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Healthy Ageing and Gender Gap in India; Evidence from the Longitudinal Ageing Study in India - Wave 1

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Abstract

The present study aims to understand healthy ageing, determinants of healthy ageing and gender inequality in healthy ageing among Indian older adults using a nationally representative large sample data- Longitudinal Ageing Study in India (LASI) - wave 1. A Healthy Ageing Index (HAI) ranged between 0 and 100 was constructed based on 28 variables representing multiple dimensions of healthy ageing. Descriptive statistics and quantile regression analysis were performed. The mean HAI was 81.40, which indicates that, on average, the study population is slightly healthier. The multivariate analysis results indicated a gender gap in health status over the distribution of HAI. We also observed that there is inequality in healthy ageing based on socioeconomic and demographic differentials. The study also found that better health risk behaviours (no smoking, no drinking of alcohol, and engage in physical activity), food security and social capital had played an important role and acted as a protective factor against unhealthy ageing. A high prevalence of frailty was associated with unhealthy ageing. The discrimination factor largely contributed to the gender inequality in healthy ageing. There should be intervention through socioeconomic and behavioural risk factors to moderate the geriatric population to achieve healthy ageing.

Keywords: Gender, Healthy ageing, Inequality, Older adults, Quantile regression, India

JEL Classification: I140, C210, I120, J140

Introduction

Population ageing has become one of the policy concerns all over the world. It also pushes the epidemiological transition where the health risks are of new forms (non-communicable diseases, injuries and accidents etc.) and replaces the traditional health risks (communicable diseases). The combined demographic and epidemiological transition can potentially challenge population health [1,2]. It is observed that these transitions are taking place at a rapid pace in LMICs [3–5], which may result in severe health and non-health consequences as there is a shortage of resources [6]. It is expected that India will have a significant share of the older population in the coming decades and thus requires policies from both health and non-health sectors [7]. Previous studies conducted in high-income country contexts confirm the possibility of healthy ageing even towards the later years of life [8–10]. These studies emphasise the importance of squeezing the health burden or the "compression of morbidity" into a short period, preferably towards the end of life. Therefore, the best alternative against the combined demographic and epidemiological transition challenges would be working towards healthy ageing as a common public policy target.

Though average life expectancy has been increasing in the past few decades, generally, older adults are noted for higher burden due to chronic diseases [1,11] and disability [12,13], which may lead to loss of overall well-being and health status [1,14,15]. Studies also confirmed that older adults are at high risk of low cognitive health [16] and depression [17]. From the supply side perspective of geriatric medicine, the system is yet to develop or still evolve in most developing country contexts. This supply-side shortage of geriatric medical and non-medical intervention with an increasingly older population (thereby the demand for geriatric care) may lead to unhealthy ageing. Unhealthy ageing mainly was found due to socioeconomic and demographic differences [18,19]. In addition to this, health risk behaviour can also determine healthy ageing [20], and the combined effect of these factors could lead to unhealthy ageing substantially [21–23].

Historically, higher life expectancy is consistently reported among the female gender category [24,25]. Contrary to this advantage, women are less likely to experience healthy life expectancy than men, and this gender gap in healthy ageing become highly prevalent among older adults [26,27]. In the Indian context, women older adults face poor health outcomes compared to male older adults [28]. It is also to noted that an Indian context-based comprehensive health assessment was not done yet. To date, most studies conducted health assessment based on indicators that accounts for a partial health measurement [28,29]. A previous study on Indian older adults has used a comprehensive assessment tool (Active Ageing Index) that was originally developed for developed country context [30]. Therefore, our study aims to assess the health status of Indian older adults with a multidimensional health assessment approach (using Healthy Ageing Index (HAI)), find key determinants of healthy ageing and the gender-based inequality in healthy ageing.

Methods

Data and sample: The present study used data from the Longitudinal Ageing Study in India (LASI) wave 1, a national level survey conducted from April 2017 to December 2018. The survey was conducted jointly by the Ministry of Health and Family Welfare, Government of India, the National Institute of Ageing, United Nations Population Fund-India, International Institute for Population Sciences (IIPS) – Mumbai, Harvard T H Chan School of Public Health (HSPH) and the University of Southern California (USC) and several other institutions. The survey interviewed a sample of 72250 consisting of all age-eligible (45 years and above) individuals and their spouses (no age criteria), separately, from 35 states and union territories of India (excluding Sikkim). The LASI designed to provide reliable national-level estimates on health outcomes and social and economic well-being of age-eligible older adults and their spouses [31,32]. The present study considered only individuals aged 60 years and above (31464 individuals). The bio-makers data of 28576 was available in the LASI. The final sample included for the analysis after dropping missing values and ineligible individuals were 23140 older adults who answered all the variables of interest in the study.

Outcome variable

In measuring healthy ageing, we constructed a Healthy Ageing Index (HAI) by considering multiple healthy ageing domains. In literature, various approaches have been followed for the measurement of health status. Among them, multidimensional health assessment of older adults is well established [33–36]. A systematic review study documenting the domains and measurements of healthy ageing has identified key health assessment domains, including physiological and metabolic health, physical capabilities, general health status, cognitive function and psychological well-being [37]. These health domains can be distinguished into subjective and objective health components and are highly recommended to use together as a multi-domain health assessment approach to better understand healthy ageing [38]. Previous studies also identified that these variables are important components of health and can predict health outcomes and mortality [39–41]. Therefore, the present study developed a multidimensional HAI including 28 variables covering physiological and metabolic health, physical capabilities, general health status, cognitive functions and psychological well-being domains. Each variable was coded in binary or quintile form with value taking between 0 and 100 (Table S1 in the supplementary data). For each individual, the total score from all 28 variables was summed, divided by 28 and then harmonised into an HAI score ranging from 0 to 100. We have used exploratory factor analysis for the development of HAI. A higher HAI indicates healthy ageing status.

The validity and reliability check of HAI was performed, and the full details are provided in the supplementary data (Table S1, Table S2, Table S3, Table S4 and Table S5). The scale reliability of HAI was checked using Cronbach Alpha. The Cronbach Alpha was 0.80 and indicated good internal consistency. The factor structure is shown in Table S2 and Table S3 of the supplementary data. We obtained seven factors. Based on the items allocated to each factor, factor 1 consists of

Instrumental Activities of Daily Living (IADL) variables, factor 2 consists of Activities of Daily Living (ADL) variables, factor 3 consists of cognitive health variables. The remaining variables were allocated to the other factors. The Bartlett's sphericity test was significant (χ^2 = 1.14e+05, $p<0.01$) and the sample adequacy test statistic was higher (Kaiser–Meyer–Olkin = 0.89), which suggest that the data meet the minimum standards for factor analysis. The eigenvalues and percentage of explained variance of the seven factors of HAI is shown in Table S3. Together these seven factors account for 51% of the total variance of the HAI. To check the external validity, we calculated the correlation between HAI and Life Satisfaction (LS) score [42]. Higher LS is associated with better health outcomes and increased longevity [43]. The LS score was constructed based on five questions in the survey and arranged the total score ranged between 5 to 35. A Higher LS score indicates a higher level of LS (Table S5). The Pearson's correlation coefficient between HAI and LS score shows a significant positive correlation ($r= 0.15$, $p<0.01$) (Table S4).

Predictor variables

Previous studies had identified various determining factors of healthy ageing. For the first part of the analysis, the present study used predictors of healthy ageing such as age (60-69 years, 70-79 years and 80 years and above), gender (male and female), education (no schooling, 1 to 5 years, 6 to 10 years and above 10 years), social background (Scheduled Tribe (ST), Scheduled Caste (SC), Other Backward Castes (OBC) and General), marital status (in union and not in a union), "Monthly Per Capita Expenditure quintile (MPCE Quintile) (poorest, poorer, middle, richer and richest)", residence (rural and urban) as the socioeconomic and demographic factors [44,45]. We also employed other relevant predictor variables, including ever smoke (yes and no), ever drink alcohol (yes and no), physical activity (yes or no) as the health risk behaviour factors [46]. Food security (yes and no) was considered as food security-related factor [47]. We used gait speed (walk test), grip strength and body balance test as frailty measurements as it may significantly predict the health outcome. Previous studies have identified that frailty may lead to slowness, weakness, weight loss, falls and other health complications such as disability and morbidity [40,48,49]. Individuals' work status (never worked, currently working, currently not working), personal income earnings (agricultural activities or non-agricultural activities or wages/salaries or family business), benefits from social welfare schemes for the older adults (National Old Age Pension Scheme -NOAPS or Annapurna scheme or widow pension or any other schemes) and government transfers to the household (various subsidies, allowances, compensation debt waiver, relief fund and other social security schemes) were considered as predictor variables. We expect that these variables may also contribute to determining household members' health [50]. The social capital factor was also employed using the frequency of visiting family/friends (yes and no) [51]. The food security variable was coded 1, "no" if the household had reduced/skip food in the last 12 months due to enough food unavailability. The variable MPCE consisted of food and non-food expenditures of households and was collected based on reference periods of 30 days and 365 days, respectively. Gait speed was measured two times (one after another) based on a four-meter walk test and classified an individual's gait speed as "slow" if the average time taken was above 0.8 seconds and as “normal/faster”, otherwise [52]. Grip strength was measured two times with 30 seconds rests between and was measured using a dynamometer. We considered the average grip strength value of the dominant hand (we removed samples who said that both hands are equally dominant). We coded grip strength as “low” if the mean value was below 28.5 for men and 18.5 for women and as “high” otherwise [53,54]. The body-balance test was conducted in three stages. First a semi-tandem test (10 seconds) was conducted and those who failed were asked to perform side-by-side tandem test (10 seconds). Those who successfully performed semi-tandem test were proceeded with a full tandem-test (60 seconds and 30 seconds for less than 70 years old and above 70 years old, respectively). We classified individuals as failed to perform semi-tandem test (base category), failed to perform full-tandem test and completed full tandem test.

Statistical analysis

We used descriptive statistics to find the preliminary results. In the multivariate models, we used quantile regression. Quantile regression is an extension of Ordinary Least Square (OLS) and accounts for the overall distribution of outcome measure based on a given percentile with a linear approach. The HAI is a negatively skewed distribution (Figure 1), and quantile regression may provide better estimates for such asymmetrical distribution [55]. To examine how the HAI associated with the predictors, we estimate the following quantile regression.

$$HAI\tau = \alpha_0(\tau) + \beta X(\tau) + \epsilon(\tau) \quad (1)$$

In equation (1), $HAI\tau$ is the HAI score corresponding to the τ percentile. X is the vector of all the predictor variables, and β is the vector of corresponding estimates of the τ quantile. $\epsilon(\tau)$ is the error term. The study results presented OLS estimates and quantile regression of 10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} percentiles.

To measure gender-based inequality in healthy ageing, we applied a quantile regression decomposition (QRD) model originally devolved by Machado and Mata [56] and modified by Blaise Melly [57,58]. The mechanisms through which QRD work is similar to the Blinder and Oaxaca model [59,60]. The empirical model is as follows.

Let’s assume that our sample is randomly drawn from the population and the OLS regression model for estimating the HAI;

$$\mathrm{HAI}i = \beta_0 + \sum_{k=1}^{k} X_{ki}\,\beta_k + ui \quad (2)$$

HAI= Healthy Ageing Index

i = i^{th} individual

X= Covarates

B = coefficients

u = error term

Now, we will estimate the model separately for male and female older adults. Based on the OLS assumption$E(ui|X_i) = 0$, we shall proceed with the following equations.

$$\bar{\text{HAI}}m = \hat{\beta}_0 + \sum_{k=1}^{k} X_{mk}\,\hat{\beta}_{mk} \qquad (3)$$

$$\bar{\text{HAI}}n = \hat{\beta}_0 + \sum_{k=1}^{k} X_{nk}\,\hat{\beta}_{nk} \qquad (4)$$

Equation (3) is the HAI for male older adults, and equation (4) is the HAI for female older adults. We shall find the gap between male and female older adults by subtracting equation (4) from equation (3). We will get

$$\bar{\text{HAI}}m - \bar{\text{HAI}}n = \left[\hat{\beta}_{m0} + \sum_{k=1}^{k} X_{mk}\,\hat{\beta}_{mk}\right] - \left[\hat{\beta}_{n0} + \sum_{k=1}^{k} X_{nk}\,\hat{\beta}_{nk}\right] \qquad (5)$$

To decompose, we add and subtract a counterfactual. A counterfactual is one that we develop from the equation (3) and (4). We assume that the non-discriminatory health status (HAI) is that of male 1. If the female had the same health status, it would be

$$CF = \left[\hat{\beta}_{m0} + \sum_{k=1}^{k} X_{nk}\,\hat{\beta}_{mk}\right] \qquad (6)$$

The counterfactual equation denotes those female older adults have health status like male older adults. We use equation (6) as the counterfactual to decompose the difference in HAI. By adding and subtracting the counterfactual in equation (5), we will get the following model.

$$\bar{\text{HAI}}m - \bar{\text{HAI}}n = \left[\hat{\beta}_{m0} - \hat{\beta}_{n0}\right] + \sum_{k=1}^{k} X_{nk}\left(\hat{\beta}_{mk} - \hat{\beta}_{nk}\right) + \sum_{k=1}^{k} (X_{mk} - X_{nk})\hat{\beta}_{mk} \qquad (7)$$

The second part of equation (7) is the gap in HAI due to returns (i.e. discrimination or unexplained gap), and the third part is the difference in characteristics (explained part).

The Blinder-Oaxaca model is based on mean estimation, and it does not consider the gap over the distribution. Machado and Mata developed a decomposition method using quantile regression. It has more flexibility than OLS as it allows the effects of the covariates on the different points (percentiles) of the dependent variable (HAI). The Machado-Mata method is the generalisation of Blinder and Oaxaca decomposition method. As per this method, we construct the counterfactual distribution based on the HAI gap at each percentile. The key four steps to generate the counterfactual HAI distribution are;

1- A random sample of size q is generated from a uniform distribution $U[0,1]: u_1, u_2, u_3 \ldots\ u_q$

2- For HAI group1 and HAI group 2 separately, estimate q qunatile regressions. We get $\{\hat{\beta}^{M}_{uj}\}^{q}_{j=1}$ and $\{\hat{\beta}^{N}_{uj}\}^{q}_{j=1}$; i.e. the coefficient vector for HAI group1 and group 2.

3- Take a random sample with replacement of size q from the covariate distribution for HAI group 1 and HAI group 2 separately. We get $\{\tilde{X}^{M}_{j}\}^{q}_{j=1}$ and $\{\tilde{X}^{N}_{j}\}^{q}_{j=1}$

4- The counterfactual distribution are estimated $\left\{CFj = \tilde{X}^{N}_{j}\hat{\beta}^{M}_{uj}\right\}$ $; j = 1,2,3 \ldots q$

The counterfactual distribution represents the HAI for female older adults with the returns of male older adults. At the θ quantile, the difference between the estimated unconditional quantile of HAIm $\left((\hat{Q}_m\ (\theta)\right)$ and HAIn $\left((\hat{Q}_n\ (\theta)\right)$ can be decomposed as

$$\hat{Q}_m\ (\theta) - (\hat{Q}_n\ (\theta) = \left(\hat{Q}_m\ (\theta) - CFj\right) + \left(CFj - \hat{Q}_m\ (\theta)\right) \qquad (8)$$

Here the first part of the equation is the explained gap and the second part is the unexplained gap. The above method was modified by Blaise Melly (2006) with similar decomposition principles. It uses all observations on covariates and combines each observation with q quantile regression coefficients to generate the unconditional distribution of HAI. Therefore, Blaise Melly's modification is advanced and more efficient and faster to compute. We implemented the analysis in Stata using the user developed command by Blaise Melly. No multicollinearity was found among the independent variables used in the regression models. The results were presented with a 95% confidence interval. All the analysis was performed using STATA version 16.

Results

Table 1 presents the descriptive characteristics of dependent and independent variables. The mean HAI was 81.40 (84.83 for male and 78.20 for female), which indicates that, on average, the study population is slightly healthier. A large share of the analytical sample was constituted by older adults aged 60-70 years old (61.79%), female (50.96%), no schooling (56.57%), OBC (45.91%), in union (64.17%) and rural residents (74.10%). Of the health risk behaviours, 42.28%, 15.57%, and 66.05% had ever smoked, drink alcohol and no physical activity, respectively. 6.27% had no food security, whereas 39.87% had no availability of food of their choice. Based on frailty indicators, low grip strength and low gait speed were reported among 71.82% and 10.21% older adults, respectively. 6.74 of older adults reported severe body-balance problems (failed to perform the semi-tandem test), whereas a large share of older adults (73.12%) reported better body balance (completed full tandem-test). 24.75% of older adults never worked during their life (mostly women). 20.19% and 30.24% older adults earned some form of personal income and received social welfare benefits, respectively. 56.56% of the households received any of the government transfers. Most of the older adults had maintained a relationship with family/friends (80.99%).

The results of the OLS and quantile regression estimates for the HAI determinants is presented in Table 2. The OLS estimates indicated a positive effect of education, urban residential status, engagement in physical activity and social capital on healthy ageing. There was a negative effect of increasing age, gender (female), better social background, not married/not in union, smoking, drinking alcohol, high frailty and lack of food security on HAI. In the quantile regression analysis, we observed a decline in healthy ageing as age increases throughout the percentiles. The lowest 10^{th} percentile of HAI had more loss of healthy ageing than the 90th percentile due to increased age. Compared to male older adults, female older adults were less likely to attain healthy ageing across all HAI percentiles. Education had a positive effect on healthy ageing. Older adults with more years of education had a better healthy ageing experience than older adults with no schooling. Among social groups, older adults from the ST background had higher HAI compared to older adults from other social backgrounds, which was contrary to our expectation. Marital status (being in a union) acted as a protective factor against unhealthy ageing. The older adults who reside in urban areas were more likely to have higher HAI than rural residents.

It was revealed that all three behavioural risk factors were significantly associated with healthy ageing. Both smoking and drinking alcohol had a negative effect on healthy ageing. The effect was higher among the lower percentiles (unhealthy) of HAI than the higher percentiles (healthy) of HAI. Older adults without food security were less likely to experience healthy ageing. The adverse effect of lack of food security was higher among the lower percentiles (unhealthy) of HAI. Frailty was a significant predictor of healthy ageing. Older adults with low grip strength, slow gait speed and low body balance were less likely to experience healthy ageing. The results revealed that older adults who never worked and are currently working are more likely to experience healthy ageing than older adults who are not currently working. Personal income was not a significant predictor of healthy ageing, except for the 75^{th} percentile (negative effect). Similarly, social welfare benefits was not a significant predictor of healthy ageing, and we observed an unexpected result where at the 90^{th} percentile, older adults who receive social welfare benefits were less likely to experience healthy ageing. Similarly, older adults from a household that received government transfers were less likely to experience healthy ageing, which was also contradictory evidence. Older adults who visit family/friends were more likely to have higher HAI, and the role of social capital was higher, especially among the lower percentiles (unhealthy) of HAI.

On gender-based inequality in healthy ageing, male older adults are more likely to experience healthy ageing compared to female older adults throughout the distribution. The gender gap in health status was higher among the unhealthy older adults and declined among the healthy older adults. A large share of this gender gap in health status can be attributed to discrimination (i.e. unexplained gap). At the 10^{th} percentile, 55.68% of the gender health status gap was due to discrimination, and the contribution of discrimination to the total gap increased among older adults in the higher percentiles (Table 3).

Discussion

Findings confirm that healthy ageing was determined by socioeconomic, demographic, health behaviour, food security and nutrition and social capital factors, which was confirmed with the evidence from previous studies [61–64]. Our estimates show that increasing age had significantly contributed to a decline in healthy ageing. Findings confirm the gender difference in healthy ageing, and female older adults had lower levels of healthy ageing than male older adults, which is similar to the existing study's findings [65]. The decomposition analysis results indicate that the discrimination factor largely contributes to this gap in health status. The policy implication of this gender difference is crucial as female older adults generally have a longer life expectancy [66] and a higher prevalence of old age-related vulnerability [67,68]. Older adults' marital status as “in union” acted as a protective factor against health loss, which was consistent with previous findings [69]. Food security was also a significant predictor of healthy ageing. It was established that the lack of food security leads to poor health outcomes, which is consistent with the previous study [47]. The findings reveal that the role of social capital has a health-protective effect. Visiting family/friends had a significant impact on healthy ageing. This evidence is consistent with the previous study [70,71].

Our findings confirmed that healthy ageing was significantly predicted by health risk behaviour. Engagement in physical activity acted as a protective factor against unhealthy ageing, which is consistent with the previous studies [72,73]. Older adults with health risk behaviour such as smoking and alcohol drinking were more likely to report unhealthy ageing than older adults without these risk behaviour. Earlier studies observed that no smoking and alcohol drinking acted as health-protective factors [74,75]. Older adults from higher social (social groups) and economic (MPCE quintile) backgrounds had lower levels of healthy ageing. Similar findings have confirmed in the previous studies [76] and which may be an indication of the rise of the “disease of the affluence” among the Indian older adults [77,78]. In other words, it indicates that there is a high prevalence of modern health risks (e.g. Non-communicable diseases) among older adults from the affluent socioeconomic background. The study found that high frailty among older adults has significantly predicted healthy ageing. Previous studies have established the significant role of frailty in creating health complications during old age [79–83].

Our results indicate that social welfare programs and government transfers to the household are not significant predictors of healthy ageing. We suspect two possibilities for these contradictory findings. Firstly, in the Indian context, the geriatric-specific programs had not received enough weight in policy formation. A previous study found that older adults, especially the vulnerable groups, are less likely to benefit from social welfare schemes [84]. Secondly, the possibility of inequitable redistribution of government transfers in the intra-household setting might have lead to no impact on healthy ageing [85–87]. Therefore, we reiterate the need for the direct distribution of policy benefits to achieve better health for older adults.

The present study is not free from limitations. An important limitation of the study is that even though different domains of healthy ageing constituted the HAI, there are still other health domains that did not consider in the study [88]. Secondly, even though self-reported health status can be used for assessing health status as used in the present study [29], there is still the possibility of underreporting of outcomes, especially the incidence of chronic disease as observed in an earlier study [74]. Finally, a causal relationship between healthy ageing and its predictors cannot be sufficiently established, given the study's cross-sectional nature [89]. Thus we recommend future studies to conduct using a longitudinal approach.

Conclusion

Older adults are noted for their increased level of health burden. The present study highlights healthy ageing and its determinants in the Indian context using a nationally representative large sample. The study assessed healthy ageing based on a newly constructed HAI. The study's findings confirmed inequality in healthy ageing among Indian older adults based on socioeconomic and demographic differences. We also found that social capital, low frailty, better health behaviour and food security are inevitable to achieve healthy ageing for all. The gender gap in health status was primarily associated with discrimination factors. Given the already acknowledged poor health status and vulnerability of older adults in India, there is policy relevance to the present study. There should be intervention through socioeconomic factors to moderate the geriatric population to achieve healthy ageing. It may include income protection schemes and other social and health schemes. In India, different older population-specific policies have implemented at various times, such as the National Old Age Pension Scheme (NOAPS), widow pension scheme, Annapurna scheme (providing food grains) and other health programs like national or state-specific insurance schemes.

Declarations

Ethical considerations

The present study used secondary survey data and the data is open for research. The ethical approval for conducting the Longitudinal Ageing Study is India was guided by the Indian Council of Medical Research. The survey data is available through the data center at International Institute for Population Sciences (https://www.iipsindia.ac.in/lasi) or through https://g2aging.org/.

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Declaration of conflicting interest

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Tables and Figures

Table 1: Distribution of dependent and independent variables

Variables	Sample size	Percentage
Dependent variables		
Mean Healthy Ageing Index (HAI) (SD)	81.45 (12.97)	
Mean HAI for male (SD)	84.83 (11.53)	
Mean HAI for female (SD)	78.20 (13.43)	
Independent variables		
Age		
60-70 years	14299	61.79
70-80 years	6723	29.06
80+ years	2118	9.15
Gender		
Male	11348	49.04
Female	11792	50.96
Education		
No schooling	13090	56.57
Up to 5 years	4176	18.05
6 – 10 years	4062	17.56
Above 10 years	1812	7.83
Social background		
Scheduled Tribe (ST)	1987	8.59
Scheduled Caste (SC)	4598	19.87
Other Backward Caste (OBC)	10623	45.91
General	5932	25.63
Marital status		
in union	14849	64.17
Not in union	8291	35.83
MPCE Quintile		
Poorest	5144	22.23
Poorer	5013	21.66
Middle	4837	20.90
Richer	4439	19.19
Richest	3707	16.02
Residence		
Rural	17146	74.10
Urban	5994	25.90
Ever smoke		
No	13357	57.72
Yes	9783	42.28

Ever drink		
No	19537	84.43
Yes	3603	15.57
Physical activity		
No	15284	66.05
Yes	7856	33.95
Food security		
Yes	21688	93.73
No	1452	6.27
Grip strength		
High	6522	28.18
Low	16618	71.82
Gait speed		
Normal/fast	20777	89.79
Slow	2363	10.21
Body-balance		
Failed to perform semi-tandem test	1560	6.74
Failed to perform full-tandem test	4660	20.14
Completed full-tandem test	16920	73.12
Work status		
Currently working	7892	34.10
Never worked	5726	24.75
Currently not working	9522	41.15
Personal income		
No	18467	79.81
Yes	4673	20.19
Social welfare benefits		
No	16141	69.76
Yes	6999	30.24
Government transfers		
No	10053	43.44
Yes	13087	56.56
Visit family/friends		
No	4400	19.01
Yes	18740	80.99
Sample	**23140**	

Table 2: OLS and Quantile Regression estimates for HAI

	OLS	Quantile Regression				
		10th Quantile	25th Quantile	50th Quantile	75th Quantile	90th Quantile
Age (Ref: 60-69 years)						
70-79 years	-2.01* (-2.35 - -1.68)	-3.63* (-4.45 - -2.81)	-2.86* (-3.42 - -2.30)	-1.90* (-2.27 - -1.53)	-1.06* (-1.36 - -0.75)	-0.64* (-0.89 - -0.39)
80 years and above	-4.98* (-5.53 - -4.43)	-9.30* (-10.65 - -7.95)	-7.23* (-8.15 - -6.30)	-4.53* (-5.14 - -3.91)	-2.86* (-3.35 - -2.36)	-1.37* (-1.79 - -0.96)
Gender (Ref: Male)						
Female	-3.73* (-4.13 - -3.34)	-5.14* (-6.09 - -4.18)	-4.61* (-5.26 - -3.95)	-3.55* (-3.98 - -3.11)	-2.84* (-3.19 - -2.48)	-1.88* (-2.18 - -1.59)
Education (Ref: no schooling)						
Up to 5 years	3.46* (3.07 - 3.85)	4.58* (3.63 - 5.53)	4.72* (4.07 - 5.37)	3.53* (3.09 - 3.96)	2.54* (2.19 - 2.89)	1.49* (1.20 - 1.78)
6-10 years	5.24* (4.82 - 5.65)	7.66* (6.65 - 8.67)	7.00* (6.31 - 7.69)	5.22* (4.76 - 5.68)	3.82* (3.45 - 4.19)	2.31* (2.00 - 2.62)
Above 10 years	6.56* (5.95 - 7.16)	10.22* (8.74 - 11.70)	8.55* (7.53 - 9.56)	6.29* (5.61 - 6.96)	4.36* (3.81 - 4.90)	2.58* (2.12 - 3.03)
Social background (ref: Scheduled Tribe-ST)						
Scheduled Caste	-1.64* (-2.13 - -1.16)	-1.66* (-2.84 - -0.47)	-2.03* (-2.84 - -1.22)	-1.59* (-2.13 - -1.06)	-1.18* (-1.62 - -0.75)	-0.88* (-1.24 - -0.51)
Other Backward Caste	-2.45* (-2.87 - -2.04)	-2.43* (-3.44 - -1.41)	-3.37* (-4.07 - -2.68)	-2.60* (-3.06 - -2.14)	-1.78* (-2.16 - -1.41)	-1.19* (-1.50 - -0.88)
General	-2.20* (-2.66 - -1.74)	-2.49* (-3.62 - -1.37)	-2.98* (-3.75 - -2.22)	-2.23* (-2.74 - -1.72)	-1.48* (-1.89 - -1.07)	-1.05* (-1.39 - -0.70)
Marital status (Ref: in union)						
Not in union	-1.02* (-1.35 - -0.68)	-1.52* (-2.33 - -0.71)	-0.84* (-1.39 - -0.29)	-1.04* (-1.41 - -0.67)	-0.56* (-0.86 - -0.26)	-0.61* (-0.86 - -0.36)
MPCE Quintile (Ref: poorest)						
Poorer	0.28 (-0.16 - 0.71)	0.61 (-0.45 - 1.68)	0.36 (-0.37 - 1.08)	0.28 (-0.20 - 0.76)	0.22 (-0.17 - 0.62)	0.01 (-0.32 - 0.33)
Middle	0.19 (-0.25 - 0.62)	0.19 (-0.88 - 1.26)	0.13 (-0.60 - 0.86)	0.16 (-0.33 - 0.64)	0.31 (-0.08 - 0.71)	0.24 (-0.09 - 0.56)
Richer	-0.16 (-0.61 - 0.29)	0.15 (-0.94 - 1.24)	-0.13 (-0.87 - 0.62)	-0.27 (-0.76 - 0.23)	-0.21 (-0.61 - 0.19)	-0.20 (-0.54 - 0.13)
Richest	-0.26 (-0.73 - 0.21)	-0.39 (-1.53 - 0.76)	-0.54 (-1.33 - 0.24)	-0.45 (-0.97 - 0.07)	-0.10 (-0.52 - 0.33)	0.10 (-0.25 - 0.44)
Residence (Ref: rural)						
Urban	1.39* (1.06 - 1.72)	1.92* (1.11 - 2.72)	1.59* (1.04 - 2.14)	0.96* (0.59 - 1.32)	0.76* (0.46 - 1.06)	0.72* (0.48 - 0.97)
Ever smoke (Ref: no)						
Yes	-0.76* (-1.08 - -0.44)	-1.42* (-2.20 - -0.63)	-0.95* (-1.48 - -0.41)	-0.43* (-0.78 - -0.07)	-0.45* (-0.74 - -0.16)	-0.41* (-0.65 - -0.17)
Ever drink (Ref: no)						

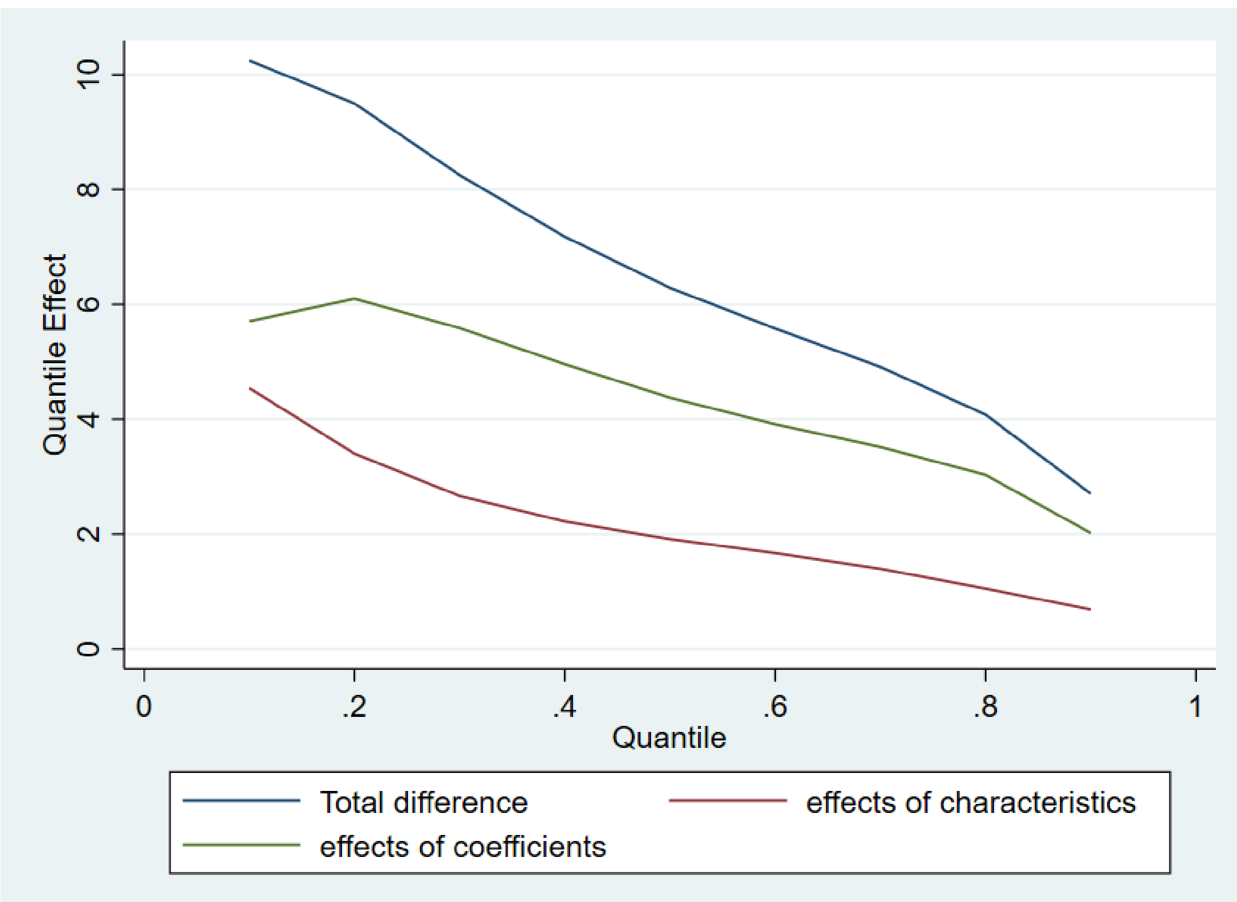
Yes	-0.67* (-1.07 - -0.26)	0.10 (-0.89 - 1.10)	-0.68* (-1.36 - -0.00)	-1.11* (-1.56 - -0.66)	-0.89* (-1.25 - -0.52)	-0.64* (-0.94 - -0.33)
Physical activity (Ref: no)						
Yes	1.10* (0.76 - 1.43)	1.65* (0.83 - 2.46)	1.41* (0.85 - 1.97)	0.97* (0.60 - 1.34)	0.63* (0.33 - 0.93)	0.53* (0.28 - 0.78)
Food security (Ref: yes)						
No	-4.49* (-5.12 - -3.86)	-7.19* (-8.72 - -5.65)	-5.92* (-6.97 - -4.87)	-3.79* (-4.49 - -3.09)	-2.65* (-3.21 - -2.08)	-2.10* (-2.57 - -1.63)
Grip strength (Ref: high)						
Low	-2.19* (-2.50 - -1.87)	-3.50* (-4.27 - -2.73)	-2.40* (-2.93 - -1.88)	-1.79* (-2.14 - -1.44)	-1.28* (-1.56 - -0.99)	-0.66* (-0.90 - -0.43)
Gait speed (Ref: normal/fast)						
Slow	-5.14* (-5.64 - -4.64)	-6.95* (-8.17 - -5.73)	-6.82* (-7.66 - -5.99)	-5.28*(-5.83 - -4.73)	-3.09* (-3.54 - -2.64)	-2.52* (-2.89 - -2.15)
Body-balance (Ref: failed to perform semi-tandem test)						
Failed to perform full-tandem test	2.62* (1.96 - 3.27)	5.15* (3.55 - 6.76)	4.06* (2.96 - 5.16)	2.79* (2.06 - 3.52)	1.90* (1.31 - 2.49)	1.41* (0.92 - 1.90)
Completed full-tandem test	4.74* (4.12 - 5.36)	8.35* (6.83 - 9.87)	6.63* (5.59 - 7.67)	4.69* (4.00 - 5.39)	3.35* (2.79 - 3.91)	2.33* (1.87 - 2.80)
Work status (Ref: Currently not working)						
Never worked	1.43* (1.03 - 1.82)	1.14* (0.17 - 2.10)	1.74* (1.09 - 2.40)	1.40* (0.96 - 1.84)	1.01* (0.65 - 1.36)	0.69* (0.40 - 0.99)
Currently working	3.55* (3.09 - 4.00)	6.24* (5.14 - 7.35)	4.38* (3.63 - 5.14)	2.61* (2.10 - 3.11)	1.60* (1.19 - 2.01)	0.78* (0.44 - 1.12)
Personal income (Ref: No)						
Yes	-0.72* (-1.19 - -0.25)	-0.99 (-2.14 - 0.16)	-0.78 (-1.56 - 0.01)	-0.61* (-1.13 - -0.09)	-0.44* (-0.86 - -0.02)	-0.08 (-0.43 - 0.27)
Social welfare benefits (Ref: No)						
Yes	-0.11 (-0.43 - 0.21)	0.08 (-0.71 - 0.86)	-0.30 (-0.84 - 0.24)	-0.08 (-0.44 - 0.28)	-0.23 (-0.52 - 0.06)	-0.33* (-0.57 - -0.09)
Government transfers (Ref: No)						
Yes	-0.43* (-0.73 - -0.13)	-0.39 (-1.12 - 0.33)	-0.47 (-0.97 - 0.02)	-0.70* (-1.03 - -0.37)	-0.47* (-0.74 - -0.20)	-0.25* (-0.47 - -0.03)
Visit family/friends (Ref: No)						
Yes	1.38* (1.02 - 1.75)	2.97* (2.07 - 3.86)	1.17* (0.57 - 1.78)	0.55* (0.14 - 0.95)	0.61* (0.28 - 0.94)	0.38* (0.11 - 0.65)
Constant	80.98* (80.05 - 81.92)	63.28* (61.00 - 65.56)	74.90* (73.34 - 76.46)	84.06* (83.02 - 85.09)	89.47* (88.63 - 90.31)	93.42* (92.72 - 94.11)
Sample	**23,140**	**23,140**	**23,140**	**23,140**	**23,140**	**23,140**

Note: MPCE Quintile: Monthly Per Capita Consumption Expenditure; Confidence Interval (CI) in parentheses, * p<0.05

Table 3: Gender gap explained by coefficient (discrimination) and characteristics

Percentiles	Total Gap in HAI (Male-Female)	Coefficient (% discrimination)	% Characteristics
1	10.25	55.68	44.32
2	9.50	64.20	35.80
3	8.25	67.72	32.28
4	7.18	69.07	30.93
5	6.29	69.60	30.40
6	5.60	70.11	29.89
7	4.91	71.60	28.40
8	4.08	74.25	25.72
9	2.70	74.63	25.37

Figure 1: Gender inequality in healthy ageing in India



Supplementary Data (Tables)

Table S1: Healthy ageing indicators and harmonisation of HAI

Domains		Variable	Categories	Scale
Physiological and metabolic health		Hypertension	1= Yes and 0= No	1 = 0 and 0= 100
		Diabetes	1= Yes and 0= No	1 = 0 and 0= 100
		Lung disease	1= Yes and 0= No	1 = 0 and 0= 100
		Heart disease	1= Yes and 0= No	1 = 0 and 0= 100
		Arthritis	1= Yes and 0= No	1 = 0 and 0= 100
		Neurological/psychiatric problem	1= Yes and 0= No	1 = 0 and 0= 100
		High cholesterol	1= Yes and 0= No	1 = 0 and 0= 100
		Thyroid	1= Yes and 0= No	1 = 0 and 0= 100
		Other chronic disease	1= Yes and 0= No	1 = 0 and 0= 100
Physical capabilities	ADL	Dressing	1= Yes and 0= No	1 = 0 and 0 = 100
		Walking	1= Yes and 0= No	1 = 0 and 0 = 100
		Bathing	1= Yes and 0= No	1 = 0 and 0 = 100
		Eating	1= Yes and 0= No	1 = 0 and 0 = 100
		Getting out of bed	1= Yes and 0= No	1 = 0 and 0 = 100
		Using toilet	1= Yes and 0= No	1 = 0 and 0 = 100
	IADL	Cooking	1= Yes and 0= No	1 = 0 and 0 = 100
		Shopping	1= Yes and 0= No	1 = 0 and 0 = 100
		Making telephone calls	1= Yes and 0= No	1 = 0 and 0 = 100
		Taking medications	1= Yes and 0= No	1 = 0 and 0 = 100
		Doing work around the house/gardening	1= Yes and 0= No	1 = 0 and 0 = 100
		Managing money	1= Yes and 0= No	1 = 0 and 0 = 100
		Movement	1= Yes and 0= No	1 = 0 and 0 = 100
General health status		Self-rated health	0= very good, 1= good, 2= fair, 3= poor and 4= very poor	0 = 100 1 = 75 2 = 50 3= 25 4 = 0
Cognitive functions		10-word recall test	0 – 10	0-2 = 0 3-4 = 25 5-6 = 50 7-8 = 75 9-10 = 100
		Date orientation – day	1= Yes and 0= No	1= 100 and 0 = 0
		Date orientation – month	1= Yes and 0= No	1= 100 and 0 = 0
		Date orientation – year	1= Yes and 0= No	1= 100 and 0 = 0

Psychological wellbeing	Center for Epidemiological Studies Depression (CESD)	0 -30	0-5 = 100 6-11 = 75 12-17 = 50 18 – 23 = 25 24 – 30 = 0
The total score of all the 28 variables has normalised in to 0 – 100 scale.			

Reliability and validity of HAI

1- Internal consistency of HAI

- Cronbach alpha = 0.80

2- Factor Structure

Table S2: Factor loadings for the HAI (varimax rotation)

	Factor Loadings						
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Hypertension				.64			
Diabetes				.63			
Lung disease					.56		
Heart disease				.52			
Arthritis						.55	
Neurological/psychiatric problem						.65	
High cholesterol				.61			
Thyroid						.57	
Other chronic disease							.97
Dressing		0.72					
Walking		0.76					
Bathing		0.78					
Eating		0.63					
Getting out of bed		0.69					
Using toilet		0.60					
Cooking	0.57						
Shopping	0.74						
Making telephone calls	0.71						
Taking medications	0.65						

Doing work around the house/gardening	0.66						
Managing money	0.79						
Movement	0.77						
Self-rated health					.57		
10-word recall test			0.55				
Date orientation – day			0.78				
Date orientation – month			0.72				
Date orientation – year			0.79				
CESD					.54		
Bartlett's sphericity						1.48e+05 (P<0.000)	
Kaiser–Meyer–Olkin						0.89	

Note: Factor loadings- higher values shows that the factor extracts sufficient variance from that variable. Factor loading 0.5 and above is good enough to consider the variable.

Table S3: Eigen values and percentage of explained variance for the HAI

	Without rotation		**Varimax rotation**	
	Eigen value	Percentage explained variance	Eigen value	Percentage explained variance
Factor 1	5.54	20	3.80	14
Factor 2	2.39	9	3.21	12
Factor 3	1.72	6	2.20	8
Factor 4	1.52	5	1.63	6
Factor 5	1.12	4	1.27	4
Factor 6	1.02	4	1.13	4
Factor 7	1.00	3	1.01	3

Result: Factor 1 and Factor 2 are the major factors expalining the variance of HAI. Together, the seven factors account for 51% of the variance of HAI.

3- **External validity**

Table S4: Pearson's correlation coefficients (r) between HAI and Life satisfaction (LS) score

	Life satisfaction score	
Healthy Ageing Index (HAI)	**r**	**P**
	0.15	0.01

Life satisfaction score

An additive life satisfaction score ranged 5-35 was created based on the following 5 questions. Higher score indicates higher life satisfaction.

Table S5: Questions and coding method for life satisfaction score

Question	Strongly disagree	Somewhat disagree	Slightly disagree	Neither agree not disagree	Slightly agree	Somewhat agree	Strongly agree
In most ways my life is close to ideal	1	2	3	4	5	6	7
The conditions of my life are excellent	1	2	3	4	5	6	7
I am satisfied with my life	1	2	3	4	5	6	7
So far, I have got the important things I want in life	1	2	3	4	5	6	7
If I could live my life again, I would change almost nothing	1	2	3	4	5	6	7