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Are household facilities influencing biomarkers? Evidence from the LASI survey, 2017–18

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ABSTRACT

Background: In light of India's rapidly ageing population, projected to make up 40% of the population by 2050, this study uses information from the Longitudinal Ageing Study in India (LASI) to examine how Household Environment Condition (HEC) affects the health of older adults. By concentrating on biomarkers, the research seeks to understand how these health indicators are spread across different states and their connections to household facilities. The results are expected to offer detailed viewpoints for policy actions, helping improve living conditions and health for the elderly in India.
Aim: The aim of this study is to explore the access of household facilities of older people from different states in India and to check the association between the available household facilities and biomarkers.
Materials and Methods: This study used data from the Longitudinal Ageing Survey of India (LASI), executed in 2017-18 where 24,323 individuals with biomarkers specifically collected from those aged 60 years and above. The analysis, employs various statistical techniques, including descriptive analysis, correlation analysis, and hypothesis testing, providing a robust methodology to explore the intricate relationships between biomarkers and household facilities among the elderly population in India.
Results: Significant variations were observed in body mass index, systolic blood pressure, waist-to-hip ratio, and grip strength between the male and female cohorts. Positive associations were observed between housing and cooking fuel, housing and a separate kitchen, and cooking fuel and a separate kitchen. However, a negative correlation was noted between housing and safe water, suggesting a potential trade-off.
Conclusion: Significant correlations between household amenities and health biomarkers suggest a potential influence of living conditions on health outcomes in the elderly citizens of India. This study highlights diverse demographic and health characteristics, emphasizing the urgent need for interventions addressing educational gaps, economic disparities, and health inequalities among the elderly in India for overall well-being of ageing population.

1. Introduction

Population Ageing is a natural and inevitable process that results in a gradual decrease in both physical and mental strength which further results in multiple diseases. By 2050, the world's population of people aged 60 years and older will double (2.1 billion).[1] According to 2011 Census, India is home to 103 million older people that accounted for 8.6% of population and will be tripled by 2050.[2] Furthermore, between 2011 and 2050, the number of the oldest-old people (aged 75 and older) is expected to increase by 340%.[3] The trend of declining fertility and increasing life expectancy has indicated the increase in vulnerabilities like increasing old-age dependency, reduced levels of potential support, and

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more elderly parents to support[4] it was further added that by the year of 2050, the overall population of India is expected to increase by 56%, pinpointing that the 60+ population will grow by 326% and 700% in the 80+ age group.[5]

Specifically, as the share of India's elderly population increases, so does the incidence of non-communicable diseases (NCDs) among adults aged 45 and older. This rise in NCDs is coupled with a lingering burden of infectious and parasitic diseases, resulting in a double burden of disease.[6] The Longitudinal Ageing Study in India (LASI), a survey of 72,250 individuals aged 45 and older and their spouses less than 45 years, covering all the states and union territories (UTs) of India are designed to fill this gap.[2]

The LASI instrument has three components: (i) the household survey; (ii) the individual survey; and (iii) the biomarker collection. Direct assessment of biomarkers, which can yield objective health measures, is particularly important in India.[7] Biomarkers, which are measurable indicators of biological processes within the body, are key components in this study. It underscores the use of biomarkers in combination with other measures to comprehensively assess the health status of the ageing population in India.[8] To investigate physical functioning biomarkers utilized in LASI, such as grip strength and balance tests, to evaluate functional limitations and disability among older adults, it emphasizes the role of these biomarkers in assessing physical performance and identifying individuals with impaired functional abilities.[9] The rationale behind using blood-based biomarkers, such as fasting glucose levels, lipid profiles, and inflammatory markers is that these biomarkers play a critical role in evaluating cardiovascular health, metabolic disorders, and inflammation-related diseases among older adults in India.[10] The assessment of sensory impairments is also an essential component of LASI, and biomarkers related to vision and hearing play a crucial role in this aspect. The significance of vision related biomarkers which aid in assessing visual acuity, refractive errors, and eye health conditions among older adults.[11] The study explores the relationship between obesity-related markers and prevalent chronic conditions such as diabetes, hypertension, and cardiovascular diseases. The findings underscore the significance of anthropometric measurements as indicators of disease risk and burden.[12]

Study shows that households of the respondents using solid fuel for cooking were 1.2 times more likely to have chronic obstructive pulmonary disease (COPD).[13] Use of solid fuels is associated with respiratory diseases like asthma, tuberculosis and cancer of the respiratory system. Assuming these associations are causal, therefore, about 17 to 60% of the respiratory diseases in India could be prevented by providing access to clean cooking fuel to the individuals.[14] Similarly, evidence was found on the association between several housing characteristics in health of an individual.[15] The major housing determinants that increase the likelihood of malaria are household size (≥ 6), housing type (kutcha), use of unclean fuel, outside water source, improper sanitation (toilet facilities) and damp wall/ceiling.[16] BMI and living environment (house type, drinking water source and toilet facilities) have unique contribution in explaining inequality in non-communicable diseases and communicable diseases respectively among the older adults in India.[17]

This study seeks to assess the impact of changes in Household Environment Condition (HEC) on the health of elderly population in India, leveraging data from the Longitudinal Ageing Study in India (LASI). From a policy perspective, the findings may offer valuable insights into which socially disadvantaged populations necessitate increased focus in ongoing programs aimed at enhancing household environmental and health conditions in India.

2. Material and Methods

2.1. Data source

The data for this analysis comes from the first wave of Longitudinal Ageing Survey of India (LASI), which was conducted in 2017-18. LASI is the Indian version of the Health and Retirement Survey (HRS) geared to offer empirical evidence on indicators related to ageing and health, economic transitions, and social behaviours in later life.

The biomarkers were collected from the oldest person living in a household with all of them aged 60 years and above keeping the objectives in mind. In this study; 24,323 individuals were included from all over the country. Out of total population considered 59.4% (n=14,437) were males and remaining 40.6% (n=9,886) were female population. Almost 65.7% (n=15,990) of the population were from rural areas and 34.3% (n=8,333) were from urban cities. Majority of them were aged between 60-74 years 74.4% (n=18093) and only 25.6% (n=6,230) were aged 75 years and above.

2.2. Measurement protocol

The LASI biomarkers module includes a comprehensive group of indicators, including measures of physiology (blood pressure and lung functions), physical functions (grip strength, balance tests, vision tests, etc.) and anthropometry (height, weight, waist and hip circumference). Anthropometric measures, including height (in cm), weight (in kg), waist circumference (in cm), and hip circumference (in cm), were used to compute more informative variables such as body mass index (BMI) and waist-to-hip ratio (WH ratio). BMI ($kg/m^{2)}$ was calculated as weight (in kg) divided by height (in meters) squared and categorized into 4 categories such as underweight (<18.5),

normal (18.5-22.9) weight, over weight (22.9-24.9) and obese (>24.9). WH ratio, derived from waist circumference to hip circumference, was categorized into normal and abnormal levels. WH ratio was classified as normal if it is up to 0.81 for men and up to 0.88 for women, while values exceeding these thresholds are considered abnormal.

Blood pressure assessments involved obtaining three consecutive readings for systolic, diastolic and pulse pressure, with the mean calculated from the last two readings. Hypertension levels were determined based on established standards: >140 for systolic blood pressure (mmHg), >90 for diastolic blood pressure (mmHg), and >100 for pulse pressure (beats). Grip strength was assessed through 4 readings (two for each hand) with the average measure taken. Eye vision was categorized based on visual acuity standards, identifying individuals with poor vision if the measured visual acuity was 0.25 or less of the respective measures for near and distance vision in either eye. This comprehensive approach provides a nuanced understanding of the health and physiological profiles of the elderly population in India.

Several variables were considered for the assessment of household facility available among the study population. These variables include the type of housing, the main source of cooking fuel used, whether there is a separate room for cooking, access to safe water, the main source of drinking water, whether the household has electricity, and toilet facilities. The data were collected as Yes/No responses and further classified into improved and not improved categories.

2.3. Statistical analysis

The dataset analysis utilized IBM SPSS Statistics Version 25.0, Chicago, USA. The final dataset, comprising 24,323 records, underwent data manipulation, involving adjustments to selected variables for enhanced analytical precision. Additionally, new variables were introduced to enrich the dataset, while irrelevant ones were systematically removed after scrutinizing their frequency distribution during the data cleaning process. To show the preliminary findings, descriptive analysis was used. The exploration of relationships between variables was facilitated through correlation analysis. Additionally, hypothesis testing including t-statistics and p-value scores were employed to demonstrate significant differences among various biomarkers and household facilities.

3. Results

Table 1 represents the background characteristics of the study population. A total of 65.7 % (n=15,990) individuals belong to rural area and the rest of them 34.3% (8,333) resides in urban area. The northern zone recorded 21.3 % (n=5,189) residents whereas only 3.2 % (n=787) population belong to island zone which is a significant disparity in demographic distribution between the northern zone and the island zone, highlighting the pronounced concentration of residents in the former compared to the latter. The educational distribution of the population reveals a majority 51.6% (n=12,562) of the population being illiterate with 12.7% (n=3.086) having less than primary education and only 8.0% (n=1,945) completed high school. It is also observed that a large proportion of the population (48.1%)is not currently employed or participating in any form of work and a significant proportion of the population is engaged in agricultural activities (14.6%). The current marital status data indicates that 53.4% (n=12,983) population is currently married and 43.8% (n=10668) is widowed. According to the MPCE quintiles distribution 20.9% (n=5,081) of the population falls in the poorest quintile suggesting lower economic well-being, while 18.6% (n=4,527) are in the richest quintile, indicating a relatively higher economic status for that segment of the population.

From Table 2; compare the household facilities in rural and urban areas, revealing that 40.4% of the rural (n=9,529) and 72.6% of the urban population (n=6,046) have improved housing, while 59.6% of the rural and 27.4% of the urban population have housing classified as not improved. Similarly, the comparison of the main source of cooking fuel between rural and urban areas reveals that 80.4% (n=6,698) of the urban population uses an improved cooking fuel source, 34.6% (n=5,538) of the rural population adopts the same. Conversely, 27.4% of the urban population and 59.6% of the rural population rely on a not improved cooking fuel source. In terms of improved separate rooms for kitchen, 60.9% (n=9,733) of the rural population and 71.8% (n=5,980) of the urban population utilize this facility.

In regard to the main source of drinking water, 60.9% (n=9733) of the rural population and 71.8% (n=5980) of the urban population rely on improved sources while only 10.0% of the rural population and 12.3% of urban population do not have improved drinking water sources. Majority of rural population (34.2%) do not have access to improved safe water facilities and only half of the urban population (54.8%) avail the same facility. Likewise, majority of households in both rural (89.1%) and urban (94.8%) areas are equipped with electricity.

In Table 3, the average systolic blood pressure for males was 131.3±20.1 mmHg, compared to 134.5±18.8 mmHg for females, indicating a noteworthy gender-based distinction (p-value <0.001) in rural areas. Urban areas demonstrated a similar pattern, with males registering a mean systolic blood pressure of 135.4±20.8 mmHg and females 136.5±19.8 mmHg, indicating a significant gender difference (p-value <0.001). Additionally, a significant gender difference in systolic blood pressure was observed between rural and urban environments. Furthermore, both

Table 1: Percentage distribution of background characteristics of elderly people

Variables	Category	n	%	Variables	Category	n	%
Zone	Northern	5189	21.3%	Gender	Male	14437	59.4%
	Southern	5111	21.0%		Female	9886	40.6%
	Eastern	4344	17.9%	Age group	60-74 years	18093	74.4%
	Western	4055	16.7%		Above to 75 years	6230	25.6%
	Central	1552	6.4%	Highest level of education	Illiterate	12562	51.6%
	Northern	3285	13.5%		Less than Primary	3086	12.7%
	Eastern						
	Island	787	3.2%		Primary completed	2977	12.3%
Place of residence	Rural	15990	65.7%		Middle completed	1810	7.4%
	Urban	8333	34.3%		High School completed	1945	8.0%
Religion	Hindu	17747	73.0%		Intermediate & above	1943	8.0%
	Muslim	2884	11.8%	Currently working	Not working	11690	48.1%
	Christian	2431	10.0%		Working	4301	17.6%
	Others	1261	5.2%		Homemaker	4783	19.7%
Caste Category	SC	4009	16.5%		Agricultural work	3549	14.6%
	ST	4096	16.8%	Current Marital Status	Currently Married	12983	53.4%
	OBC	9253	38.1%		Widowed	10668	43.8%
	Others	6965	28.6%		Others	672	2.8%
Living arrangements	living alone	1630	6.7%	MPCE quintile	Poorest	5081	20.9%
	living with spouse and/or others	3860	15.8%		Poorer	5032	20.7%
	living with spouse and children	8894	36.6%		Middle	4915	20.2%
	living with children and others	8410	34.6%		Richer	4768	19.6%
	living with others only	1529	6.3%		Richest	4527	18.6%

Table 2: Frequencydistribution of different household facilities by place of residence.

Variables	Category	Residence				Chi-square test	
		Rural		Urban		Test-statistic	p-value
		n	%	n	%		
Type of house	Not improved	9529	59.6%	2287	27.4%	2266.5	<0.001
	Improved	6461	40.4%	6046	72.6%		
Main source of cooking fuel	Not improved	10452	65.4%	1635	19.6%	4585.6	<0.001
	Improved	5538	34.6%	6698	80.4%		
Separate room for kitchen	Not improved	6257	39.1%	2353	28.2%	284.3	<0.001
	Improved	9733	60.9%	5980	71.8%		
Main source of drinking water	Not improved	1603	10.0%	1022	12.3%	28.5	<0.001
	Improved	14387	90.0%	7311	87.7%		
Safe water	Not improved	10520	65.8%	3763	45.2%	962.2	<0.001
	Improved	5470	34.2%	4570	54.8%		
HH has electricity	Not improved	1750	10.9%	436	5.2%	218.5	<0.001
	Improved	14240	89.1%	7897	94.8%		
Type of toilet facility	Not improved	9839	61.5%	2232	26.8%	2645.8	<0.001
	Improved	6151	38.5%	6101	73.2%		

Table 3: Comparison of different biomarkers in rural and urban areas by gender.

Parameters	Area	Male			Female			t-test statistic	p-value
		N	Mean	SD	N	Mean	SD		
Systolic *	Rural	8885	131.3	20.1	4193	134.5	18.8	-11.8	<0.001
	Urban	5643	135.4	20.8	3145	136.5	19.8	-4.3	<0.001
Diastolic	Rural	8885	81.5	11.1	4193	81.7	10.4	3	0.002
	Urban	5643	80.9	11.1	3145	80.7	10.8	3.9	<0.001
Pulse Rate	Rural	8885	77.3	11.7	4193	77.9	11.9	-22.8	<0.001
	Urban	5643	81.9	11.9	3145	81.3	11.5	-12.3	<0.001
BMI *	Rural	8758	20.9	4	4126	23.3	4.1	-2.2	0.024
	Urban	5524	21	4.4	3066	24.3	5.4	-8.5	<0.001
Grip*	Rural	8449	22.8	6.9	3984	23.7	6.8	84.4	<0.001
	Urban	5233	14.3	4.9	2925	14.6	4.7	65.5	<0.001
Timed Walk	Rural	8610	5.6	2	4044	5.7	2.2	-26.3	<0.001
	Urban	5398	6.8	2.7	2962	6.7	3	-16.5	<0.001
WH Ratio *	Rural	8756	0.9	0.1	4122	1	0.1	17.6	<0.001
	Urban	5518	0.9	0.1	3059	0.9	0.1	23.2	<0.001

* denotes significant difference between rural and urban areas.

rural (p-value=0.002) and urban (p-value <0.001) areas exhibited a significant gender disparity in diastolic blood pressure, while no such difference was found between rural and urban areas. It's evident that all p-values for pulse rate, BMI, grip strength, timed walk, and waist-to-hip ratio between male and female populations in both rural and urban areas are < 0.001, except for BMI in rural areas (0.024), indicating a clear rejection of the null hypothesis. This suggests that there is significant difference in all the biomarkers between males and females in both rural and urban settings. When comparing these biomarkers between rural and urban areas, a significant difference was observed for systolic blood pressure, BMI, grip strength, and waist-to-hip ratio. However, for diastolic blood pressure, pulse rate, and timed walk factors, there was no significant difference between rural and urban areas (Table 3).

From the Table 4, the distribution on household facilities reveals significant disparities among states in India. Delhi, Chandigarh, and Haryana exhibit the highest percentages of households with improved or clean housing facilities, reflecting well-developed infrastructure and potentially higher living standards, with Delhi leading at 93.9%. However, the North-eastern states of Mizoram, Nagaland, and Manipur report much lower percentages, ranging from 16.8% to 18.2%, indicating challenges or deficiencies in housing infrastructure in this region. Similarly, improved cooking fuel facilities are most prevalent in Delhi (96.7%), Chandigarh (93.4%), and Puducherry (81.4%), while Nagaland reports the minimum at 21.2%. Notably, Jammu and Kashmir leads in improved separate kitchen facility in 90.8% of the households followed by Kerala (90.7%) and Lakshadweep (89%), whereas Mizoram lags behind at 5.7%. A total of 98.4% of the households in both Puducherry and Uttarakhand have access to improved drinking water facility while Nagaland and Mizoram have the minimum percentage at 68.9% and 68.8% respectively.

High percentage of households in Puducherry with improved electricity facilities points to the region's infrastructure development at 99% which is the highest among the states. Similarly, in Manipur (98.2%) and Nagaland (98%) access to improved electricity are notably high among the households with Uttar Pradesh having the minimum at 73.1%. Chandigarh, Nagaland, and Kerala show the highest percentages of households with improved toilets with Chandigarh reporting the maximum 93.7%. On the contrary, Arunachal Pradesh reports the minimum at 8.5% pointing to challenges or deficiencies in sanitation infrastructure in the state.

Table 5 explore that Nagaland boasts the highest percentage of population with normal BMI at 53.8%, followed by Arunachal Pradesh with 51.7%. Delhi, however, exhibits a concerning scenario with 75.8% of its population having abnormal BMI, comprising 10.9% underweight, 20.9% overweight, and 44% obese individuals—the highest among all states. Conversely, only 24.2% of Delhi's population maintains a normal BMI. Delhi stands out with 97.1% of its population having normal pulse rates, the highest among other states in the country. In Mizoram, 74.2% of the population demonstrates normal systolic blood pressure, while Daman and Diu record the highest percentage (89.2%) of normal diastolic blood pressure. Arunachal Pradesh leads in maintaining balance, with 90.2% of its population having normal balance tests, while Nagaland claims the top spot again with 98.8% of the population having normal eye vision. Concerning waist-to-hip ratio, most states show a low percentage of the population falling within the normal category, with a mean of 12.2±5.3%. Gujarat stands out with 20.5% of its population having a normal waist-to-hip ratio, while only 0.8% of Chandigarh's population falls into this category,

Table 4: State wise percentage of house holds with improved/clean facilities.

State name	Housing	Cooking fuel	Separate kitchen	Drinking water	Electricity	Toilet
Andaman and Nicobar	33.1	57.8	58.3	89.1	93.7	57.8
Andhra Pradesh	67.2	77.9	64.6	75.7	95.2	53.3
Arunachal Pradesh	18.5	42.5	38.6	81.9	80.3	8.5
Assam	41.5	33.1	81.4	95.5	89.9	39.3
Bihar	34.8	30.9	50.8	97.1	81.9	22.1
Chandigarh	89.0	93.4	83.1	95.7	95.0	93.7
Chhattisgarh	29.2	22.1	62.4	94.0	87.1	32.6
Dadra and Nagar Haveli	23.6	33.4	63.3	78.8	78.5	20.3
Daman and Diu	69.9	66.4	65.8	70.2	83.9	27.7
Delhi	93.9	96.7	72.8	94.2	97.5	81.9
Goa	69.9	78.9	75.4	94.1	96.1	65.7
Gujarat	51.7	46.5	64.1	87.1	89.2	28.0
Haryana	82.1	44.9	76.7	90.9	95.8	40.8
Himachal Pradesh	69.4	44.0	86.4	85.1	95.8	38.8
Jammu and Kashmir	65.7	45.4	90.8	95.7	96.4	55.0
Jharkhand	35.8	26.7	44.6	95.3	88.6	32.1
Karnataka	41.5	48.5	84.2	82.0	95.5	52.5
Kerala	66.0	49.0	90.7	91.0	93.4	82.9
Lakshadweep	65.5	32.0	89.0	92.1	92.8	80.3
Madhya Pradesh	38.6	32.9	54.4	97.7	85.9	20.6
Maharashtra	64.9	71.4	64.0	93.5	95.6	60.0
Manipur	16.8	48.4	87.7	42.8	98.2	55.6
Meghalaya	24.6	26.3	67.8	83.7	95.9	71.9
Mizoram	18.2	59.1	5.7	80.0	94.8	81.5
Nagaland	17.2	21.2	79.2	68.7	98.0	87.9
Odisha	52.0	27.1	55.7	97.3	88.8	47.6
Puducherry	69.8	81.4	74.3	98.4	99.0	67.8
Punjab	54.9	60.5	72.8	95.6	95.1	76.0
Rajasthan	67.0	44.4	60.7	91.7	89.6	47.8
Sikkim	47.2	65.8	83.2	68.9	95.7	65.2
Tamil Nadu	55.7	77.1	65.3	84.5	95.1	65.3
Telangana	49.6	80.0	50.2	70.3	93.2	44.2
Tripura	19.8	33.6	64.8	96.7	92.1	56.4
Uttar Pradesh	52.4	43.8	40.6	97.6	73.1	15.4
Uttarakhand	70.3	44.0	82.0	98.4	97.3	45.4
West Bengal	50.8	47.0	57.8	94.3	94.8	80.4

indicating an unhealthy trend.

In the Table 6 the correlation table unveils associations among key household amenities in the studied population. A moderately positive correlation is observed between housing and cooking fuel (r=0.597), indicating that improved housing conditions coincide with enhanced access to cooking fuel which is significant. Additionally, the presence of a separate kitchen shows significant positive correlation with housing (r=0.418, p<0.01), emphasizing that better housing conditions are associated with the availability of a separate kitchen. However, safe water exhibits a negative correlation with housing (r=-0.225), suggesting that improved housing conditions might be linked to a decrease in access to safe water. There is a moderately positive correlation between drinking water and housing (r=0.366) which is significant, indicating that improved access to drinking water is associated with enhanced housing conditions.

A significant negative correlation (r=-0.377, $p < 0.05$) suggests that households with better access to safe water may experience a decrease in access to drinking water, indicating a potential trade-off or competition between the two sources within the community. Furthermore, electricity displays positive correlations with housing (r=0.291), cooking fuel (r=0.383), and separate kitchen (r=0.491), indicating that improved housing and kitchen facilities are associated with enhanced electricity access. Notably, toilet facilities show moderately positive correlations with cooking fuel (r=0.390), and separate kitchen (r=0.329), emphasizing that better housing conditions and kitchen facilities coincide with improved toilet amenities at

Table 5: State wise percentage of population with normal biomarkers.

State Name	Body Mass Index				Pulse Rate	Systolic Pressure	Diastolic Pressure	WH Ratio	Balance Test	Eye Vision
	Under-weight	Normal	Over-weight	Obese						
Andaman and Nicobar	13.8	34.7	20.3	31.1	89.4	48.7	67.5	11.3	79.0	93.0
Andhra Pradesh	16.0	39.0	14.3	30.7	89.7	61.9	75.5	16.8	72.4	88.2
Arunachal Pradesh	14.2	51.7	16.4	17.7	89.9	63.8	69.7	9.5	90.2	96.2
Assam	34.2	44.6	9.9	11.2	92.6	52.6	75.7	11.4	80.7	95.6
Bihar	32.8	43.2	11.3	12.7	92.4	70.8	82.1	10.6	79.4	92.5
Chandigarh	8.6	27.6	18.9	44.9	88.1	65.2	81.0	0.8	71.9	94.9
Chhattisgarh	39.1	42.4	7.4	11.1	91.3	58.4	71.5	12.2	86.7	92.0
Dadra & Nagar Haveli	48.0	33.8	6.8	11.5	89.4	65.4	78.9	15.0	72.2	88.5
Daman & Diu	15.5	31.8	15.5	37.1	92.5	60.5	89.2	13.8	67.4	91.7
Delhi	10.9	24.2	20.9	44.0	97.1	63.8	80.2	7.7	79.8	91.7
Goa	12.8	40.0	16.0	31.1	89.9	62.0	81.2	17.2	67.9	90.7
Gujarat	22.3	36.1	15.3	26.4	93.4	65.6	82.3	20.5	79.7	86.8
Haryana	24.0	38.3	15.0	22.7	94.1	70.9	84.6	11.4	68.0	88.5
Himachal Pradesh	19.7	36.7	16.6	27.0	92.1	57.0	75.2	7.0	80.2	88.3
Jammu & Kashmir	15.8	40.6	17.6	26.0	87.5	68.1	79.6	2.7	79.9	90.4
Jharkhand	35.3	41.7	9.8	13.2	92.6	58.1	79.1	12.5	85.8	90.1
Karnataka	22.8	37.7	13.8	25.7	88.9	65.8	77.1	20.3	73.8	85.5
Kerala	11.0	32.7	20.7	35.6	87.8	53.7	83.1	5.0	69.9	91.0
Lakshadweep	5.8	30.4	23.8	40.1	91.8	37.7	73.6	3.3	76.0	94.9
Madhya Pradesh	37.5	38.3	9.1	15.1	93.1	70.5	81.6	19.1	74.2	86.5
Maharashtra	18.1	35.7	16.2	30.0	90.3	68.1	74.9	16.9	77.8	91.5
Manipur	20.7	40.4	15.7	23.1	86.6	63.3	69.2	9.2	78.1	93.3
Meghalaya	29.8	48.9	10.8	10.5	93.3	53.8	65.3	9.2	79.9	96.7
Mizoram	17.2	46.9	15.3	20.6	93.6	74.2	78.2	20.1	88.6	93.6
Nagaland	14.2	53.8	17.1	14.9	87.5	50.8	64.7	13.7	87.4	98.8
Odisha	34.7	40.8	10.8	13.7	90.2	72.2	81.4	11.9	83.8	91.3
Puducherry	12.1	33.3	18.1	36.5	91.3	67.0	84.0	18.4	81.2	92.2
Punjab	11.6	33.1	16.8	38.5	90.6	52.6	69.0	3.5	51.2	87.1
Rajasthan	29.6	42.3	12.7	15.4	90.1	70.3	83.0	12.0	81.1	83.9
Sikkim	8.2	34.0	22.3	35.5	91.6	41.4	53.2	9.8	85.2	95.8
Tamil Nadu	17.2	33.9	17.3	31.6	91.7	63.1	79.8	16.6	82.2	93.0
Telangana	21.4	36.4	14.4	27.8	89.0	63.4	80.2	18.6	73.5	84.7
Tripura	38.2	37.6	12.4	11.8	87.3	64.1	75.8	16.9	86.9	95.6
Uttar Pradesh	38.4	39.8	9.7	12.1	90.9	72.4	82.8	13.8	77.3	84.0
Uttarakhand	26.4	41.4	13.1	19.2	91.1	66.4	72.7	12.0	78.3	89.0
West Bengal	29.9	39.8	12.7	17.6	93.2	57.0	81.3	9.2	83.6	92.6

Table 6: Inter class Spearman's correlation coefficients among the house hold facilities.

	Housing	Cooking fuel	Separate kitchen	Drinking water	Safe water	Electricity
Cooking fuel	0.597**					
Separate kitchen	0.418*	0.075				
Drinking water	0.366*	-0.090	-0.077			
Safe water	-0.225	0.069	0.241	-0.377*		
Electricity	0.291	0.383*	0.491**	-0.151	0.290	
Toilet	0.249	0.390*	0.329	-0.031	0.382*	0.763**

**.Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significantat the 0.05 level (2-tailed).

Table 7: Correlation between biomarkers and house hold facilities.

Correlations	Housing	Cooking fuel	Separate kitchen	Drinking water	Safe water	Electricity	Toilet
BMI (Underweight)	-0.431**	-0.623**	-0.344*	0.225	-.453**	-.577**	-.604**
BMI (Normal)	-0.642**	-0.605**	-0.358*	-0.143	0.076	-0.148	-0.245
BMI (Overweight)	0.420*	0.536**	0.407*	-0.17	.448**	.546**	.610**
BMI (Obese)	0.660**	0.788**	0.406*	-0.079	0.246	.468**	.528**
Normal pulse	0.248	0.059	-0.287	0.296	-0.261	-0.078	-0.111
Normal Systolic	0.085	0.102	-0.435**	0.199	-.398*	-0.26	-.374*
Normal Diastolic	0.447**	0.179	-0.184	0.376*	-.380*	-0.277	-0.224
Hypertension	-.438**	-0.238	0.23	-0.327	.378*	0.284	0.23
Normal WH	-0.289	0.052	-0.460**	-0.126	0.021	-0.122	-0.321
Normal Balance	-0.449**	-0.325	-0.334*	-0.041	0.112	-0.056	-0.085
Normal Vision	-0.324	-0.108	0.113	-0.165	0.533**	0.245	.414*

significant. The strong positive correlation between toilet and electricity (r=0.763) indicates that households with electricity are more likely to have improved toilet facilities. Additionally, it's worth noting that this correlation is significant, indicating a high degree of confidence in the observed relationship between electricity and toilet facility within the population being studied. These findings provide a comprehensive understanding of the interconnectedness among household amenities, offering valuable insights into potential patterns within the studied community.

Table 7 illustrates the associations between biomarker factors and household amenities within the study population. For individuals with underweight BMI, there are moderately negative correlations with housing facilities (r=-0.431), cooking fuel (r=-0.623), access to safe water (r=-0.453), electricity (r=-0.577), and toilet facilities (r=-0.604), all of which are statistically significant at the 0.01 level (2-tailed). Conversely, underweight BMI shows statistically significant moderate negative correlation with a separate kitchen (r=-0.344) facility reaching significance at the 0.01 level (two-tailed). Furthermore, the correlation between underweight BMI and access to drinking water is weakly positive (r=0.225). Moving on to individuals with a normal BMI, there are significant negative correlations at the 0.01 level (two-tailed) between normal BMI and housing facilities (r=-0.642), cooking fuel (r=-0.605), and a separate kitchen (r=-0.358). There is also a weak negative correlation with access to electricity (r=-0.148), drinking water (r=-0.143) and toilet facilities (r=-0.148) although these are not statistically significant. However, normal BMI exhibits weak positive correlations with safe water (r=0.076). For those with overweight BMI, the data indicates positive correlations with housing facilities (r=0.420) and a separate kitchen (r=0.407), both statistically significant at the 0.05 level (two-tailed). Conversely, overweight BMI is negatively correlated with access to drinking water (r=-0.170), although not statistically significant. Additionally, there are significant moderate positive correlations between overweight and safe water (r=0.448), cooking fuel (r=0.536), access to electricity (r=0.546) and toilet facilities (r=0.610). In case of individuals with obese BMI, there are statistically significant moderate positive correlations between obese BMI and housing facilities (r=0.660), cooking fuel (r=0.788), electricity (r=0.468) and toilet facility (r=0.528). There is also a significant positive correlation with and a separate kitchen (r=0.406). However, obese BMI shows a weak negative correlation with access to drinking water (r=-0.079) and is not significantly correlated with safe water facilities.

Normal pulse rate is not significantly correlated with any of the household facilities. Normal systolic blood pressure is significant negative correlated moderately with separate kitchen (r=- 0.435), safe water facilities (r=-0.398) and toilet facilities (r=-0.374). Similarly, normal diastolic blood pressure is moderately positive correlated with housing facilities (r=0.447) and drinking water facilities (r=0.374). Conversely, there is moderate negative correlation between normal diastolic BP and safe water facilities (r=-0.380) at 0.05 level of significance. Individuals with hypertension show moderately negative correlations with housing facilities (r=-0.438) and moderately positive correlation with safe water facilities (r=0.378).

Moderately negative correlations exist between individuals with normal waist-hip ratio (WHR) and those with a separate kitchen (r=-0.460), as well as between individuals with normal balance and housing facilities (r=-0.449). The correlation between normal vision with safe water (r=0.533) and toilet facilities (r=0.414) are moderately positive and statistically significant, indicating a meaningful association between normal vision and these amenities.

4. Conclusion

The study population consisting elderly people aged above 60 years demonstrated distinct variations on the basis of demography, occupation, religion, caste and living

arrangements. A considerable educational gap was observed with half of the population being uneducated. Majority of the population was not employed, while a significant proportion is involved in agricultural work. The economic profile based on MPCE quintiles indicated a progressive decline in economic status from the richest to the poorest quintile, suggesting notable economic disparities within the population. Significant differences were observed in type of house, main source of cooking fuel, separate room for kitchen, main source of drinking water, safe water, electricity and type of toilet facility between rural and urban areas available in the household. The male and female groups exhibited significant difference in all the biomarkers. Significant disparities in systolic blood pressure, body mass index, grip strength, and waist-to-hip ratio were observed between rural and urban areas. However, diastolic blood pressure, pulse rate, and timed walk showed no statistically significant distinctions across these environments.

Nagaland recorded highest percentages of having normal BMI and normal eye vision. Delhi's abnormal BMI percentage is alarming and needs immediate action. Normal Systolic and diastolic blood pressure was observed in Mizoram and Daman & Diu respectively. Abnormal waist to hip ratio is a matter concern for most of the states indicating unhealthy trend across the country. There are disparities in housing infrastructure and electricity accessibility across different regions which should be taken into consideration for optimisation of household facilities. Among the household amenities significant correlations were observed, indicating a notable association or relationship between the various household amenities studied. Similarly, there were marked fluctuations in correlations, pointing to potential association between health biomarkers and the availability of household facilities in India.

In summary, this study sheds light on the diverse demographic and health characteristics of the elderly population aged above 60 in India, revealing substantial disparities in education, occupation, economic status, and health biomarkers across regions. The findings underscore the urgent need for targeted interventions to address educational gaps, economic disparities, and health inequalities. Furthermore, the association between health biomarkers and availability of household facilities for an individual suggests a possible influence of living conditions on health outcomes. Recognizing and comprehending these correlations provides valuable insights that can guide specific interventions aimed at improving living conditions and promoting overall well-being.

5. Conflict of Interest

The authors declare no conflicts of interest.

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