da-Wei 2001, Sengupta and Syamala 2012, Sengupta, Angeli et al. 2014).

In this paper we address some of these challenges to examine the link between household wealth and mortality in India using prospective survey data from India Human Development Survey (IHDS), a nationally representative panel survey conducted in 2004-5 and 2011-12.

Health and Wealth: Correlation and Causation

A strong relationship between economic deprivation and ill health was first scientifically documented by René Villermé, who compared mortality rates and poverty across the arrondissements of Paris in the 1820s, although references to the relationship can be found even in ancient Greek and Chinese texts (Deaton 2002). In England and Wales, 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 United States only in the latter half of the twentieth century with the publication of Kitagawa & Hauser's path-breaking study of demographic and socioeconomic mortality differentials based on the 1960 Census matched to death certificates filed in May–August of the same year(Kitagawa 1973,

Hummer, Rogers et al. 1998). Though there exists ample literature on the nexus between socio-economic status and health and mortality, research on the issue in an Asian context are visible only after the late 1990s (Liu, Hermalin et al. 1998, Liang, McCarthy et al. 2000, Zimmer and Amornsirisomboon 2001, Zimmer, Kaneda et al. 2007, Zimmer, Martin et al. 2007, Zimmer 2008, Chen, Yang et al. 2010).

In spite of the considerable body of evidence showing this correlation, the direction of causation is not clearly established. Economists usually argue that poor health restricts a family's capacity to earn income or accumulate assets by limiting work or by raising medical expenses. The alternative pathway running from wealth to health is more popular among medical practitioners and public health researchers. James P. Smith (1999) in his pioneering research "Healthy Bodies and Thick Wallet" concluded that the causal direction of the social health gradient is not clearly understood; it varies with age. In pre-retirement, health affects income; for older individuals, income affects health. But, several researchers have also expressed their concerns regarding the hazard associated with wealth. The hazard of wealth includes the excessive consumption of food, alcohol and tobacco, linked to physical inactivity and other lifestyle factors (Razzell and Spence 2006).

Whether socioeconomic status has a protective impact on health outcomes also depends on the pathways through which this socioeconomic status is able to spread a protective umbrella over individual health. Preston and Haines (Preston and Haines 1991) argued that at the turn of the 20th century even educated or better off mothers could do little to protect their children from death before the germ theory became well known. Similarly, studies in Sub Saharan Africa in late 20th century

where communicable diseases have held sway, found that maternal education-child health linkages were the weakest (Hobcraft, McDonald et al. 1984, Hobcraft 1993, Desai and Alva 1998).

Challenge of Rising Prosperity

As we noted earlier, a large number of studies have noted that higher incomes are associated with lower mortality (Kawachi, Kennedy et al. 1997, McDonough, Duncan et al. 1997, Ross, Wolfson et al. 2000, Mackenbach 2002, Muller 2002). But pathways through which this relationship operates is not always clear nor do we understand how social context shapes this relationship. For example, using the Asset and Health Dynamics among the Oldest-Old (AHEAD) panel, Adams et al. (Adams, Hurd et al. 2003) found no direct causal link from household SES to mortality among elderly Americans, but observed an association between SES and the incidence of gradual onset health conditions. They explain the weak link between SES and mortality among American elderly as mainly due to Medicare coverage and universal access to pensions which do not depend upon the ability to work in old age.

In India, higher incomes pose a very different challenge. Public health spending is miniscule (only 1.03 percent of the GDP); people mostly rely on their own spending capacity to combat ill-health with more than 80% of the illnesses being treated by private physicians (Barik and Desai 2014) and more than three-fifth of the total health care expenditure are met by households through out-of-pocket payments (World Bank 2011). This would suggest that higher income households should be

able to get better care. However, there are reasons to doubt the strength of this relationship.

Much of India's public health system is geared around providing primary care for communicable diseases (IDFC Ltd. 2014). However, with rising prosperity and associated obesity, cardiovascular diseases become more important (Venkatramana and Reddy 2002, Srinath Reddy, Shah et al. 2005, Ghosh 2006) and the health sector is poorly equipped to deal with these diseases. A study of doctors around New Delhi found that very few doctors, even private doctors, could identify symptoms of heart attack (Das and Hammer 2007). This lack of familiarity with diseases of the more prosperous could reduce the usual relationship between wealth and health. This brief review suggests that the strength of the relationship between socioeconomic status and mortality deserves to be empirically examined.

Nexus of Income, Life Style Diseases and Mortality in India

India is the second-fastest-growing economy in the world. The Indian economy grew at an average rate of 7.25 percent in the first decade of the twenty first century (2000-10), resulting in rising per capita incomes and declining poverty. Researchers have documented a sharp income growth in both rural and urban areas during this period (Mitra and Saxena 2013).

However, Gillespie and Kadiyala (2012) has argued that the high level economic growth in India was far less pro-poor than its other Asian counterparts to reduce social-ills like child malnutrition. These growing incomes have not led to better health outcomes. For example, studies of dietary diversity document declining

diversity over time (Gaiha, Kaicker et al. 2013), anemia remains prevalent at almost all income levels (NFHS – III), and the proportion of individuals suffering from non-communicable diseases has grown even as India has experienced a surge of economic growth . Cardiovascular diseases, stroke, diabetes, cancer are the four leading NCDs in India(Upadhyay 2012). India has the highest number of people with diabetes than any other country in the world (Ghaffar, Reddy et al. 2004), so it is often referred to as the diabetic capital of the world (IDF 2009).

At a global level, the infectious and parasitic health disorders in the past are now being replaced by chronic, non-communicable conditions as evident from the latest Global Burden of Disease report 2013 (IHME 2013). The share of non-communicable diseases on total disability adjusted life years (DALY) has increased from 31% in 1990 to 43% in 2010. The steep rise in the prevalence of non-communicable diseases has spread across regions where more developed regions are prone to a higher prevalence. These illnesses usually incapacitate a person for a longer period and claim a huge toll on the individual and the welfare of the family. This issue is particularly critical for India since South Asian populations in the abroad have also shown very high rates of diabetes, high blood pressure and heart conditions (Gunarathne, Patel et al. 2009, Gupta, Wu et al. 2011). Coronary heart disease rates have been reported to be unusually high in several parts of the world in people originating from the Indian subcontinent (McKeigue, Miller et al. 1989). A UK study showed that men and women from India had the highest standardized mortality rates due to cardiovascular disease, and that young Indian men were at particularly high risk (Balarajan, Bulusu et al. 1984). Harding (2003) also noted that cardiovascular

and cancer mortality of South Asian migrants increased with duration of residence in England and Wales. But, it is not clear whether the high burden of NCD among overseas South Asian populations abroad may be due to dietary/environmental factors or genetic predisposition.

So, on the one hand rising incomes place individuals in lifestyles that are more prone to sedentary life-style diseases such as diabetes, heart disease, and high blood pressure. On the other hand, rising incomes also make it possible to seek better health care. The Indian health system is mostly privately funded with more than 60 percent of all treatment costs borne by the family members from out-of-pocket spending. Thus the burden of treatment cost is disproportionately distributed among various income classes ranging from less than a percent among the top quintile to 15 per cent among the lowest quintile (Barik and Desai 2014) . Out of India's small health care expenditure (less than 4 percent of GDP), only one-fourth is funded by the central and the state governments. Although some efforts are now being made to provide hospitalization coverage to the poor (CPR 2011, IDFC Ltd. 2014), only a few households have health insurance. A lack of access to good medical care in rural areas is particularly problematic and often requires considerable expenditure. Although there has been some increase in secondary and tertiary care units like Tehsil or District level hospitals and specialty hospitals like All India Institute of Medical Sciences (AIIMS), etc. in the last decade, the majority of rural India depends heavily on the usually poor performance of primary health centres and sub-centres even for emergency care. Access to either public or private specialized health care centres, concentrated in urban India, can be costly. This implies that even as higher incomes

increase the risk of life-style related diseases, they also allow for better treatment of those diseases so income's net impact on mortality remains subject to empirical examination.

Absence of Research on Adult Mortality in India

Most of the research on mortality in India has focused on infant and child mortality (Singh, Pathak et al. 2011, Ghosh 2012, Kumar, Singh et al. 2013). However, adult mortality research in India still remains in its infancy. Earlier studies of adult mortality in India were more concentrated on the levels and trends (Dandekar 1972, Dyson 1984, Clark 1987) of mortality. Preston (1980) discussed only the major causes of mortality decline in some less developed countries including India, and focused mainly on the macro-level contributors of this decline such as per-capita national income and the prevalence of various diseases.

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 frequently incomplete, particularly in rural areas, and tends to produce dusty records that are difficult to analyze. Adult mortality statistics come mainly from the Sample Registration System (SRS), which is fairly complete but lacks socio-economic information about individuals.

Saikia and Ram (2010), using retrospective data from the National Family Health Survey (NFHS), tried to explore the factors associated with adult death (ages 15-59 years). Since NFHS focused mainly on maternal and child health, it did not

contain good information on adult mortality. They relied on retrospective reporting of adult mortality by the survey households, a method which is subject to a high level of recall lapse. Moreover, with retrospective recall, it is not possible to obtain data on the household socioeconomic status before the individual's death (Saikia and Ram 2010). Since both household structure and household income are affected by death, particularly the death of the patriarch, it is difficult to develop an analytical model using retrospective data.

IHDS: Advantages of Panel Data

In this paper, we rely on the India Human Development Survey (IHDS), 2004-05 and 2011-12. The IHDS is the first Indian nationwide panel survey with a sample sufficiently large to study rare events like mortality. IHDS is a multi-topic panel study of over 41,000 households from 32 states and union territories across India. The first round of IHDS collected socioeconomic and health data for over 200,000 individuals across 1503 villages and 971 urban neighbor-hoods. In 2011-12, about 83% of these households were re-interviewed. The re-contact rate was 90% in rural areas and 72% in urban areas. Regardless of whether the household was re-interviewed, a tracking sheet was filled out in round 2 that contained information about the current status (including deaths) of each individual from the survey household in round 1.

Table 1 provides a detailed description of attrition of the IHDS 2004-05 sample population. IHDS 2004-05 collected information from 215,754 individual on various aspects like health status, education, employment, activities of daily living, etc., out of which 8,532 died and 19,841 lost for re-interview. 187,381 persons were still living,

of which 150,988 were followed on IHDS 2011-12 survey. Loss of sample was higher among the rich and those living in the urban areas, mostly due to revamp of temporary settlements and change in residence due to change in job or job location. On the other hand, loss due to death was higher among the upper age groups, and those suffering from any life-style related diseases or were with physical disability during the first round of the survey.

[Insert Table 1 Here]

The analytical sample contains information of 133,379 adults aged 15 years or above during the first round of the survey, of which 7,996 died before the commencement of IHDS 2011-12 survey. We have excluded the sample, whose survival status was unknown due to loss of the sample for re-interview.

The dependent variable of the analysis is the status of the person - alive or dead. All the predictors of the analysis come from the IHDS 2004-05 survey. Among all the predictors, our main focus was to explore the role of household level economic resources, measured in terms of wealth level (asset ownership) to shape adult mortality. Wealth is the accumulation of resources amassed over the lifetime. Unlike income, which is the flow of resources into the household, wealth helps in consumption smoothing even in the short-term absence of income. Again, most of the old age expenses are met through wealth than income (Duncan, Daly et al. 2002). Epidemiological studies seldom include wealth as a measure of socio-economic status. IHDS asked a series of questions about household possession of various basic durable assets and the quality of the housing. Similar housing and consumer goods questions are now widely used in developing country surveys as an easily

administered scale measuring household economic level. The household wealth index was constructed using such a set of 23 dichotomous variables measuring household possession of basic and durable assets (Figure 1). The unweighted mean number of assets to a household was 8.52 with unweighted standard deviation of 4.48. The wealth index was created using a simple sum of the assets; the unweighted Cronbach's reliability coefficient alpha of the wealth scale was 0.8876. A household was assumed to have no expensive items like car, air conditioner, washing machine, computer, and credit card if the household didn't possess at least six of the assets. Again, households with more than four assets were considered to have two basic items like two pairs of clothes and footwear. Four consumer goods items were modified because they were less expensive alternatives for other items in the scale: air coolers (vs. air conditioners); a black and white television (vs. a color television); a motor scooter (vs. an automobile); and a bicycle (vs. a scooter or an automobile). In these cases, if the household owned the more expensive alternative (e.g., an air conditioner), then the less expensive item (e.g., air cooler) was recoded as owned, regardless of whether the household reported owning the less desirable item, else the less expensive items did not scale well. The values of the wealth index used in this analysis varies from 0 to 23, where a value of '0' denotes that the household possess neither of the 23 assets and a value of '23' indicates the ownership of all 23 assets (see http://ihds.umd.edu/assets.html). Further, the asset scale has been recoded into five quintiles for easy comprehension of the descriptive statistics in Table 1.

[Insert Figure 1 Here]

Beside wealth, we also controlled for a set of individual and household level variables like age, sex, completed years of schooling, marital status, morbidity status (as characterized by suffering from any life-style related diseases like high BP, heart diseases, etc.), problems in performing activities of daily living (ADL), working status, membership of social groups. The community level variables include rural or urban residence, and the state of residence.

Age of the individual has been recoded into four broad categories – 15-29 years, 30-44 years, 45-59 years and 60 years or above. Respondents were asked if any of the household members ever diagnosed with 13 specific types of major morbidities or any other unspecified morbidity, and if diagnosed, was it cured or still exists. The IHDS list of major morbidity includes Cataract, Tuberculosis, High BP, Diabetes, Leprosy, Cancer, Asthma, Polio, Paralysis, epilepsy, Mental illness, STD or AIDS, and "others", where the "others" mostly include the accident cases. In the present analysis, we include all major morbidities except cataract to construct the morbidity index. Zimmer et al. (2002)(Zimmer, Linda et al. 2002), using three waves of "Survey of Health and Living Status of the Elderly in Taiwan" data (1993-99), found an increasing prevalence of functional limitations between the two time periods (1993-1996 and 1996-1999) among older Taiwanese and they attributed the increased survival probability as an possible explanation for the same. In the present study, we see the impact of difficulties in ADL during round one on adult death by the second round of the survey. The ADL variable was constructed using three responses from the questions related to difficulty in physical functionality of individuals.

Questions were asked about all persons above age 7 years if they were able to walk 1 km, can go to toilet without help and can dress without help. The responses were recorded as – can do without difficulty, can do with some difficulty, and unable to do. The latter two responses were used to construct the difficulty in ADL variable. Working status measure only the status of the individual, i.e., working or not during 2004-05 survey round.

Wealth and Mortality through Health Risks and Physical Limitations:

Figure 2 diagrammatically represents the relationship of health and mortality with household economic status based on the bivariate analyses of IHDS data. It shows that wealth has a positive relationship with life-style diseases and a negative relationship with mortality and with ADL disabilities. On the one hand, the prevalence of these life-style diseases increases monotonically with increases in wealth. On the other hand, the mortality rate declines gradually with wealth, but remains quite flat in the higher end of the wealth scale. Interestingly, the prevalence of difficulties in ADL is less responsive to changes in household wealth. In the next section we will explore the direct and indirect (via meeting the treatment costs of health and ADL) influence of wealth on mortality reduction.

[Insert Figure 2 Here]

Regression results

Table 2 presents a comprehensive picture of wealth effects on adult mortality in the Indian context. We present three models side by side to compare the log-odds of household wealth in predicting mortality. In the first model we include all the

covariates of adult mortality except the two health gradients namely the presence of any life-style disease and having any difficulty in performing activities of daily living. In the latter two models, we incorporate these two components one by one to uncover any improvement in the predictive power of the wealth index.

The first model, in line with the earlier research in the Asian context, confirms a strong inverse relationship between household possession of assets and adult mortality. The risk of mortality reduces as household level wealth increases. Wealthier people are more likely to have a better nutritional intake than the poorer ones. Cunningham, Hays et al. (2005), in a study of HIV infected population in USA reported 89 per cent greater risk of mortality among people with no wealth than their wealthy counterpart. Adding any pre-existing life-style diseases in the current model improves the predictive power of wealth in reducing mortality. That is, because life-style diseases are more common among wealthier households, they mask some of the direct effect of wealth on mortality. However adding ADL disability into the model reduces the predictive power of wealth slightly, but the wealth coefficient still remains higher than the first model. Some of the reason why the poor have higher mortality is because they are more often disabled, but this is only a very partial explanation. The Bayesian Information Criterion (BIC) confirms model 3 as the best fit among the three models. Koyano, Shibata et al. (1989) also observed a significantly higher mortality among the disabled elderly Japanese living in urban neighborhood than their non-disabled counterpart. All the three models ensures a significantly inverse association between wealth and adult mortality in India. Hajat, Kaufman et al. (2011) found a strong inverse correlation between wealth and poor health status and

between wealth and mortality among US population. Jianakoplos, Menchik et al. (1989) using the National Longitudinal Survey (NLS) of older man showed that elderly individuals in the bottom two decile of the wealth distribution exhibit mortality rate three times as large as those of individuals in the top decile. Menchik (1993) using the same NLS panel found an inverse relationship between wealth and mortality even after controlling for health, permanent income and background variables.

The risk of mortality increases significantly in the presence of either any pre-existing life-style disease or difficulties in ADL. But, the role of household wealth in the presence of these health conditions is not clear from the analysis of Table 2. So, as a next step we present the predicted probabilities of adult mortality in the presence of any life-style morbidity and disability through interaction with wealth as shown in Figure 3 and 4 respectively.

Table 2: Log odds of adult (15+ years) death by individual level socio-economic characteristics, physical functionality and life-style related health problems in India (Short models).

	Model 1		**Model 2**		**Model 3**	
	coeff	se	coeff	Se	coeff	Se
Household Asset	-0.032**	0.006	-0.035**	0.007	-0.033**	0.007
Any life-style diseases (None omitted)						
Yes			0.741**	0.06	0.670**	0.061
Any difficulty in performing ADL (None omitted)						
Yes					0.737**	0.087
Constant	-3.046**	0.169	-3.132**	0.169	-3.183**	0.168
Number of Observations	1,32,351		1,32,351		1,32,351	

** p<0.01, * p<0.05

All models include sex, age, education, marital status, working status, membership of social group, place of residence, and state dummy. Full model is presented in appendix Table 2A.

The Bayesian Information Criterion (BIC) statistic is the lowest in Model 3 and the highest in Model 1, implying Model 3 as the best fit among the three.

Mortality and the Life-style Diseases: The Role of Wealth

Life-style disease reduces survival substantially, however, this effect is mainly for the poor. The poor who have a major illness such as diabetes, heart disease or high blood pressure are far more likely to die than either individuals in similar asset group but without these diseases or those in upper income groups who have diseases. Until income threshold is extremely high – at asset count of 20 assets or more, wealth plays a significant role to curb mortality. However, only less than a percent of the sample households own 20 assets or more. This suggests that morbidity burden is mitigated by health care for the very rich.

Figure 3 graphically presents the predictive probability of life-style morbidity coupled with household wealth, in shaping adult mortality in India. This result is quite expected, since medical intervention can prolong mortality, caused from various life-style related reasons. Wealthier people can afford the expensive treatment required to combat with these health condition, and thus live for a longer period compared to their poorer counterpart. Late diagnoses due to a delay in seeking care among the poor leads to chronic illness and higher complications. Additionally, low education among this group results into less awareness about the fatality of the health

condition. There is significant difference between the rich and the poor in mortality with these kind of life-style morbidity condition.

[Insert Figure 3 Here]

Mortality and the ADL: The Role of Wealth

Similar to life-style diseases, reduction in risk of mortality in presence of ADL is more evident for the rich than the poor. Prevalence of these difficulties in ADL are more among the poor, but rich overcomes the odds of death. Figure 4 illustrates that, the difference in predicted probability of mortality between people with/without functional limitation across wealth status is significantly different. The predicted values remains higher in case of people reported problems in ADL.

[Insert Figure 4 Here]

Besides wealth, the other two socio-economic indicators i.e., education and work status also show a significant negative relationship with adult death (Table 2A). Additional years of education increases the survival probability of adults mainly through various indirect pathways as found from a number of studies from high-income countries as well for some Asian countries (Elo and Preston 1996, Liu, Hermalin et al. 1998). HIV infected population with less than a high school degree in USA were 53 per cent at greater risk of death than their more educated counterpart (Cunningham, Hays et al. 2005). Those who are working are at lower risk of mortality in India. This may also depend on the nature of work they do, but investigating this would require a level of detail which is beyond the scope of the present study.

The influence of the demographic predictors on mortality are mostly supported by earlier studies. The risk of mortality is highest among the elderly, whereas death risk

is significantly higher among people above age 30 years, compared to the youth below age 30. However, risk of death is also lower among the females, highly educated, and married compared to their other counterparts. The married have a significantly lower rate of mortality than the widow, the divorced, or separated. Gove (1973) also noted a lower mortality among the married compared to the single, widowed, separated or divorced. Risk of mortality is significantly higher among the Adivasis, as compared to the high caste Hindus. The Adivasis are indigenous tribe groups, located in mountain area or dense forest. Poverty, hunger, illiteracy, poor nutritional intake, and high level substance use are rampant among this population group. Additionally, their habitations are far from the health facilities. These may be some of the reasons of higher mortality among the Adivasis. However, we didn't find any significant rural-urban differential in adult mortality in India.

Conclusion

The findings provide clear evidence that wealth plays a protective role in curbing adult mortality in India. Although the prevalence of any life-style related disease increases with increasing wealth, it is not sufficient to offset the protective effect of wealth. A sedentary life-style, stress in the work place, obesity, and other problems rise with more income and therefore enhance the risk of non-communicable diseases like hypertension, heart disease, and diabetes. (Figure 2) Most of these diseases are non-curable but can be controlled with regular treatment. Wealthier people can manage these treatments and can prolong their lives. On the

other hand, while the risk of being affected by these life-style conditions is relatively lower among the poor, once affected, they cannot afford the continued high treatment costs and so they experience a premature death. Desai et al. (2010) found that 10-14 percent of the people from lower economic strata, suffering from any major morbidity, didn't seek treatment.

Wealth plays a protective role in curbing death from functional limitations as well. The number of deaths due to functional limitations are small and occur mostly in the higher ages. Moreover, most of the people with physical limitations at higher ages likely also suffer from various chronic illnesses as well. Again, improvement in survival probability depends very much on the severity of physical limitation. Zimmer et al. (2002) reported a 12% increase in mortality probability among older Taiwanese with severe difficulty in climbing stairs, whereas the survival probability increased by 17% and 22% respectively among those having severe difficulty in walking only or having difficulty both in climbing and walking(Zimmer, Linda et al. 2002). However, role of wealth in increasing survival probabilities with degree of severity of functional limitation requires a closer look.

References

Adams, P., M. D. Hurd, D. McFadden, A. Merrill and T. Ribeiro (2003). "Healthy, wealthy, and wise? Tests for direct causal paths between health and socioeconomic status." Journal of Econometrics **112**(1): 3-56.
Antonovsky, A. (1967). "Social class, life expectancy and overall mortality." The Milbank Memorial Fund Quarterly: 31-73.
Balarajan, R., L. Bulusu, A. Adelstein and V. Shukla (1984). "Patterns of mortality among migrants to England and Wales from the Indian subcontinent." BMJ **289**(6453): 1185-1187.
Barik, D. and S. Desai (2014). Determinants Of Private Healthcare Utilisation And Expenditure Patterns In India. India Infrastructure Report 2013|14 The Road to Universal Health Coverage. S. B. a. S. Ghosh. New Delhi, India, IDFC Ltd.**:** 52-64.
Chen, F., Y. Yang and G. Liu (2010). "Social change and socioeconomic disparities in health over the life course in China a cohort analysis." American sociological review **75**(1): 126-150.
Clark, A. W. (1987). "Social Demography of Excess Female Mortality in India: New Directions." Economic & Political Weekly **22**(17): WS12-WS15+WS18-WS21.
CPR (2011). India's Health Insurance Scheme for the Poor: Evidence from the Early Experience of the Rashtriya Swasthya Bima Yojana.
Cunningham, W. E., R. D. Hays, N. Duan, R. Andersen, T. T. Nakazono, S. A. Bozzette and M. F. Shapiro (2005). "The effect of socioeconomic status on the survival of people receiving care for HIV infection in the United States." Journal of Health Care for the Poor and Underserved **16**(4): 655-676.
Dandekar, K. (1972). "Mortality and Longivity in India, 1901-1961." Economic and Political Weekly **7**(18): 889-892.
Das, J. and J. Hammer (2007). "Location, location, location: residence, wealth, and the quality of medical care in Delhi, India." Health Affairs **26**(3): w338-w351.
Deaton, A. (2002). "Policy implications of the gradient of health and wealth." Health Affairs **21**(2): 13-30.
Desai, S. and S. Alva (1998). "Maternal education and child health: Is there a strong causal relationship?" Demography **35**(1): 71-81.
Duncan, G. J., M. C. Daly, P. McDonough and D. R. Williams (2002). "Optimal indicators of socioeconomic status for health research." American Journal of Public Health **92**(7): 1151-1157.
Dyson, T. (1984). "Excess Male Mortality in India." Economic & Political Weekly **19**(10): 422-426.
Elo, I. T. and S. H. Preston (1996). "Educational differentials in mortality: United States, 1979-85." Soc Sci Med **42**(1): 47-57.
Gaiha, R., N. Kaicker, K. Imai, V. S. Kulkarni and G. Thapa. (2013). "Has dietary transition slowed in India? An analysis based on the 50th, 61st and 66th rounds of the National Sample Survey." IFAD Working Paper No. 16 Retrieved June 23, 2014, 2014, from http://www.ifad.org/operations/projects/regions/pi/paper/16.pdf.
Ghaffar, A., K. S. Reddy and M. Singhi (2004). Burden of non-communicable diseases in South Asia.

Ghosh, A. (2006). "Comparison of anthropometric, metabolic and dietary fatty acids profiles in lean and obese dyslipidaemic Asian Indian male subjects." Eur J Clin Nutr **61**(3): 412-419.
Ghosh, R. (2012). "Child mortality in India: a complex situation." World Journal of Pediatrics **8**(1): 11-18.
Gillespie, S. and S. Kadiyala (2012). "Exploring the Agriculture–Nutrition Disconnect in India." Edited by Shenggen Fan and Rajul Pandya-Lorch: 173.
Gove, W. R. (1973). "Sex, marital status, and mortality." American journal of sociology: 45-67.
Grossman, M. (1972). "On the concept of health capital and the demand for health." The Journal of Political Economy: 223-255.
Gunarathne, A., J. V. Patel, B. Gammon, P. S. Gill, E. A. Hughes and G. Y. Lip (2009). "Ischemic stroke in South Asians: a review of the epidemiology, pathophysiology, and ethnicity-related clinical features." Stroke **40**(6): e415-423.
Gupta, L. S., C. C. Wu, S. Young and S. E. Perlman (2011). "Prevalence of Diabetes in New York City, 2002–2008: Comparing foreign-born South Asians and other Asians with U.S.-born whites, blacks, and Hispanics." Diabetes Care **34**(8): 1791-1793.
Hajat, A., J. S. Kaufman, K. M. Rose, A. Siddiqi and J. C. Thomas (2011). "Long-Term Effects of Wealth on Mortality and Self-rated Health Status." American Journal of Epidemiology **173**(2): 192-200.
Harding, S. (2003). "Mortality of Migrants from the Indian Subcontinent to England and Wales: Effect of Duration of Residence." Epidemiology **14**(3): 287-292.
Hobcraft, J. (1993). "Women's education, child welfare and child survival: a review of the evidence." Health Transition Review: 159-175.
Hobcraft, J. N., J. W. McDonald and S. O. Rutstein (1984). "Socio-economic factors in infant and child mortality: a cross-national comparison." Population studies **38**(2): 193-223.
Hummer, R. A., R. G. Rogers and I. W. Eberstein (1998). "Sociodemographic differentials in adult mortality: A review of analytic approaches." Population and development review: 553-578.
IDF (2009). IDF Diabetes Atlas, Fourth Edition. World Diabetes Congress Montreal 2009. D. W. Nigel Unwin, Delice Gan, Olivier Jacqmain, Grégory Ghyoot. Montreal, International Diabetes Frederation.
IDFC Ltd. (2014). India Infrastructure Report 2013|14 The Road to Universal Health Coverage. S. B. a. S. Ghosh. New Delhi, India, IDFC Ltd.
Jianakoplos, N., P. Menchik and O. Irvine (1989). Using panel data to assess the bias in cross-sectional inferences of life-cycle changes in the level and composition of household wealth. The measurement of saving, investment, and wealth, University of Chicago Press, 1989**:** 553-644.
Kawachi, I., B. P. Kennedy, K. Lochner and D. Prothrow-Stith (1997). "Social capital, income inequality, and mortality." American journal of public health **87**(9): 1491-1498.
Ke-You, G. and F. Da-Wei (2001). "The magnitude and trends of under- and over-nutrition in Asian countries." Biomed Environ Sci **14**(1-2): 53-60.
Kitagawa, E. M. (1973). Differential mortality in the United States: A study in socio-economic epidemiology, Cambridge, Mass: Harvard University Press.

Koyano, W., H. Shibata, K. Nakazato, H. Haga, Y. Suyama and T. Matsuzaki (1989). "Mortality in Relation to Instrumental Activities of Daily Living: One-year Follow-up in a Japanese Urban Community." Journal of Gerontology **44**(3): S107-S109.
Kumar, C., P. K. Singh, R. K. Rai and L. Singh (2013). "Early neonatal mortality in India, 1990–2006." Journal of community health **38**(1): 120-130.
Liang, J., J. F. McCarthy, A. Jain, N. Krause, J. M. Bennett and S. Gu (2000). "Socioeconomic gradient in old age mortality in Wuhan, China." The Journals of Gerontology Series B: Psychological Sciences and Social Sciences **55**(4): S222-S233.
Liu, X., A. I. Hermalin and Y.-L. Chuang (1998). "The effect of education on mortality among older Taiwanese and its pathways." The Journals of Gerontology Series B: Psychological Sciences and Social Sciences **53**(2): S71-S82.
Mackenbach, J. P. (2002). Income inequality and population health.
McDonough, P., G. J. Duncan, D. Williams and J. House (1997). "Income dynamics and adult mortality in the United States, 1972 through 1989." American journal of public health **87**(9): 1476-1483.
McKeigue, P. M., G. Miller and M. Marmot (1989). "Coronary heart disease in south Asians overseas: a review." Journal of clinical epidemiology **42**(7): 597-609.
Menchik, P. L. (1993). "Economic status as a determinant of mortality among black and white older men: does poverty kill?" Population Studies **47**(3): 427-436.
Mitra, A. and A. Saxena (2013). India Consumer Survey 2013, Credit Suisse Securities Research & Analytics.
Muller, A. (2002). Education, income inequality, and mortality: a multiple regression analysis.
Preston, S. H. (1975). "The changing relation between mortality and level of economic development." Population studies **29**(2): 231-248.
Preston, S. H. (1980). Causes and consequences of mortality declines in less developed countries during the twentieth century. Population and economic change in developing countries, University of Chicago Press**:** 289-360.
Preston, S. H. and M. R. Haines (1991). "Fatal years." Child mortality in late nineteenth-century America (Princeton, 1991): 123-127.
Preston, S. H. and P. Taubman (1994). "Socioeconomic differences in adult mortality and health status." Demography of aging **1**: 279-318.
Razzell, P. and C. Spence (2006). "The Hazards of Wealth: Adult Mortality in Pre-Twentieth-Century England." Social History of Medicine **19**(3): 381-405.
Ross, N. A., M. C. Wolfson, J. R. Dunn, J.-M. Berthelot, G. A. Kaplan and J. W. Lynch (2000). Relation between income inequality and mortality in Canada and in the United States: cross sectional assessment using census data and vital statistics.
Saikia, N. and F. Ram (2010). "DETERMINANTS OF ADULT MORTALITY IN INDIA." Asian Population Studies **6**(2): 153-171.
Sengupta, A., F. Angeli, T. S. Syamala, C. Van Schayck and P. Dagnelie (2014). "State-wise Dynamics of the Double Burden of Malnutrition among 15–49 Year-old Women in India: How Much Does the Scenario Change Considering Asian Population-specific BMI Cut-off Values?" Ecology of food and nutrition **53**(6): 618-638.
Sengupta, A. and T. Syamala (2012). "The changing face of malnutrition in India." Journal of Health Management **14**(4): 451-465.

Singh, A., P. K. Pathak, R. K. Chauhan and W. Pan (2011). "Infant and Child Mortality in India in the Last Two Decades: A Geospatial Analysis." PLoS ONE **6**(11): e26856.
Smith, J. P. (1999). "Healthy bodies and thick wallets: the dual relation between health and economic status." The journal of economic perspectives: a journal of the American Economic Association **13**(2): 144.
Srinath Reddy, K., B. Shah, C. Varghese and A. Ramadoss (2005). "Responding to the threat of chronic diseases in India." The Lancet **366**(9498): 1744-1749.
Upadhyay, R. P. (2012). "An Overview of the Burden of Non-Communicable Diseases in India." Iran J Public Health **41**(3): 1-8.
Venkatramana, P. and P. C. Reddy (2002). "Association of overall and abdominal obesity with coronary heart disease risk factors: comparison between urban and rural Indian men." Asia Pacific Journal of Clinical Nutrition **11**(1): 66-71.
World Bank (2011). World Development Indicators, World Bank
Zimmer, Z. (2008). "Poverty, wealth inequality and health among older adults in rural Cambodia." Social Science & Medicine **66**(1): 57-71.
Zimmer, Z. and P. Amornsirisomboon (2001). "Socioeconomic status and health among older adults in Thailand: an examination using multiple indicators." Social Science & Medicine **52**(8): 1297-1311.
Zimmer, Z., T. Kaneda and L. Spess (2007). "An Examination of Urban Versus Rural Mortality in China Using Community and Individual Data." The Journals of Gerontology Series B: Psychological Sciences and Social Sciences **62**(5): S349-S357.
Zimmer, Z., G. M. Linda and C. Ming-Cheng (2002). "Changes in functional limitation and survival among older Taiwanese, 1993, 1996, and 1999." Population Studies **56**: 265-276.
Zimmer, Z., L. G. Martin, M. B. Ofstedal and Y.-L. Chuang (2007). "Education of adult children and mortality of their elderly parents in Taiwan." Demography **44**(2): 289-305.

Tables

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

	Still alive	Dead	Lost to reinterview	Total
Age				
Less than 15	91.2	0.8	8.0	68,462
15-29 years	89.8	1.2	8.9	59,795
30-44 year	88.6	2.2	9.2	42,423
45-59 year	84.7	6.4	8.9	27,170
60 years or more	64.3	26.4	9.3	17,904
Sex				
Male	86.8	4.4	8.7	1,09,805
Female	87.8	3.6	8.7	1,05,949
Place of Residence				
Rural	88.8	4.3	6.9	1,43,374
Urban	83.0	3.3	13.6	72,380

Asset Groups				
Poorest	87.8	4.9	7.3	39,472
2nd Quintile	88.7	4.1	7.1	38,792
Middle	87.6	3.9	8.5	36,475
4th Quintile	87.3	3.7	9.1	54,226
Richest	84.5	3.4	12.1	46,789
Life-style Diseases				
No	87.9	3.4	8.7	2,03,879
Yes	76.9	13.9	9.2	11,875
Any Difficulty in ADL				
No	86.8	4.3	8.9	1,78,186
Yes	64.9	26.6	8.5	2,533
Total	**87.29**	**4.01**	**8.7**	**100.0**
	1,87,381	**8,532**	**19,841**	**2,15,754**

Appendix Table

Table 2A: Log odds of adult (15+ years) death by socio-economic characteristics, physical functionality and life-style related health problems in India (Full model).

	Model 1		Model 2		Model 3	
	coeff	se	coeff	se	Coeff	se
Household Assets	-0.032**	0.006	-0.035**	0.007	-0.033**	0.007
Sex (Male omitted)						
Female	-0.801**	0.050	-0.803**	0.053	-0.796**	0.053
Education	-0.053**	0.006	-0.053**	0.006	-0.053**	0.006
Marital Status (Married/spouse absent omitted)						
Unmarried/No gauna	-0.153	0.111	-0.125	0.111	-0.130	0.111
Widowed	0.564**	0.055	0.573**	0.059	0.567**	0.058
Divorced/Separated	0.827*	0.357	0.836*	0.352	0.802*	0.353
Any life-style diseases (None omitted)						
Yes			0.741**	0.060	0.670**	0.061
Any difficulty in performing ADL (None omitted)						
Yes					0.737**	0.087
Age (15-29 years omitted)						
30-44 years	0.573**	0.108	0.531**	0.108	0.528**	0.107
45-59 years	1.577**	0.104	1.490**	0.105	1.484**	0.104
60 years & above	2.849**	0.104	2.751**	0.105	2.725**	0.104
Social Groups (High caste omitted)						
OBC	-0.034	0.053	-0.020	0.053	-0.024	0.053
Dalit	0.031	0.057	0.053	0.058	0.054	0.058
Adivasis	0.302**	0.076	0.347**	0.077	0.354**	0.077
Muslims	-0.120	0.067	-0.103	0.067	-0.100	0.067
Christ/Sikh/Jain	-0.073	0.103	-0.106	0.105	-0.129	0.107
Place of residence (Rural omitted)						
Urban	0.062	0.046	0.048	0.050	0.056	0.049
Work status (Not working omitted)						
Working	-0.679**	0.046	-0.655**	0.046	-0.625**	0.046
Constant	-3.046**	0.169	-3.132**	0.169	-3.183**	0.168
Observations	132,351		132,351		132,351	

** p<0.01, * p<0.05

All models include state dummy variables. Results are not shown for parsimony.

The Bayesian Information Criterion (BIC) value is the lowest in Model 3 and the highest in Model 1, implying Model 3 as the best fit among the three.

Figures

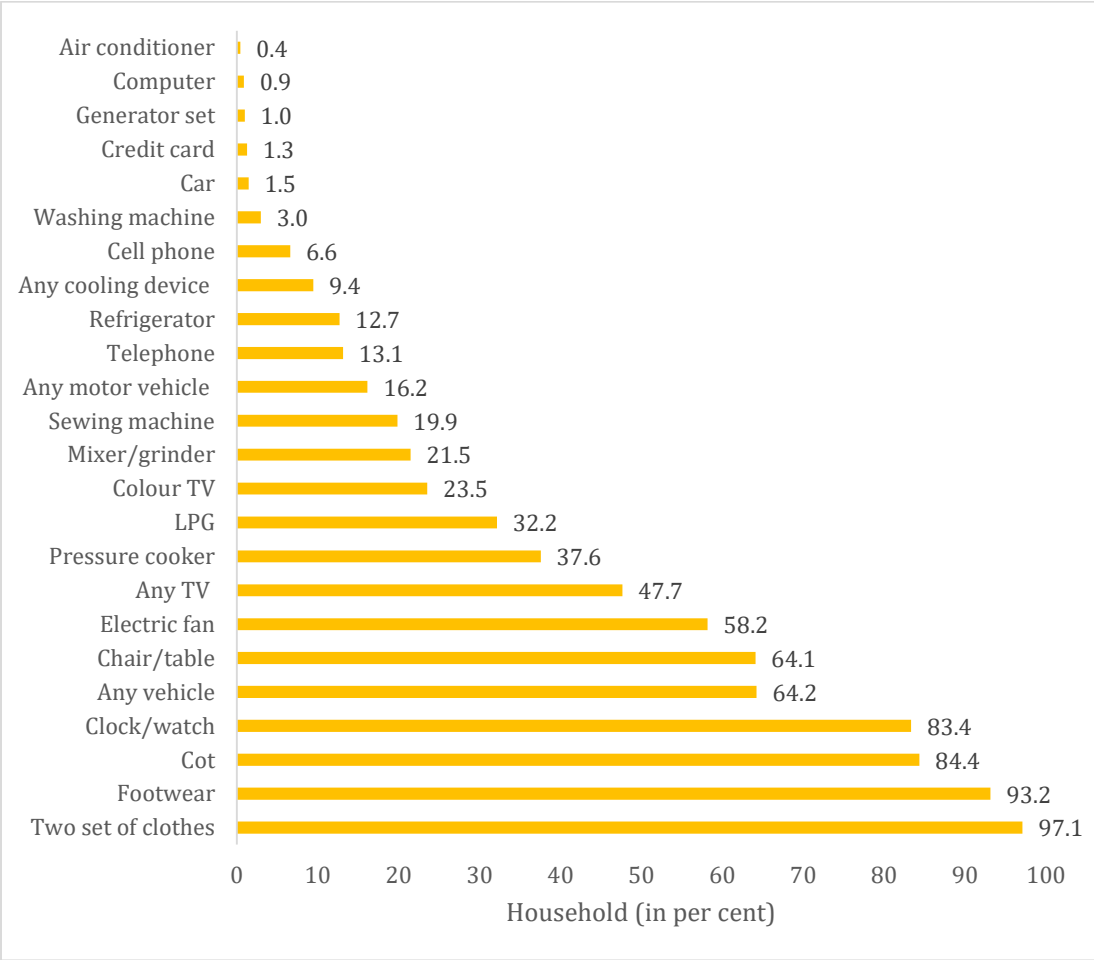

Figure 1: Possessions of various assets in selected sample households in India, 2004-05

Table 3A: Predicted probability of mortality in the presence/absence of any Life-style diseases or ADL.

Wealth Quintile	Major morbidity		Difficulty in ADL	
	No	Yes	No	Yes
Q1	0.066	0.121	0.072	0.127
Q2	0.059	0.103	0.063	0.110
Q3	0.053	0.086	0.055	0.095
Q4	0.047	0.072	0.049	0.082
Q5	0.041	0.060	0.042	0.070

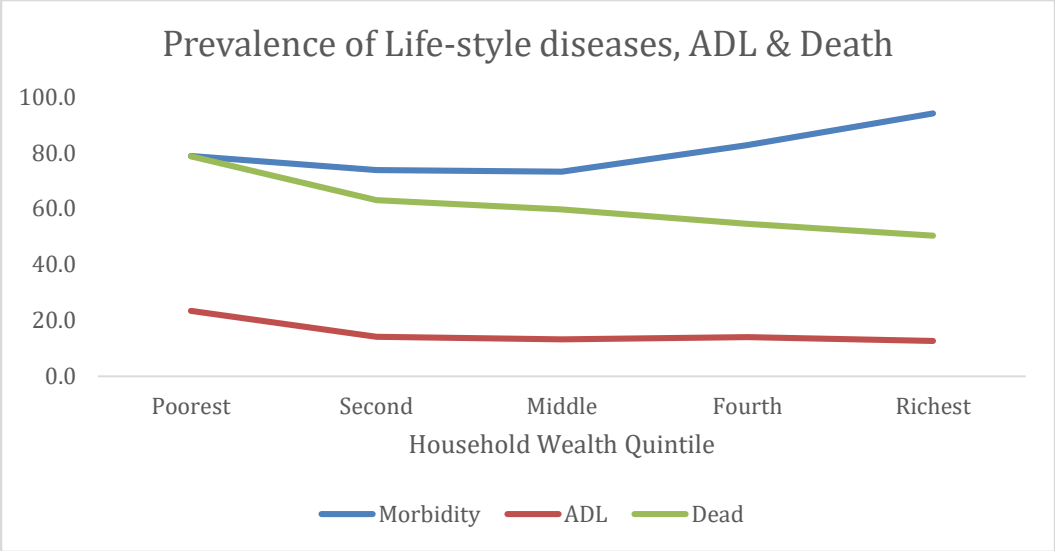

Figure 2: Prevalence (per thousand) of life-style diseases, activities of daily living, and mortality by asset ownership among adults aged 15 years or above.

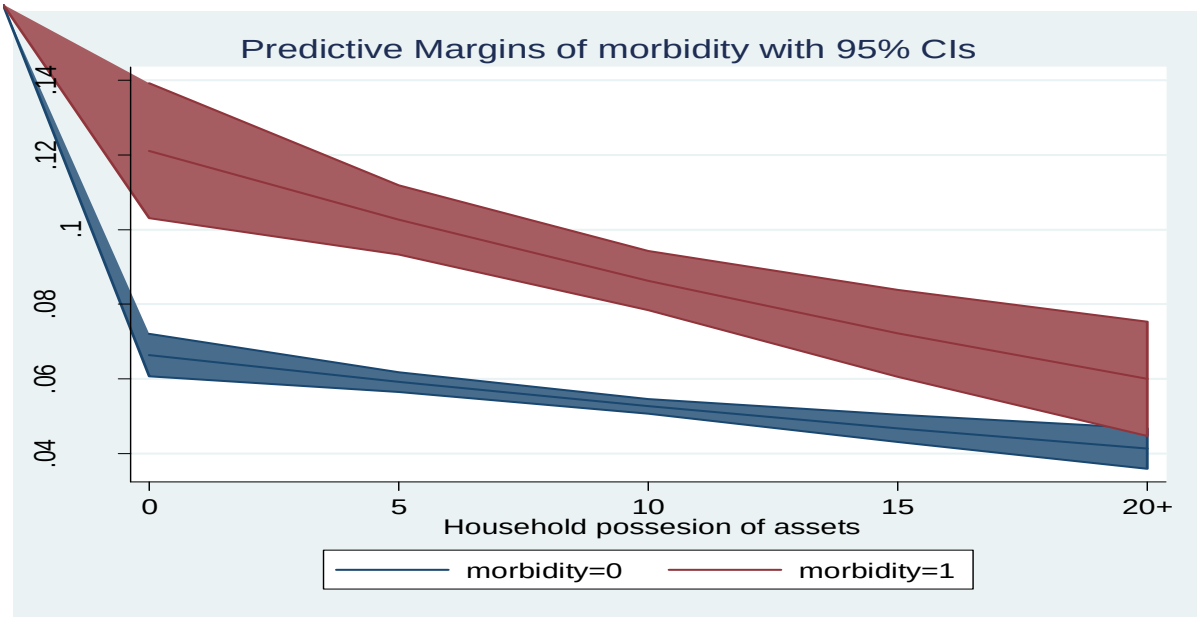

Figure 3: Predicted margins of asset ownership and life-style diseases on adult mortality in India.

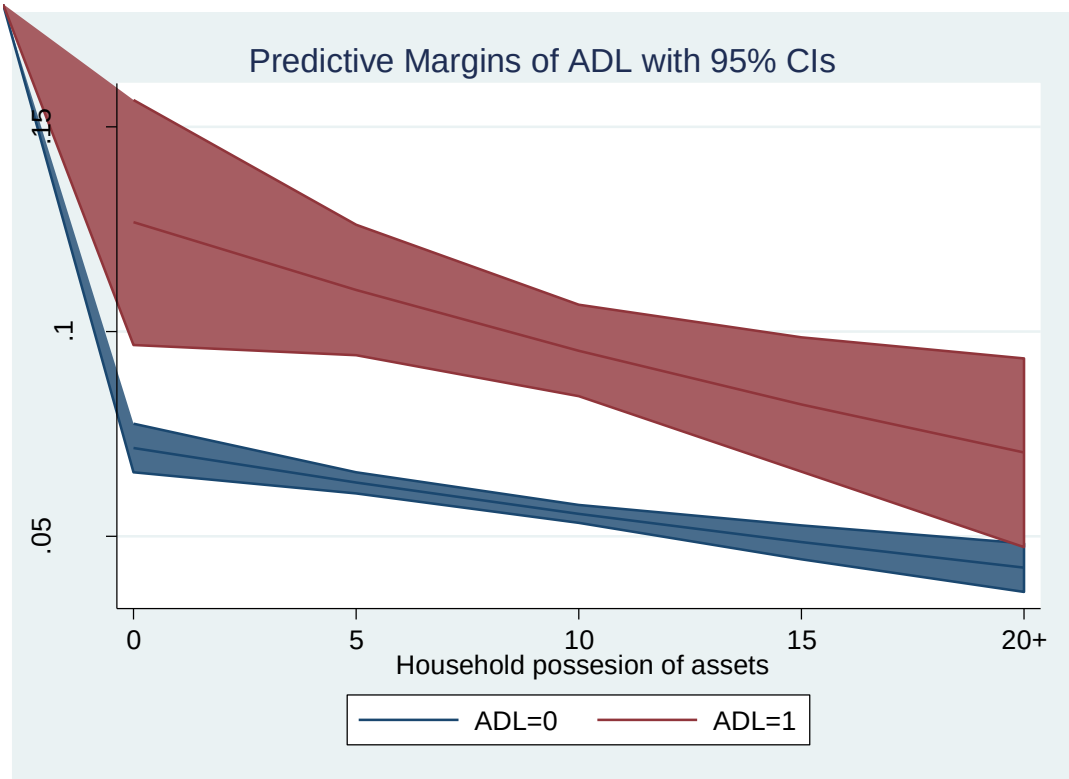

Figure 4: Predicted margins of asset ownership and difficulties in activities of daily living on adult mortality in India.