

Research Article

# Association of Anemia With Poor Housing Quality Among Older Indian Adults: Multilevel Modelling Analysis of Nationally Representative Cross-Sectional Study in India.

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## Abstract

**Introduction:** Anemia is an important public health disorder. There is a significant chunk of India population residing under poor housing quality with inadequate sanitation and hygiene, which might lead to higher anemia prevalence. The objective was to determine the association with anemia with poor housing quality among older Indian adult population (>45 years as per residence).

**Methods:** This study analysed the nationally representative dataset of Longitudinal Ageing Study in India (LASI 2017–18, Wave-1). Bivariate analysis and logistic regression was conducted to show the association of anemia (outcome variable with poor housing quality (explanatory variable). Multivariable logistic regression was conducted adjusting for covariates as per there models. P value<0.05 was consider as statistically significant. SATA version 17 was used for analysis.

**Results:** Our study found that, higher adjusted odds of having anemia among older Indian adults were observed among participants with overcrowding (AOR 1.30, 95%CI 1.19-1.42), having access to open/ non-sanitary toilet facility (AOR 1.56, 95%CI 1.41-1.72), no electric supply (AOR 1.31, 95%CI 1.12-1.53 and overall poor housing quality (AOR 1.34, 95%CI 1.21-1.48). All of these association was even higher in urban areas except having access to open/ non-sanitary toilet facility which was much higher in rural areas (AOR 1.61, 95%CI 1.45-1.79).

**Conclusion:** Through a nationally representative large dataset, this study generated compelling evidence despite several obstacles indicating a positive association between anemia and poor housing quality among older Indian adults. It might raise awareness and assist individuals steer clear of the negative effects of overcrowding, using open/ non-sanitary toilet facility, lack of electric supply and overall housing quality on anemia status. It is advised to conduct additional research to determine temporality and causation.

**Keywords:** Anemia, Housing, Housing Quality, Sanitation, Modelling, and Lasi.

## 1. Introduction

Essentially, anaemia is a homeostatic imbalance in haemoglobin concentration (<12 g/dL in women and <13 g/dL in men), i.e. the rate of erythrocyte production is less than the rate of erythrocyte breakdown or loss. It causes societal stress, financial loss, and ill health. It is the outcome of numerous distinct factors, many of which coexist but can also be isolated. Iron deficiency is the most prevalent cause of nutritional deficiency anaemia worldwide, while anaemia can also result from other illnesses such as folate, vitamin B12 and vitamin A deficiencies, chronic inflammation, parasite infections, and genetic abnormalities [1,2].

Anaemia is more common in developing nations, with South Asian nations accounting for 37.5% anaemia cases worldwide. Some of the major causes of the high burden are pregnancy and lactation, illnesses, inadequate diet, and limited access to health care. Anaemia affected 12–17% of geriatric population (>65 worldwide; this percentage included 40% of hospital admissions and 47% of nursing home patients. Due to demographic changes, the world's population is ageing, which means that the total burden of anaemia-related diseases among the elderly will likely rise [3-6].

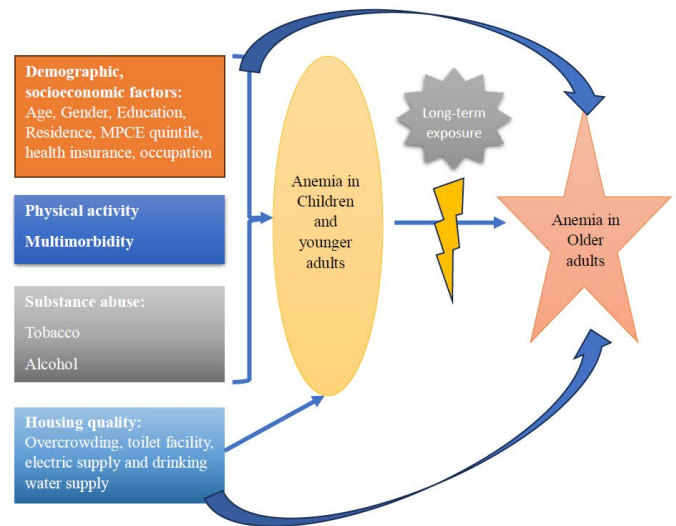
The nutritional status, structural and environmental factors, home dynamics as well as community, and household dynamics, all have an impact on anaemia in children and younger adults. Pre-schoolers suffering from anaemia might lead to impaired cognitive function, stunted motor development, poor academic achievement, weakened immunity, and increased susceptibility to illnesses. These health risks in younger age are precursors to various health issues in older age drastically increasing the associated comorbidities [7,8].

The association of anaemia with various demographic, socioeconomic and nutritional factors are well established. Still, there is a scarcity of information regarding the effect of housing quality, overcrowding, toilet facility, electric supply and drinking water supply. The lacunae of information are much pronounced among older adults. Hence, we have conducted this study. Figure 1 shows the conceptual framework of this study.

### 1.1 Objective

To determine the association of anaemia with poor housing quality-

- among older Indian adults (>45 years).
- among rural and urban older Indian adults (>45 years).



**Figure 1:** Conceptual Framework for This Study

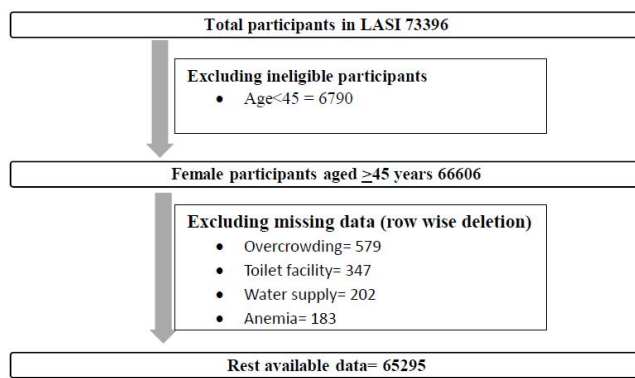
## 2. Methods

LASI-1st wave is a longitudinal survey with a national representation that intends to collect detailed information on the psychological, social, economic, and health aspects of ageing in India from all the states and union territories. It was developed to fill the information vacuum regarding thorough and internationally comparable survey data on India's ageing population. The funding agencies were National Institute on Ageing, the Government of India's Ministry of Health and Family Welfare, and the United Nations Population Fund. The University of Southern California, the International Institute for Population Sciences, and the Harvard T.H. Chan School of Public Health were the contributors. Over 73,000 adult Indians were surveyed. Out of them, 24862 participants were included for the present study.

The study, which is the biggest of its kind in the world and the first of its kind in India, evaluates the scientific evidence in the context of variables like demographics, household economic status, chronic health conditions, symptom-based health conditions, functional health, mental health (cognition and depression), biomarkers, healthcare utilisation, family and social networks, social welfare programmes, employment, retirement, satisfaction, and life expectations. The survey intends to follow a representative sample of the older adult population every two years for the following 25 years, with a revised sample size to account for attrition due to death, migration, non-reachable, and non-response [9].

### 2.1 Ethics

The Indian Council of Medical Research's (ICMR Central Ethics Committee on Human Research (CECHR) gave its ethical clearance for the LASI survey's execution [9].



**Figure 2:** Flowchart Showing Participants Selection Process in This Study

## 2.2 Outcome variable

The outcome variable of choice was anaemia. Self-reported anemia prevalence was obtained by questioning 'In the past 2 years, have you had anemia?' Answering 'yes' was considered as anemia present.

## 2.3 Explanatory Variables

Housing quality was considered as explanatory variable of choice. Poor housing quality was calculated by either presence of any of the four components; i.e. overcrowding, no/non-sanitary toilet facility, no electric supply and poor/unhygienic (unprotected well, surface water, river/dam/lake/ponds/stream /canal/irrigation channel, tanker truck, cart with small truck drinking water supply. Rest were considered as good housing quality.

## 2.4 Covariates

Age group (45-59 and >60 years), Gender (male, female), minimum education (illiterate, less than primary, primary completed, middle completed, secondary school, higher secondary, and Diploma/ graduate), residence (rural, urban), marital status (unmarried, married/ in live-in, Widow/ separated/ divorced), mpce (monthly per capita expenditure-poorest, poorer, middle, richer, richest quintile, health insurance (no, yes), occupation (unemployed, professional and semi-professional- 'legislators and senior officials, professionals, technicians and associate professionals', clerical and skilled- 'clerks, service workers and shopkeepers, skilled agriculture and fishery workers, craft and related trade worker, plant and machine operator', unskilled), physical activity (everyday, once per week, 1-3 times per week, once per month, never), self-rated health (excellent, very good, good, fair, poor), tobacco abuse (no, yes), alcohol consumption (no, yes and multimorbidity were taken as other explanatory variables. Following chronic morbidities were included- hyper-

tension, diabetes, cancer, chronic lung diseases (e.g.- chronic obstructive pulmonary disease, asthma, chronic bronchitis, other chronic lung problems), chronic heart disease (e.g.- congestive heart failure, myocardial infarction, heart attack, other chronic heart diseases), stroke, musculoskeletal disorder (MSD e.g.- rheumatism, arthritis, osteoporosis, other chronic joint or bone disorders), dyslipidaemia (high cholesterol), thyroid disorders, Chronic renal failure, visual impairment and hearing impairment. Interviewer asked related question about chronic health conditions/ morbidities with dichotomous answers (no/ yes)- "Has any health professional ever diagnosed you with the following chronic conditions or diseases?" Participants having at least two chronic health conditions were described as multimorbidity.

## 2.5 Statistical Analysis

Data was analysed in Stata version 17 (StataCorp. 2017. Stata Statistical Software: Release 17. College Station, TX: StataCorp LP.). Characteristics of participants were described as mean (standard deviation for continuous variables frequencies and percentages for categorical variables. Individual sample weights were considered during the analysis. Univariate logistic regression was conducted between outcome variable and each explanatory variable. To avoid multicollinearity among explanatory variables VIF (Variance inflation factor) was applied. VIF > 5 indicates high correlation between a given explanatory variable and other explanatory variables in the model, which might create problems with the regression analysis. Self-related health and marital status had VIF>5. Hence, all the explanatory variables except these two were included for final association. P-value <0.05 were considered as statistically significant. P-value <0.2 was taken for further multivariable logistic regression. Individual sampling weight was considered during the analysis.

## 3. Results

The mean (SD) age was 59.71 (10.66 years) which was almost similar to the anaemic participants. The prevalence of anemia was almost twice in female (5.75% than male (3.12%). Almost half of the participants were illiterate (50.82% and 5.68% participants were educated up to diploma/ graduate having lowest anemia prevalence (2.23%). More than two-third (69.75% participants resided in rural area with higher anemia prevalence (4.84%). Around 1.21% participants were unmarried with lesser anemia prevalence (3.14%). Poorer and the poorest had the higher anemia prevalence. Higher prevalence of anemia was observed among participants with no health insurance (4.55%), unemployed (4.98%), never had any physical activity (5.25%), poor self-rated health (9.36%), multimorbidity (6.33%), consuming tobacco (4.70% and alcohol (4.74%).

**Table 1: Various Characteristics of Indian Population Aged >45 Years**

Variable	Total Participants N= 65295 N (%)	Anemic Participants N= 2962 (4.54 %) %	p-value
Age (years): mean (SD)	59.71 (10.66)	59.56 (10.72)	-
Age group			
45-59	325890 (49.91)	4.51	0.577
>60	32705 (50.09)	4.56	
Gender			
Male	30141 (46.16)	3.12	<0.001
Female	35154 (53.84)	5.75	
Education (minimum)			
Illiterate	33,184 (50.82)	4.91	<0.001
Less than primary	7,185 (11.00)	4.76	
Primary completed	7,937 (12.16)	5.28	
Middle completed	5,358 (8.21)	4.71	
Secondary school	5,075 (7.77)	3.33	
Higher secondary	2,848 (4.36)	2.39	
Diploma/ Graduate	3,708 (5.68)	2.23	
Residence			
Rural	45546 (69.75)	4.84	<0.001
Urban	19749 (30.25)	3.84	
Marital Status			
Unmarried	789 (1.21)	3.14	0.022
Married/ in live-in	48340 (74.03)	4.34	
Widow/ separated/ divorced	16166 (24.76)	5.18	
MPCE quintile			
Richest	13,623 (20.86)	3.86	<0.001
Richer	13,949 (21.36)	4.21	
Middle	13,211 (20.23)	4.84	
Poorer	12,655 (19.38)	4.97	
Poorest	11,857 (18.16)	4.90	
Health insurance			
No	63,787 (97.69)	4.55	0.003
Yes	1,508 (2.31)	4.12	
Occupation			
Unemployed	32,585 (49.90)	4.98	<0.001
Professional and semi-professional	1,755 (2.69)	2.08	
Clerical and skilled	18,764 (28.74)	4.41	
Unskilled	12,191 (18.67)	3.90	
Physical activity			
Everyday	16,367 (25.07)	4.40	0.200
More than once / week	4,345 (6.65)	4.58	
Once / week	2,387 (3.65)	3.98	
1-3 times /month	3,575 (5.47)	4.20	
Never	38,622 (59.15)	5.25	

Self-rated health			
Excellent	2,766 (4.29)	4.55	<0.001
Very good	11,354 (17.63)	2.53	
Good	24,139 (37.47)	3.03	
Fair	19,035 (29.55)	5.82	
Poor	7,121 (11.05)	9.36	
Multimorbidity			
No	41431 (63.45)	3.50	<0.001
Yes	23863 (36.55)	6.33	
Tobacco usage			
No	40965 (62.74)	4.27	0.688
Yes	24330 (37.26)	4.70	
Alcohol consumption			
No	55504 (85.00)	3.36	<0.001
Yes	9792 (15.00)	4.74	

Overall, overcrowding was present among more than one-third (36.27% participants) which was higher in rural (39.76% area). Prevalence of anemia was higher (4.99%) among participants with overcrowding. Overall, 27.01% of participants were using open/ non-sanitary toilet facility, which was much higher in rural area (36.53%). Participants using open/ non-sanitary latrine had higher anemia (5.60%). Overall, 7.96% of participants had no electric supply, which was higher in rural areas (10.56%). Participants

with no electric supply had higher anemia (5.30%). Almost half (46.74% of the participants) had access to poor quality of water supply overall, which was much higher in urban areas (70.72%). Participants accessing poor quality of water supply had higher anemia (4.99%). Majority (77.49% of the participants) had poor housing quality overall, which was higher in urban areas (79.23%). Participants with poor housing quality had higher anemia (4.65%).

**Table 2: Distribution of Indian Population as Per Anemia Status According to Housing Quality**

Characteristics		Overall N=65295		Rural N=45546		Urban N=19749	
		Total %	Anemic %	Total %	Anemic %	Total %	Anemic %
Overcrowding	No	63.73	4.28*	60.24	4.73	71.77*	3.41*
	Yes	36.27	4.99*	39.76	5.01	28.23*	4.93*
Toilet facility	Sanitary	72.99	4.14*	63.47	4.33*	94.95	3.48
	Open/ Non-sanitary	27.01	5.60*	36.53	5.73*	5.05	3.86
Electric supply	Yes	92.04	4.48*	89.44	4.79*	98.04	3.69
	No	7.96	5.18*	10.56	5.30*	1.96	3.84
Quality of water supply	Good	53.26	4.02*	63.61	5.14	29.38	3.67
	Poor	46.74	4.99*	36.39	4.31	70.72	4.23
Housing quality	Good	22.51	4.14*	23.26	4.41*	20.77	3.45*
	Poor	77.49	4.65*	76.74	4.97*	79.23	3.94*

\*p-value<0.05= significant

The adjusted odds of having anemia was significantly 1.30 times higher (AOR 1.30, 95%CI 1.19-1.42 in participants with overcrowding, which was much higher in urban (AOR 1.43, 95%CI 1.29-1.71 areas. The adjusted odds of having anemia was significantly 1.56 times higher (AOR 1.56, 95%CI 1.41-1.72 among participants using open/ non-sanitary toilet facility, which was much higher in rural (AOR 1.61, 95%CI

1.45-1.79 areas. The adjusted odds of having anemia was significantly 1.31 times higher (AOR 1.31, 95%CI 1.12-1.53 in participants with no electric supply. The adjusted odds of having anemia was significantly 1.34 times higher (AOR 1.34, 95%CI 1.21-1.48 in participants with poor housing quality, which was much higher in urban (AOR 1.48, 95%CI 1.20-1.83 areas.



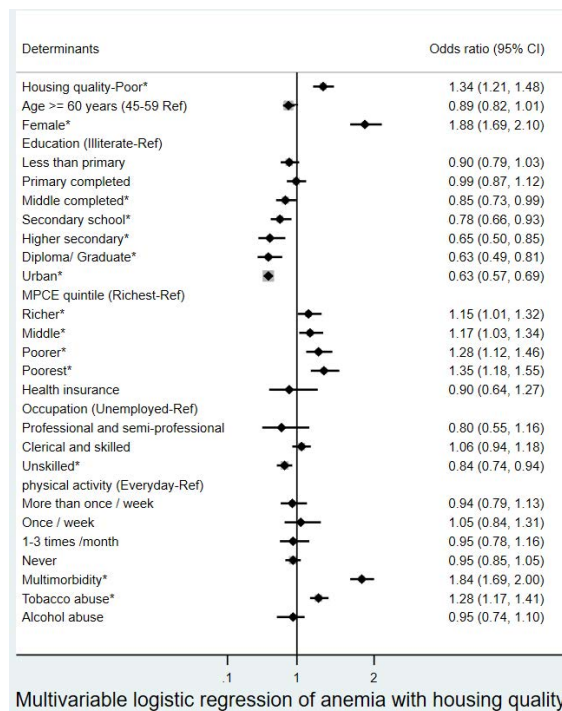
**Table 3: Univariate and Multivariable Logistic Regression of Anemia With Housing Quality Among Indian Population**

Characteristics		Anemic			
		Univariate	Multivariable		
		Crude odds ratio (95% Confidence interval)	Adjusted odds ratio (95% Confidence interval) Model-1	Adjusted odds ratio (95% Confidence interval) Model-2	Adjusted odds ratio (95% Confidence interval) Model-3
<b>Overall (&gt;45 years)<sup>a</sup></b>					
Overcrowding	No	Reference	Reference	Reference	Reference
	Yes	1.27 (1.16-1.37)*	1.33 (1.22-1.45)*	1.32 (1.21-1.44)*	1.30 (1.19-1.42)*
Toilet facility	Sanitary	Reference	Reference	Reference	Reference
	Open/ Non-sanitary	1.60 (1.47-1.76)*	1.50 (1.36-1.66)*	1.57 (1.43-1.74)*	1.56 (1.41-1.72)*
Electric supply	Yes	Reference	Reference	Reference	Reference
	No	1.33 (1.15-1.55)*	1.24 (1.06-1.45)*	1.32 (1.13-1.54)*	1.31 (1.12-1.53)*
Quality of water supply	Good	Reference	Reference	Reference	Reference
	Poor	0.87 (0.81-1.01)	0.94 (0.86-1.02)	0.92 (0.85-1.01)	0.93 (0.86-1.01)
Housing quality	Good	Reference	Reference	Reference	Reference
	Poor	1.29 (1.17-1.42)*	1.33 (1.21-1.47)*	1.35 (1.22-1.49)*	1.34 (1.21-1.48)*

Model 1-Adjusted for age group, gender, education, residence, mpce quintile, health insurance and occupation.  
 Model 2- Model 1+ physical activity and multimorbidity.  
 Model 3- Model 2+ tobacco and alcohol abuse.  
 \*p-value<0.05= significant

The adjusted odds of having anemia was significantly 1.88 times higher among female. With increase in the education status the odds were decreasing. The odds of having anemia was increasing with increase in the mpce quintile. Lesser adjusted odds (AOR 0.63, 95%CI 0.57-0.69 were observed

in urban (AOR 0.63, 95%CI 0.57-0.69 and unskilled participants (AOR 0.84, 95%CI 0.74-0.94). Higher adjusted odds of having anemia was observed participants with multimorbidity (AOR 1.84, 95% CI 1.69-2.00 and tobacco abuse (AOR 1.28, 95% CI 1.17, 1.41).



**Figure 3: Multivariable Logistic Regression of Anemia With Housing Quality and Various Determinants Among Indian Population.**

**Table 4: Multivariable logistic regression of anemia with housing quality among Indian population as per gender**

Characteristics		Anemic			
		Univariate	Multivariable		
		Crude odds ratio (95% Confidence interval)	Adjusted odds ratio (95% Confidence interval) Model-1	Adjusted odds ratio (95% Confidence interval) Model-2	Adjusted odds ratio (95% Confidence interval) Model-3
<b>Rural</b>					
Overcrowding	No	Reference	Reference	Reference	Reference
	Yes	1.17 (1.07-1.29)*	1.28 (1.16-1.42)*	1.27 (1.15-1.41)*	1.26 (1.14-1.39)*
Toilet facility	Sanitary	Reference	Reference	Reference	Reference
	Open/ Non-sanitary	1.47 (1.33-1.62)*	1.56 (1.41-1.73)*	1.63 (1.48-1.81)*	1.61 (1.45-1.79)*
Electric supply	Yes	Reference	Reference	Reference	Reference
	No	1.18 (1.01-1.38)	1.25 (1.06-1.46)*	1.33 (1.13-1.56)*	1.31 (1.12-1.54)*
Quality of water supply	Good	Reference	Reference	Reference	Reference
	Poor	0.81 (0.69-1.06)	0.83 (0.70-1.09)	0.85 (0.85-1.02)	0.88 (0.80-1.01)
Housing quality	Good	Reference	Reference	Reference	Reference
	Poor	1.26 (1.13-1.41)*	1.29 (1.16-1.45)*	1.31 (1.17-1.47)*	1.30 (1.16-1.46)*
<b>Urban</b>					
Overcrowding	No	Reference	Reference	Reference	Reference
	Yes	1.42 (1.21-1.67)*	1.48 (1.24-1.76)*	1.46 (1.22-1.74)*	1.43 (1.29-1.71)*
Toilet facility	Sanitary	Reference	Reference	Reference	Reference
	Open/ Non-sanitary	1.10 (0.75-1.62)	1.05 (0.71-1.56)	1.14 (0.77-1.70)	1.12 (0.75-1.66)
Electric supply	Yes	Reference	Reference	Reference	Reference
	No	1.33 (0.72-2.44)	1.31 (0.71-2.43)	1.48 (0.80-2.75)	1.44 (0.78-2.67)
Quality of water supply	Good	Reference	Reference	Reference	Reference
	Poor	1.08 (0.91-1.29)	1.09 (0.92-1.29)	1.08 (0.91-1.29)	1.08 (0.92-1.29)
Housing quality	Good	Reference	Reference	Reference	Reference
	Poor	1.48 (1.20-1.82)*	1.49 (1.21-1.84)*	1.49 (1.21-1.84)*	1.48 (1.20-1.83)*
Model 1-Adjusted for age group, gender, education, mpce quintile, health insurance and occupation.					
Model 2- Model 1+ physical activity and multimorbidity.					
Model 3- Model 2+ tobacco and alcohol abuse.					
<b>*p-value&lt;0.05= significant</b>					

#### 4. Discussion

Our study found that, higher adjusted odds of having anemia among older Indian adults were observed among participants with overcrowding, having access to open/ non-sanitary toilet facility, no electric supply and overall poor housing quality. All of these association was even higher in urban areas except having access to open/ non-sanitary toilet facility. While overcrowding may not be a direct cause of anaemia, it can have an indirect effect on general health, access to healthcare, sanitation and dietary habits, which may increase the risk of anaemia in vulnerable populations. Food quality and availability are impacted by overcrowding and people are more likely to consume insufficient amounts of iron, which can result in iron deficiency anaemia. Because of the way that overcrowding promotes the development of

parasitic diseases such as hookworm and malaria, anemia might result from chronic disease-causing inflammation that interferes with the synthesis of red blood cells and iron utilisation, leading to anemia of chronic disease. Stress induced hormonal changes due to overcrowding might disrupt metabolism of iron [10-13].

Non-sanitary or open toilets foster an atmosphere that is favourable to illnesses, malnutrition, and infections—all of which can contribute to the development of anaemia. Poor nutrition, particularly a low intake of iron, can result from spoiled or improperly preserved food due to lack of refrigeration in absence of electricity. Information may be accessed via electrical devices (such TVs, PCs, and smartphones). It is essential to know about iron-rich foods, balanced diets, and

preventing anaemia. Access to these instructional resources is restricted in areas without electricity. Briefly put, lack of power affects overall health, education, healthcare, and nutrition, which in turn affects the prevalence of anaemia [12-16].

With increase in the educational status, the odds of having anemia decreased. This might be due to with increase in the education status, the participants became more aware about their health status, which leads to early detection, prevention and treatment of anemia. Participants residing in urban area had 37% lower adjusted odds of having anemia. Factors which might contribute to this were higher education, awareness, improved nutrition, better maternal education and early access to healthcare infrastructure. The adjusted odds of having anemia was highest (AOR 1.35, 95%CI 1.18-1.55 among poorest participants. This might be due to lesser awareness, education, prevention, access to healthcare inability to pay the out-of-pocket expenditure due to treatment. Participants having multimorbidity (AOR 1.84, 95%CI 1.69-2.00 and history of tobacco abuse (AOR 1.28, 95%CI 1.17-1.41 had significantly higher odds of having anemia. This might be due to shared risk factors (inflammation. Poor nutrition), interaction with iron metabolism, challenging and stigma is accessing healthcare services. Similar results were documented by various studies [17,18].

#### 4.1 Strengths and Limitations

The strength of our study was the large nationally representative dataset which increased its generalisability. We have established the positive association between anemia and poor housing quality among older adults which was noble of its kind. This study not only showed the current scenario of poor housing quality with stratified details but also unveil the curtain from the association between anemia, which was further stratified into detailed classification as per residence. Despite these there were some limitations. Due to its cross-sectional nature temporality could not be established. Due to self-reporting type of documentation of data, the actual prevalence of anemia might be higher. Due to the self-reporting style, there were higher probability of recall bias and social desirability bias, which could not be eliminated.

#### 4.2 Policy implication and recommendation

India is the second largest nation in view of population having densely packed cities especially metro areas. In heavily populated places, lowering the prevalence of anaemia requires addressing overcrowding, boosting access to healthcare, increasing nutrition, and encouraging sanitation. To overcome this problem under the flagship of honourable prime minister, "Pradhan Mantri Awas Yojana - Urban (PMAY-U)" and "Pradhan Mantri Awas Yojana - Gramin (PMAY-G)" were launched to construct all-weather pucca houses for people with disabilities, the elderly, people of colour, people with special needs, people who are unmarried, people who identify as transgender, and other vulnerable groups in society. In order to solarize one crore homes in India, the "PM Surya Ghar: Muft Bijli Yojana" was introduced. Homes with installed solar panels would receive up to 300 units of free power each month. Households were provided with inex-

pensive LED bulbs through Ujala (Unnat Jyoti by Affordable LEDs for All scheme/ LED-based Domestic Efficient Lighting Programme (DELDP), which resulted in considerable energy savings and positive environmental effects. To achieve the status of open defecation free (ODF), India launched "Swachh Bharat Mission - Gramin (SBM-G)" to construct sanitary toilet. The programme helped accomplish SDG 6.2 (Sanitation and Hygiene in addition to having a major influence on the economy, the environment, and human health. Thus, Government has initiated various schemes to improve the current situation of poor housing quality, but it is a long way to go to effectively implement in each corner of the nation. We recommend proper clinical or community-based trial to establish the temporality, causation, and natural history of association of anemia with poor housing quality among older adults [19-23].

#### 5. Conclusion

Through a nationally representative large dataset, this study generated compelling evidence despite several obstacles indicating a positive association between anemia and poor housing quality among older Indian adults. It might raise awareness and assist individuals steer clear of the negative effects of overcrowding, using open/ non-sanitary toilet facility, lack of electric supply and overall housing quality on anemia status. The current study thus calls for the implementation and effective continuation of national and regional programmes that might decrease overcrowding, improve the accessibility and availability of sanitary toilet facility and electricity, so assisting the nation in advancing towards the achievement of SDG 6: Ensure access to water and sanitation for all. It is advised to conduct additional research to determine temporality and causation.

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#### Disclosures

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#### Conflicts of Interest

authors have no conflict of interest to declare.

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**Supplementary Table 1: Distribution of Participants as Per Variance Inflation Factor**

Variable	VIF	1/VIF	Variable	VIF	1/VIF
Housing quality- poor	1.33	0.75	Occupation		
Age	1.27	0.79	Professional and semi-professional	1.16	0.86
Gender	1.73	0.58	Clerical and skilled	1.53	0.65
Education			Unskilled	1.42	0.70
Less than primary	6.52	0.15	Physical activity		
Primary completed	3.11	0.32	More than once / week	1.21	0.83
Middle completed	3.29	0.30	Once / week	1.12	0.89
Secondary school	2.68	0.37	1-3 times /month	1.16	0.86
Higher secondary	2.48	0.40	Never	1.69	0.59
Diploma/ Graduate	1.72	0.58	Multimorbidity	1.20	0.83
Residence	1.3	0.77	Tobacco abuse	1.37	0.73
MPCE quintile			Alcohol consumption	1.28	0.78
Poorer	1.64	0.61	Self-rated health		
Middle	1.67	0.60	Very good	4.8	0.21
Richer	1.71	0.59	Good	6.8	0.15
Richest	1.81	0.55	Fair	6.04	0.17
Marital status			Poor	3.41	0.29
Married/ in live -in	15.36	0.07	Mean VIF	3.18	
Widow/ separated/ divorced	15.61	0.06	Widow/ separated/ divorced	15.61	0.06
Health insurance	1.05	0.95	Health insurance	1.05	0.95