SSM - Population Health 25 (2024) 101619

Contents lists available at ScienceDirect

SSM - Population Health

journal homepage: www.elsevier.com/locate/ssmph

A comparative study of health outcomes between elderly Migrant and non-migrant population in India: Exploring health disparities through propensity score matching

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ARTICLE INFO

Keywords:
Migration
Self-rated health
Depression
Multimorbidity
Functional limitation
India

ABSTRACT

Migrants constitute a vulnerable segment of the population, particularly susceptible to various health challenges. Despite this, limited research has delved into the comparative health statuses of migrants and non-migrants in the rising elderly population. This study aims to bridge this gap by exploring health disparities between these two groups. Leveraging data from a nationally representative, large-scale Longitudinal Ageing Study in India (LASI) survey (n = 29002; 3103 Migrants and 25899 Non-migrants), this research focuses on four health indicators: self-rated health (SRH), depression, multimorbidity, and functional limitations. The study undertakes descriptive and bivariate analyses for migrant and non-migrant groups and employs propensity score matching techniques to fulfil its objectives. The findings reveal that for respective migrant and non-migrant populations, the prevalence of poor-SRH was 24.04 % and 16.29 %; depression was 12.32 % and 6.62 %; multimorbidity was 26.78 % and 15.71 %, and functional limitation was 28.35 % and 23.13 %. The study uncovers a 2.4 percentage point increase in poor self-rated health, a 1.0 percentage point rise in depression, and notably, a 4.2 and 1.0 percentage point elevation in multimorbidity and functional limitations among migrants relative to non-migrants. Evident from the outcomes is a stark health disparity, emphasising migrants' heightened vulnerability across multiple health dimensions. The implication of this research highlights the necessity for policy interventions aimed at eliminating health inequalities between migrant and non-migrant populations.

1. Introduction

Increased longevity and declining fertility rates have led to the greying of the population worldwide. In 2019, there were 703 million older people in the world, and by 2050, that number is projected to have doubled (World Population Prospects, 2019). According to estimates, there will be 330 million senior citizens in India by 2050, which will account for 19.4 % of the country's total population (Sivaraju, Alam, & Verma, 2017). Likewise, there has been a significant surge in global international migration over the last twenty years, with the number of international migrants worldwide reaching over 281 million in 2020 from 173 million in 2000 (McAuliffe & Khadria, 1953). In India, there were around 319 million internal migrants in 2001, which increased to 450 million as of 2011; that number is expected to rise to a massive 600 million (Rajan & Bhagat, 2022a). However, despite being several times more substantial than international migration, internal migration has not gained as much attention (Wickramage, Vearey, Zwi, Robinson, & Knipper, 2018).

Migration can yield both positive and negative health consequences. On the positive end, migrants may discover better incomes, which may lead to better access to health care services in the destination places (Rajan, Bhagat, & Ram, 2022b; Rajan, 2022). On the contrary, migrants may be more susceptible to health issues due to various factors. These include psychological stress from the removal and resettlement procedure, alienation from their new environment, loss of social ties, a lower socioeconomic position, and language obstacles (Lu, 2010).

India is on the rise of chronic diseases (Singh, Chauhan, & Puri, 2023). The spectrum of chronic conditions extends beyond non-communicable diseases (NCDs) to encompass metabolic risk factors like obesity, hypertension, and high cholesterol, culminating in a surge of multimorbidity (MacKinnon et al., 2023; WHO, 2016). This burden is amplified in marginalised groups like migrants, accentuating health disparities (Sheikh et al., 2016). Additionally, migration engenders augmented functional health impediments due to socioeconomic

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https://doi.org/10.1016/j.ssmph.2024.101619
Received 10 September 2023; Received in revised form 28 December 2023; Accepted 31 January 2024
Available online 1 February 2024

discrepancies, cultural acclimatisation, constrained healthcare access, and psychosocial stressors, thereby compromising the wellbeing of migrants (Mandal, Pradhan, Mohanty, & Muhammad, 2023).

Empirical investigations on the health status of migrants, in contrast to that of non-migrant populations commonly reveal that, following their migration, migrants exhibit better health outcomes than the native populations despite having a comparatively disadvantaged socioeconomic status. This remains in the initial few years of migration, but with a longer stay, migrants lose this early health benefit (Juárez & Revuelta-Eugercios, 2016) Thus, the phenomenon is known as the Healthy Migrant Effect (HME); this phenomenon is quite evident among migrants in the developed and developing countries like Sweden (Helgesson, Johansson, Nordquist, Vingård, & Svartengren, 2019), Canada (McDonald & Kennedy, 2004), Netherlands, Belgium, and England (Reus-Pons, Kibele, & Janssen, 2017), South America (Cabieses, Tunstall, & Pickett, 2013), Australia (Anikeeva et al., 2012), Indonesia (Lu, 2008, 2010), China (Chen et al., 2022; Lu & Qin, 2014), Chile (Rada, Oyarte, & Cabieses, 2022). However, this also has some important contrast evidence worldwide; for example, a study in three European countries (Belgium, Netherlands, and England and Wales) found that non-migrants could be expected to live longer than migrants (Reus-Pons et al., 2017). Jatrana, Richardson, and Pasupuleti (2018) found mixed results in HME in the Australian context. They found that English-speaking migrants tend to report good health compared to native Australians; however, for all health outcomes, non-English-speaking migrants were at a disadvantage compared to native-born Australian people. (Dodd et al., 2017) examined HME in the Indian context, taking a relatively small sample in southern India, and found no significant difference in the health status of migrant and non-migrant persons.

Prior studies on migration and health in India primarily emphasised the adverse health impacts on migrants that result mainly from their participation in labour mobility (Dodd et al., 2017; Ravindranath & Mohan, 2022). Communicable disease among migrant workers was the major focus area, with a specific interest in HIV/AIDS (Saggurti et al., 2008, 2009) and malaria (Kumar et al., 2012). Additional studies have investigated health consequences linked to occupational health problems (Akram, 2014; Sarivaara, Uusiautti, & Määttä, 2013) and non-communicable diseases (Ebrahim et al., 2010; Sarivaara et al., 2013). Furthermore, very little literature suggests that migrants had an elevated risk of mental health problems than natives (Srivastava, Singh, Mishra, & Aditya, 2023). Ebrahim and colleagues found that rural-to-urban migrants had a higher risk of obesity and diabetes than their non-migrant urban counterparts (Ebrahim et al., 2010). Some Indian studies (Ebrahim et al., 2010; Mandal et al., 2023; Paul, Mandal, & Samanta, 2023; Srivastava et al., 2023) demonstrated that migrants are the vulnerable section of the population, exposed to various health issues. It remains inconclusive about the various exposures to health and how they act on migrant and non-migrant populations. No study attempted to investigate the difference in health status between migrants and non-migrants at later ages. Moreover, being a country with the second largest elderly population, more emphasis should be devoted to how these intersecting characteristics shape the ageing of migrant populations and find ways of addressing this within middle-aged and elderly-focused healthcare services (WHO, 2015). Hence, considering the limited research on migrant health disparities, this study recognises the nuanced health gap between migrant and non-migrant groups in India. Existing investigations into this disparity have predominantly focused on the global north. Nonetheless, the relevance of these findings to the global south, particularly within the Indian context, remains uncertain. To address this gap, the present pan-India study aims to elucidate the health disparity between migrants and non-migrants, contributing to a more comprehensive understanding of the issue.

2. Materials and methods

2.1. Data

The present study used the baseline survey of India's first nationally representative Longitudinal Ageing Study in India (LASI) conducted during 2017–2018. LASI is a national survey of health, social determinants, and wellbeing of middle-aged and older adults in India. This survey was conducted by the International Institute for Population Sciences (IIPS) in collaboration with the Harvard T.H. Chan School of Public Health and the University of Southern California (LASI, 2020). The LASI survey provides vital information on demographics, symptom-based health conditions, functional and mental health, family and social networks, household economic status, health insurance, healthcare utilisation, biomarkers, retirement, and life expectations across all of India's states and union territories (Bloom, Sekher, & Lee, 2021). This national survey adopted a multistage stratified area probability cluster sampling strategy, including a three-stage rural and four-stage urban sampling design. The initial step in each state/UT involved choosing the subdistricts (Tehsils/Talukas) or Primary Sampling Units (PSUs). The selection of wards in urban areas and villages in rural areas within the chosen PSUs took place in the second stage. In the third stage, households in rural areas were selected from sample villages. However, one Census Enumeration Block (CEB) was randomly chosen in each urban area during the third stage, and households were then chosen from this CEB during the fourth stage. Consequently, there was an additional stage of sampling in urban areas. Detailed information on the survey design, methodology and data collection was published in the LASI survey report and elsewhere (LASI, 2020; Perianayagam et al., 2022). Fig. 1 illustrates the sample selection procedure for the current study. The sample comprised 29002 participants, including 19319 males and 9683 females. The sex ratio for the whole sample was 502; for the migrant subgroup, it was 915. The mean age of the participants was 59.45 ± 10.61 SD, with a range of 45–116 years.

2.2. Treatment variable

The participants in our study were middle-aged and older individuals aged 45 and above who migrated to other places within 10 years from their place of last residence. As migration is the treatment variable, the migration information of the respondents was accessed in three steps. Those who responded "Since Birth" to the survey question "How many years have you been living (continuously) in this area?" were classified as non-migrant and others as migrant. However, among the migrants, those who reported their last residence was any country other than India to the survey question "Where were you living before coming to this place (place of last residence)" were excluded from the study as they were not considered internal migrants. Therefore, any respondents who did not respond to the survey question regarding their migration status and those who international migrants were also excluded from the study as the treatment sample was solely based on internal migrants. Furthermore, to get an explicit effect of migration on health outcomes, migrants who had resided in the destination areas for more than 10 years were excluded from the study. There was no overlapping between the treatment and control groups, as they were mutually exclusive.

2.3. Outcome variables

2.3.1. Poor-SRH

The following question was used in the LASI to measure participants' self-rated health status: "Overall, how is your health in general? Would you say it is very good, good, fair, poor, or very poor?" For the present study, the responses were dichotomised into "1″ for the response for poor-SRH (very poor and poor) and "0″ for the rest of the references as good-SRH (excellent, very good and good) (Mandal et al., 2023; Saha, Rahaman, Mandal, Biswas, & Govil, 2022).

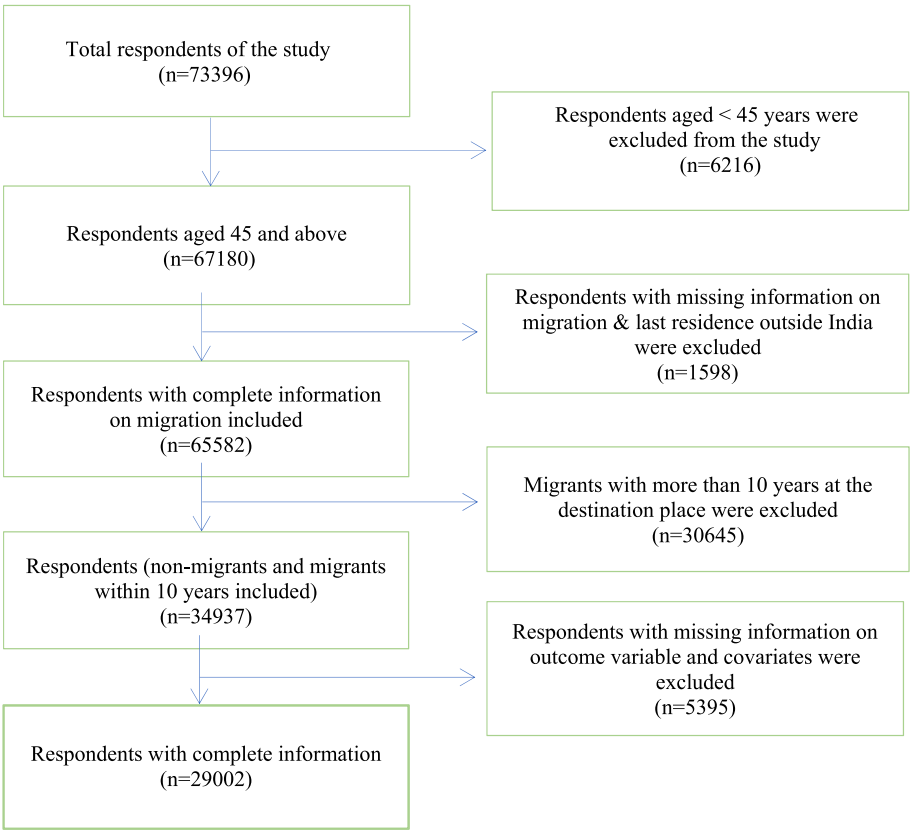

Fig. 1. Flowchart of sample selection.

2.3.2. Depression

The prevalence of major depression in older adults experiencing dysphoric symptoms was assessed using the Composite International Diagnostic Interview - Short Form (CIDI-SF) on a scale ranging from 0 to 10. This scale has been extensively used in population-based health surveys and estimates a probable psychiatric diagnosis of major depression. It has been verified in field settings. CIDI-SF has three screening (based on the presence of dysphoria and/or anhedonia for 2 or more weeks during the past 1 year) and seven symptom-based questions, and a positive response to three or more symptoms out of ten items are considered 'depressed'. Depression was coded for the study as 0 for "not diagnosed with depression" and 1 for "diagnosed with depression" (Muhammad, Skariah, Kumar, & Srivastava, 2022).

2.3.3. Multimorbidity

Multimorbidity was assessed using the question, 'Has any health professional ever diagnosed you with the following chronic conditions or diseases?' (High cholesterol, cancer or malignant tumour, diabetes, chronic heart disease, stroke, any kind of lung disease, bone or joint disease, neurological or mental disorders, and hypertension). When participants report having received a diagnosis from a medical professional for two or more chronic health conditions, this is known as multimorbidity. All chronic illnesses are totalled for this study, and one or no chronic illness is classified as "No Multimorbidity" (coded as 0), whereas multiple chronic illnesses are classified as "Multimorbidity" (coded as 1) (LASI, 2020; Srivastava, Chauhan, & Patel, 2021).

2.3.4. Functional limitation

To assess Activities of Daily Living (ADL) limitations, LASI respondents were questioned if they were having any of the following limitations and they anticipated any of the following limitations to continue longer than three months: difficulty with dressing, walking across the room, bathing, eating, getting in or out of bed, or using the toilet (including getting up and down). In the LASI survey, Activities of Daily Living (IADL) were assessed by asking respondents if they were having any difficulties that were expected to last for at least 3 months, such as shopping for groceries, preparing a hot meal, making a telephone call, doing work around the house or garden, taking medications, managing money like paying bills and keeping track of expenses, and getting around or finding an address in unfamiliar places. In this study, we combined 1 + ADL and 1+IADL limitations for each individual and classified them as having a functional limitation (coded as 1) or not (coded as 0) (Mandal et al., 2023).

2.4. Matching covariates

In this study, a number of matching variables have been included on the basis of available literature (Barman, Saha, Dakua, & Roy, 2023; Ebrahim et al., 2010; Firdaus, 2017; MacKinnon et al., 2023; Mandal et al., 2023; Marques, Gama, Cheng, Osborne, & Dias, 2022; Saha, Mandal, Muhammad, Barman, & Ahmed, 2023; Saha, Muhammad, Mandal Id, Adhikary, & Barman, 2023; Samanta, Munda, Mandal, & Adhikary, 2023). The list of pre-intervention variables includes demographic, household, and health behaviours, includes age (45–59, 60–74, 75+ years), sex of the respondents (Male and female), educational attainment (no education, primary, secondary, and higher), marital status (married, widowed, and others), employment status (currently working, never worked, and retired), social participation (yes, and no), food insecurity status (no, mild, moderate, and severe), wealth quintile (poorest, poorer, middle, richer and richest), caste (scheduled caste, scheduled tribe, other backward classes and others) religion (Hindu, Muslim and others), physical activity (active and inactive), alcohol consumption (never, infrequent, frequent, and heavy), tobacco consumption (non-consumer, currently smoking, smokeless tobacco, and both smoking and smokeless) (refer to table A1 for more details).

2.5. Econometric analysis

2.5.1. Descriptive statistics

Bivariate and multivariate analysis have been performed to achieve study objectives. The prevalence of major health outcomes was presented as proportions for both migrant and non-migrant groups stratified by individual, household, and behavioural factors. The chi-squared test was used to check for differences in the prevalence of health outcomes between non-migrant and migrant populations. A multivariate logistic regression model was performed separately in both population groups to examine the adjusted effect of predictor variables on the probability of reporting major health outcomes.

2.5.2. Propensity score matching (PSM)

The PSM was used in the current study to evaluate the treatment effects of migration on four outcome variables, i.e., poor-SRH, depression, multimorbidity and functional limitation. PSM is a statistical method that helps assess the treatment effects for observational and cross-sectional data by minimising selection bias and modelling the experimental design with balanced baseline characteristics (Rosenbaum & Rubin, 1983). It creates a comparison group that can address the counterfactual (defined as what would be the outcome if the treatment did not occur). In PSM, different observed predictors are combined to provide a propensity score, representing each individual's likelihood of being assigned to the treatment group. A matched sample of participants in the treatment and control groups is created by utilising kernel matching based on this score. The propensity score is a balancing score of the observable predictors, indicating that the distribution of variables is similar in the treatment and comparison groups. Individuals who were migrant were assigned to the treatment group and matched with the control group using a one-to-one matching approach. The calculated propensity scores were based on various individual and household-level characteristics such as age, sex, educational status, marital status, working status, social participation, food insecurity, MPCE quintile, religion, caste, physical activity, alcohol, and tobacco consumption. A description of the method is given as follows:

In this study, PSM is the probability that migration determines the health outcome of a person with certain pre-specified characteristics and is written as

$$p(x) = Pr(D = 1|X) \tag{1}$$

Where D = 0 if the person is non-migrant.

D = 1 if the person is a migrant.

And X is the vector of pre-intervention characteristics.

Defining the impact of migration on health outcomes; In PSM, three parameters are estimated. These are average treatment effect (ATE), average treatment effect on treated (ATT) and average treatment effect on untreated (ATU).

The ATE measures the mean impact of migration across the population. This parameter may be defined as

$$ATE = E[D_1] = E(Y_1 - Y_0) = E(Y_1) - E(Y_0) \tag{2}$$

here $E(.)$ is the mathematical expectation. (Y_1) is the average value of the potential health outcome for all the units in the migrant group; and (Y_0) is the average value of the potential health outcome for all the units in the non-migrant group.

In observational studies, most of the time, the parameter of interest is the average treatment effect on the treated (ATT), which is

$$ATT = E(Y_1 - Y_0|D = 1) \tag{3}$$

$$ATT = E(Y_1|D = 1) - E(Y_0|D = 1) \tag{4}$$

where $(D) = (0, 1)$ refers to the control and treatment conditions. The term $E(Y_0|D = 1)$ is a counterfactual mean which is not observable from the data. It shows the average outcome that the treated individuals would have obtained in the absence of migration, which is unobserved.

$$ATU = E(Y_1 - Y_0|D = 0) \tag{5}$$

$$ATU = E(Y_1|D = 0) - E(Y_0|D = 0) \tag{6}$$

Where $(D) = (0, 1)$ refers to the control and treatment conditions. Where, $E(Y_0|D = 0)$ is the observed mean, and it shows the average health outcome for the persons who were non-migrant. Where $E(Y_1)|D = 0$ is the counterfactual mean outcome for non-migrants. It shows the average outcome that the controlled individuals would have obtained in the presence of migration, which is unobserved.

2.6. Background characteristics of the study population

Around 54.71 % of the migrant respondents and 49.62 % of the non-migrant respondents were Middle-aged (45–59). The share of the respondents aged between 60 and 74 was 32.23 % for migrants and 39.11 % for non-migrants. Around 13.06 % of migrants and 11.27 % of the non-migrants were aged 75+. Additionally, 42.82. % of non-migrant respondents had no formal education, 17.53 % of the non-migrants were widowed, and 59.88 % of the respondents were employed. Further, among migrant respondents, 39.71 % had no formal education, 25.38 % were widowed, and 35.75 % were employed. Notably, 6.60 % of non-migrant respondents and 6.24 % of migrant respondents faced severe food insecurity. However, 63.12 % of non-migrants and 60.26 % of migrants were physically active. Furthermore, 17.19 % and 29.28 % of the non-migrant and migrant respondents belonged to the lowest wealth quintile, respectively (see table A2 in Appendix).

3. Results

3.1. Prevalence of four different health outcome for migrant and non-migrant population

Non-migrants had a lower prevalence of Poor-SRH (16.28 % vs 18.95 %), depression (6.62 % vs 9.33 %), multimorbidity (15.70 % vs 20.25 %) and functional limitation (23.12 % vs 31.79 %) than their migrant counterparts. The stratified prevalence of the health outcomes can be found in Table 1 and Table 2. Fig. 2 displays the prevalence of poor self-rated health, depression, multimorbidity, and functional limitation among migrants stratified by the stream of migration.

3.2. Determinants of different health outcomes among middle-aged and older migrant individuals

We utilised logistic regression estimates for poor-SRH, depression, multimorbidity, and functional limitation in the migrant population, adjusting for a distinct set of determinants (see Fig. 3). Among migrants, after adjusting for all selected covariates, respondents who had primary education [OR: 1.97; CI: 1.51, 3.40], or secondary education [OR: 1.90; CI: 1.17, 3.09] were more likely to report poor-SRH in comparison with their highly educated counterpart. Migrants who were retired from work were 2.84 times more likely to report poor-SRH than those who were currently working. In comparison with the middle-aged and older migrants without any food insecurity, those who had severe food insecurity were more likely to report poor-SRH [OR: 2.41; CI: 1.33, 4.36]. Female migrants were less likely to suffer from depression than male peers [OR:0.43; CI: 0.19, 0.99]. Migrants without any education [OR: 5.30; CI: 4.20, 6.40], primary education [OR: 4.63; CI: 2.33, 5.98], or secondary education [OR: 1.81; CI: 1.68, 2.11] likely to have elevated depression than highly educated migrants. Migrants with severe food insecurity were 4.41 times [OR: 4.41; CI: 2.19, 8.89] more likely to suffer from depression compared to those who did not have any food insecurity. Migrants from the poorest stata had a significant higher likelihood of having depression than the richest migrants [OR: 3.23; CI: 1.32, 5.91].

Table 1
Prevalence of poor-SRH and depression among migrant and non-migrant populations stratified by migration status.

Background Characteristics	Poor-SRH			Depression		
	Migrant	Non-migrant	Difference (p-value)	Migrant	Non-migrant	Difference (p-value)
Age						
45–59	11.78	9.72	<0.001	14.37	6.19	<0.001
60–74	23.56	18.16	<0.001	9.56	6.66	<0.001
75+	36.94	28.39	<0.001	10.53	8.41	<0.001
Sex						
Male	25.4	15.21	0.038	16.09	6.76	0.027
Female	22.88	19.41	<0.001	9.13	6.21	<0.001
Education						
Higher	8.28	7.31	<0.001	3.85	4.90	0.192
Secondary	18.48	13.53	<0.001	5.71	5.67	0.04
Primary	26.67	18.18	<0.001	13.08	8.15	<0.001
Illiterate	32.84	19.75	<0.001	19.78	7.02	<0.001
Marital Status						
Currently married	23.87	14.50	<0.001	13.18	6.25	<0.001
Widowed	25.79	23.28	0.001	10.54	8.49	<0.001
Others	14.19	21.58	<0.001	7.62	5.81	<0.001
Employment status						
Never worked	22.24	20.52	0.007	9.74	6.41	<0.001
Retired	38.45	26.73	<0.001	20.14	8.46	<0.001
Currently Working	11.42	10.56	<0.001	6.78	5.81	<0.001
Social participation						
Yes	22.24	11.35	<0.001	5.72	5.70	<0.001
No	24.14	16.63	<0.001	12.71	6.69	<0.001
Food insecurity status						
No food insecurity	22.63	13.48	<0.001	12.68	5.25	<0.001
Mild food insecurity	24.24	17.76	<0.001	7.72	6.61	0.041
Moderate food insecurity	25.89	30.15	0.003	30.78	11.26	<0.001
Severe food insecurity	34.95	28.59	<0.001	25.92	17.12	<0.001
MPCE quintile						
Richest	22.18	16.67	<0.001	7.24	6.10	<0.001
Richer	20.22	16.59	0.001	9.42	5.31	<0.001
Middle	18.29	15.68	<0.001	8.24	6.67	<0.001
Poorer	22.69	17.3	<0.001	8.84	7.41	0.030
Poorest	31.95	15.00	<0.001	21.55	8.09	<0.001
Caste						
Others	15.2	14.1	<0.001	5.67	6.44	0.023
OBC	29.87	17.11	<0.001	16.66	7.01	<0.001
SC/ST	21.61	16.73	<0.001	10.63	6.15	<0.001
Religion						
Hindu	20.13	16.56	<0.001	8.00	6.72	<0.001
Muslim	47.57	15.79	0.014	9.81	6.67	<0.001
Others	23.35	13.42	<0.001	8.89	5.28	<0.001
Physical activity						
Active	22.15	12.52	<0.001	13.52	5.87	<0.001
Inactive	26.90	22.73	0.001	10.49	7.92	<0.001
Alcohol consumption						
Never consumed	25.34	16.59	<0.001	12.87	6.39	0.63
Infrequent	16.54	16.83	0.23	6.03	7.96	0.052
frequent	7.83	13.10	0.045	6.00	6.12	0.533
heavy drinker	20.84	12.85	0.115	8.43	7.27	0.641
Tobacco consumption						
Non consumer	26.80	16.53	<0.001	13.17	5.58	<0.001
Currently smoking	13.81	17.93	0.001	7.63	7.16	0.12
Smokeless tobacco	18.91	14.12	0.002	11.39	7.58	0.574
Both smoking and smokeless	12.94	19.41	0.157	12.69	9.91	<0.001
Total	**24.04**	**16.29**	**<0.001**	**12.32**	**6.62**	**<0.001**

Note: SC/ST: Schedule caste/Schedule tribe, OBC: Other backward caste, MPCE: Monthly per capita consumption expenditure, p-value is based on chi-square test when comparing the same category between migrant and non-migrant sample.

Old age migrants (60-74) were more likely to suffer from multimorbidity than their younger counterparts [OR: 2.05; CI: 1.34, 3.16]. In comparison with the highly educated respondents, migrants with primary education were more likely to suffer from multimorbidity [OR: 1.90; CI: 1.17, 3.09]. Middle and old aged migrants who never worked [OR: 1.95; CI: 1.21, 3.14] or retired [OR: 2.84; CI: 1.72, 4.69] were more likely to suffer from multimorbid conditions than their currently working counterparts. Middle-aged and older migrants from poorest were 3.24 times [OR: 3.24; CI: 1.78, 5.90] more likely to suffer from multimorbidity than their richest counterparts. Functional limitation was likely to be 2.79 times higher among the oldest old (70+) migrants than their middle-aged counterparts [OR 2.79; CI: 1.40, 5.55]. Migrants without any formal education were more likely to suffer from functional limitations than highly educated Migrants [OR: 6.61; CI: 4.55, 8.29]. The likelihood of suffering from functional limitation was 3.86 times higher in retired migrants than those who were currently working [OR: 3.86; CI: 2.25, 6.62]. Physically inactive migrants were more likely to suffer from physical limitation than physically active migrants [OR: 1.71; CI: 1.19, 2.45] (also see table A4 in Appendix).

Table 2
Prevalence of multimorbidity and functional limitation among migrant and non-migrant populations stratified by migration status.

Background Characteristics	Multimorbidity			Functional limitation		
	Migrant	Non-migrant	Difference (p-value)	Migrant	Non-migrant	Difference (p-value)
Age						
45–59	22.30	11.23	<0.001	20.94	12.61	<0.001
60–74	32.90	20.41	<0.001	28.75	27.93	<0.001
75+	30.47	19.10	<0.001	58.45	52.76	<0.001
Sex						
Male	28.38	13.81	<0.001	23.48	18.74	0.021
Female	25.43	21.22	<0.001	32.47	35.86	<0.001
Education						
Higher	22.15	21.77	<0.001	6.77	8.60	0.224
Secondary	30.39	18.45	<0.001	13.27	16.03	<0.001
Primary	27.12	14.21	<0.001	26.04	21.20	<0.001
Illiterate	26.04	12.95	<0.001	48.10	32.52	<0.001
Marital Status						
Married	28.83	14.95	<0.001	23.37	19.08	<0.001
Widowed	22.33	20.50	<0.001	43.11	41.38	<0.001
Others	17.43	8.77	<0.001	29.35	22.83	<0.001
Employment status						
Never worked	30.08	25.92	<0.001	36.55	29.38	0.070
Retired	38.88	23.56	<0.001	45.83	40.37	<0.001
Currently Working	12.25	9.96	<0.001	10.46	12.35	<0.001
Social participation						
Yes	29.05	14.79	<0.001	10.37	16.74	0.040
No	26.65	15.77	<0.001	29.42	23.57	<0.001
Food insecurity status						
No food insecurity	29.60	14.79	<0.001	29.78	21.68	<0.001
Mild food insecurity	21.47	15.93	<0.001	24.23	22.57	<0.001
Moderate food insecurity	20.03	18.56	0.705	37.60	33.63	0.0740
Severe food insecurity	32.95	21.59	0.041	33.72	35.36	<0.001
MPCE quintile						
Richest	17.27	10.05	<0.001	26.70	26.10	<0.001
Richer	14.33	12.48	<0.001	23.70	13.19	<0.001
Middle	15.90	13.88	<0.001	24.60	22.29	<0.001
Poorer	26.18	18.28	<0.001	27.58	22.41	<0.001
Poorest	46.17	26.48	<0.001	33.24	21.00	<0.001
Caste						
Others	24.03	19.25	<0.001	24.28	18.84	<0.001
OBC	32.65	17.11	<0.001	31.05	25.72	<0.001
SC/ST	13.28	10.54	<0.001	27.21	22.43	<0.001
Religion						
Hindu	22.64	14.60	<0.001	24.66	23.12	<0.001
Muslim	50.26	23.65	<0.001	56.31	22.95	<0.001
Others	28.76	16.55	<0.001	17.53	23.50	<0.001
Physical activity						
Active	28.11	13.41	<0.001	23.78	18.91	<0.001
Inactive	24.77	19.64	<0.001	35.29	30.34	<0.001
Alcohol consumption						
Never consumed	28.30	16.72	<0.001	30.42	24.59	<0.001
Infrequent	19.05	14.32	<0.001	13.08	19.18	0.056
frequent	8.61	9.89	0.006	10.61	17.19	0.096
heavy drinker	10.24	7.05	0.391	9.92	15.69	0.805
Tobacco consumption						
Non consumer	31.45	19.33	<0.001	29.39	24.33	<0.001
Currently smoking	10.74	11.71	0.010	26.50	19.18	<0.001
Smokeless tobacco	16.58	11.69	<0.001	24.32	23.78	<0.001
Both smoking and smokeless	12.42	14.39	0.156	28.48	21.20	0.002
Total	**26.78**	**15.71**	**<0.001**	**28.35**	**23.13**	**<0.001**

Note: SC/ST: Schedule caste/Schedule tribe, OBC: Other backward caste, MPCE: Monthly per capita consumption expenditure, p-value is based on chi-square test when comparing the same category between migrant and non-migrant sample.

3.3. Determinants of different health outcomes among middle-aged and older non-migrant individuals

Fig. 4 provides the logistic regression estimates of four different health outcomes for non-migrant middle-aged and older adults in India. Increasing age was significantly associated with repositing of poor-SRH among the non-migrant respondents. A significant negative association has been identified between the level of educational attainment and reporting poor-SRH among non-migrants. Non-migrant individuals who were retied [OR: 2.12; CI: 1.83, 2.45] or never worked [OR: 1.64; CI: 1.32, 2.06] were more likely to report poor-SRH than currently working individuals. Respondents with severe food insecurity were 2.42 times significantly more likely to report poor-SRH than respondents without any food insecurity [OR: 2.42; CI: 1.93, 3.03]. Non-migrants who did not have any formal education and primary education were 1.44 times [OR: 1.45; CI: 1.04, 2.01] and 1.62 times [OR: 1.13; CI: 1.14, 2.33] more likely to suffer from depression than their higher-educated counterparts, respectively. Retired non-migrant individuals more likely to suffer from depression than their currently working peers [OR: 1.44; CI: 1.17, 1.75]. Non-migrants from poorest stata [OR: 1.59; CI: 1.23, 2.05] and having severe food insecurity [OR: 3.73; CI: 2.86, 4.86] were more likely to suffer from depression then their counterparts who were richest, and did

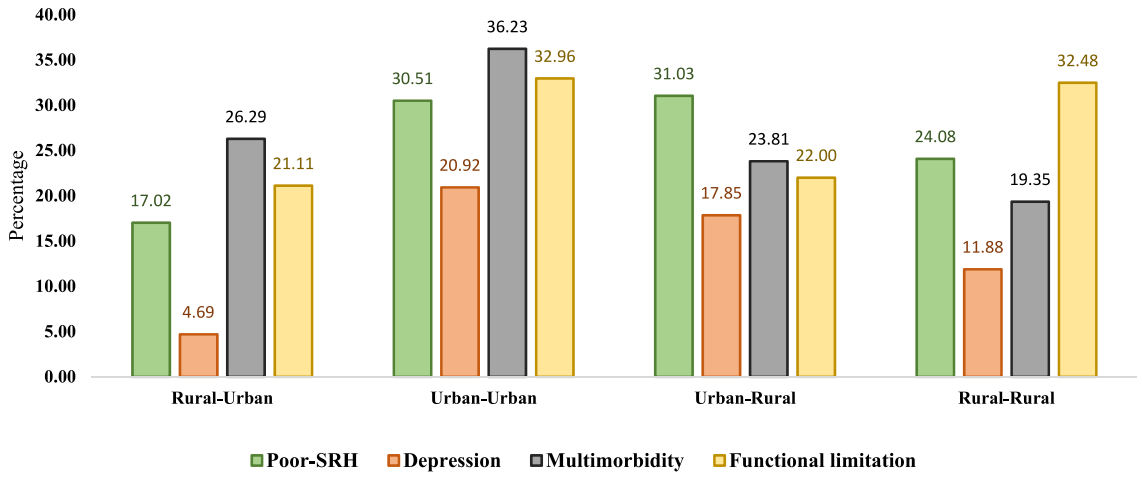

Fig. 2. Prevalence of health outcomes by streams of migration among the migrant population, India.

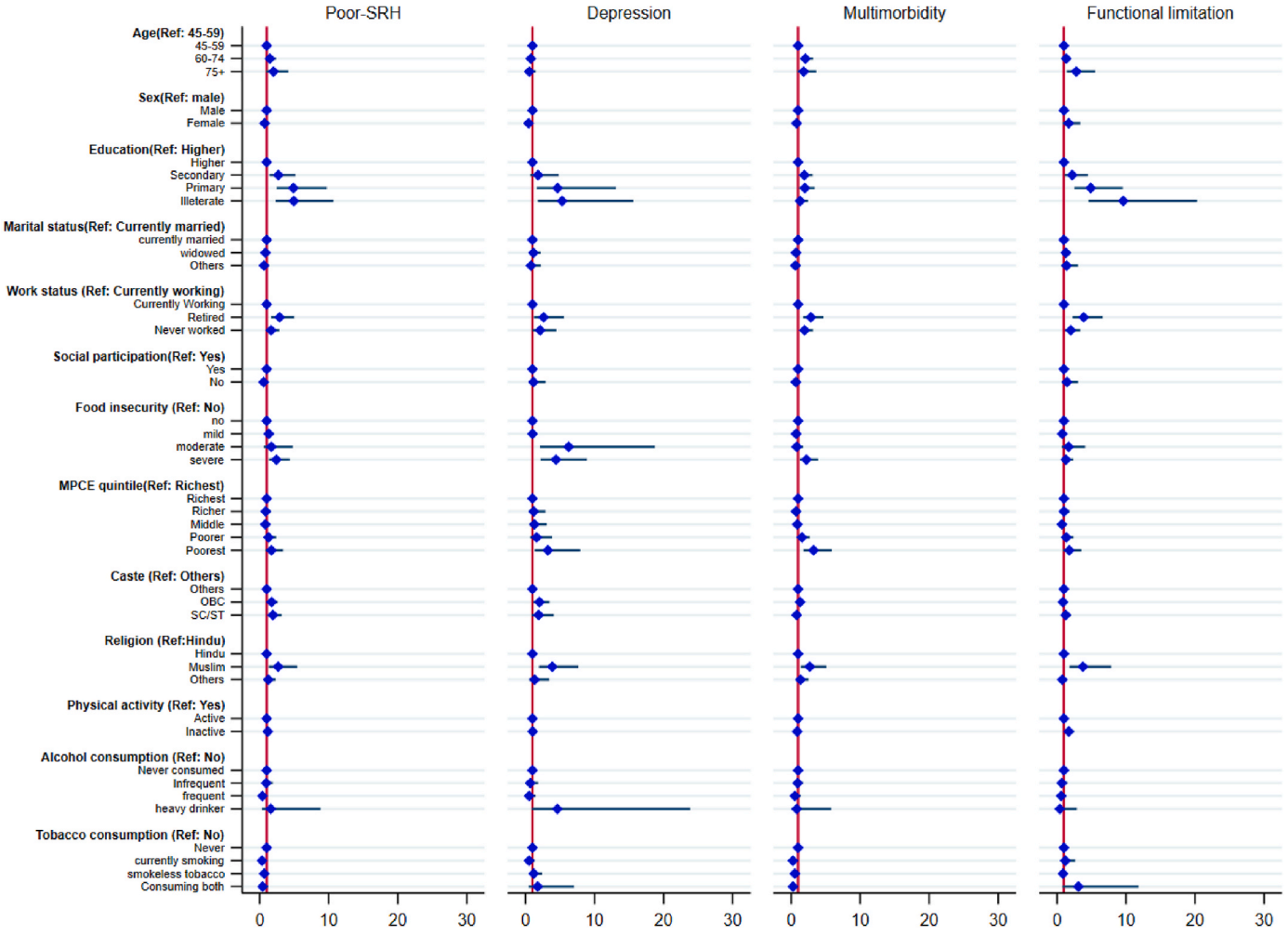

Fig. 3. Logistic regression estimates for four different health outcomes by their background characteristics among Middle-aged and older migrants.

not have any food insecurity, respectively. Non-migrants who were consuming both smoking and smokeless tobacco were more likely to develop depression than non-migrant who never consumed any tobacco [OR: 1.70; CI: 1.22, 2.36]. Retired non-migrants were highly likely to have multimorbidity than their counterparts who were currently working [OR: 2.21; CI: 1.87, 2.60]. Respondents from poorer [OR: 1.92; CI: 1.57, 2.35] and poorest [OR: 2.77; CI: 2.10, 3.66] stata were more likely to suffer from multimorbidity than richest non-migrants. Female

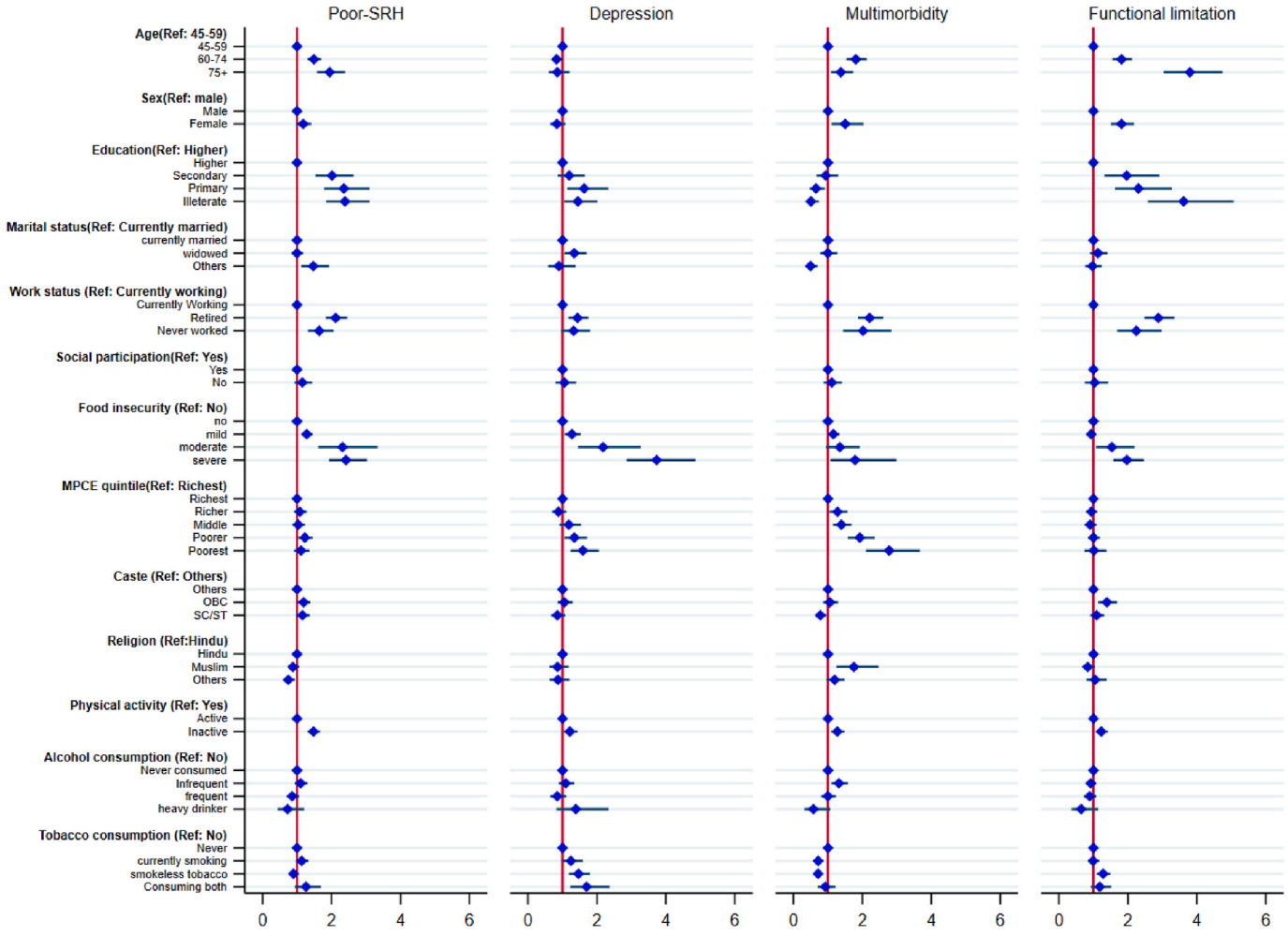

Fig. 4. Logistic regression estimates for four different health outcomes by their background characteristics among Middle-aged and older non-migrants.

respondents were more likely to suffer from multimorbidity than their male counterparts [OR: 1.81; CI: 1.54, 2.13]. This was also identical in the case of functional limitation in females [OR: 1.81; CI: 1.55, 2.12]. Compared with the highly educated non-migrants, respondents from lower educational backgrounds were more likely to suffer from functional limitations [OR: 3.61; CI: 2.57, 5.06]. Those who were never physically inactive were more likely to suffer from functional limitation than their counterparts who were physically active [OR: 1.23; CI: 1.06, 1.42].

3.4. Multivariate logistic regression estimates the effect of migration on health outcomes

The odds of reporting poor health for each health outcome, being a migrant (compared to non-migrant as reference), were calculated and progressively adjusted by each set of determinants (Table 3). The unadjusted analysis revealed, being a migrant was significantly associated with higher odds of experiencing poor-SRH, depression and multimorbidity except for functional limitations. After controlling for demographics, being a migrant was significantly associated with higher odds of suffering from poor-SRH, depression, multimorbidity and functional limitation. However, after adjusting by socioeconomic covariates and health behaviour factors, only the association with depression remained significant. Being a migrant was associated with 1.88 times [OR: 1.88; CI: 1.05, 3.34] higher odds of depression than non-migrant individuals.

Fig. 5 shows the covariate balance plot. Considering both raw and

Table 3
Logistic regression estimates of different health outcomes for a migrant sequentially adjusted by demographic, socioeconomic and behavioural factors.

	Model 1: Crude OR	Model 2: Adjusted OR by Model 1 + Demographics	Model 3: Adjusted OR by Model 2 + SES	Model 4: Adjusted OR by Model 3 + HB
	OR [95 % CI]	OR [95 %CI]	OR [95 %CI]	OR [95 %CI]
Poor-SRH	1.63* [1.06, 2.49]	1.69* [1.00, 2.85]	1.46 [0.98, 2.18]	1.45 [0.96, 2.18]
Depression	1.98* [0.92, 4.27]	2.20* [0.94, 5.15]	1.82* [1.02, 3.25]	1.88* [1.05, 3.34]
Multi-morbidity	1.96*** [1.32, 2.93]	1.68 [0.96, 2.94]	1.31 [0.91, 1.88]	1.28 [0.90, 1.81]
Functional limitation	1.32 [0.91, 1.90]	1.17 [0.67, 2.03]	0.98 [0.65, 1.46]	0.99 [0.66, 1.48]

Note: OR represents odds ratio, CI represents confidence interval, Demographics includes age, sex, education status, marital status; Socioeconomic variables (SES) Includes employment status, social participation, food insecurity status, MPCE quintile, caste, religion; Health Behavioural variables (HB) includes physical activity, alcohol consumption and tobacco consumption, ***$p \leq 0.001$, **$p \leq 0.01$ and * $p \leq 0.05$.

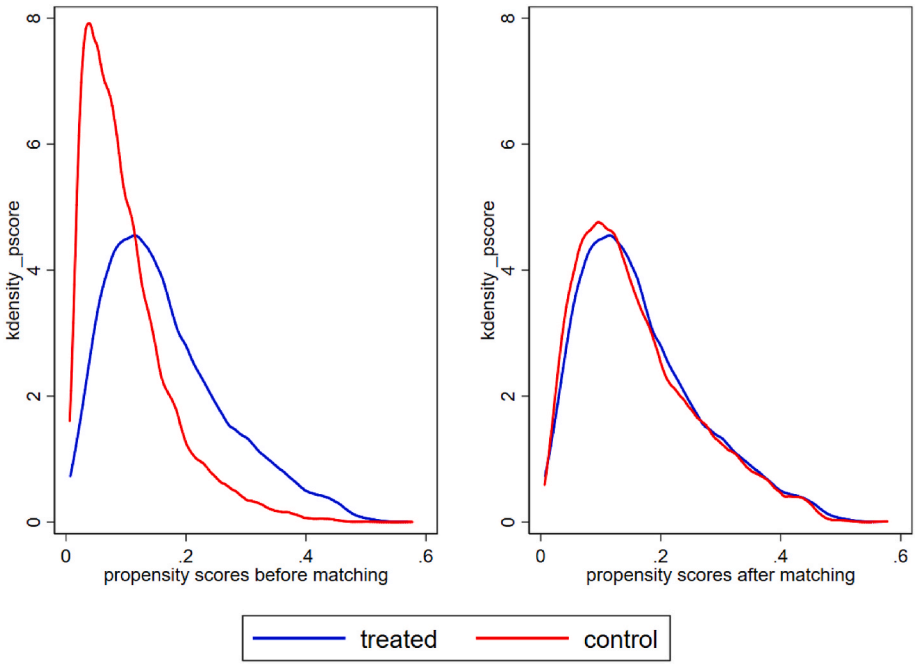

Fig. 5. Balance diagnostic before and after matching using Kernel density.

matched samples, the balance plot shows kernel density plots for the variables across treatment levels. In order to evaluate the accuracy of the overlap assumption, the reported estimated densities represent the probabilities associated with each treatment. As shown in Fig. 5, the calculated densities show significant volume in the overlapped region, providing strong support for the overlap assumption. This finding highlights the substantial overlap between the two density distributions. Notably, the density map for the matched sample shows a significant amount of overlap, demonstrating that matching based on estimated propensity scores successfully balanced the confounders. With both assumptions satisfied in the study, it is clear that the treatment assignment is substantially ignorable, ensuring the unbiasedness of the calculated treatment effects.

Table 4 presents the average values of individual matching variables before and after matching for both the treated and control groups. It illustrates the reduction in percentage bias subsequent to matching, along with the standardised difference assessing distinctions among the matched pairs. Notably, the mean differences became statistically insignificant across all covariates after matching, signifying a sufficient balance achieved among the covariates.

3.5. Propensity matching score estimates the effect of migration on health outcomes

Table 5 illustrates the propensity matching score results to understand the impact of migration on self-rated health, depression, multimorbidity and functional limitation. The unmatched sample estimates revealed that the migrants in India had reported 3.0 percentage points higher poor-SRH than non-migrants. The ATT findings revealed that within the treatment group, individuals who underwent migration experienced an average increase of 2.4 percentage points in reporting poor-SRH compared to those respondents who had not migrated. The ATT results indicate that depression was typically 1.0 percentage points higher among migrant groups than non-migrant groups. Middle-aged and older adults who were migrants, on average, suffered 4.2 % more multimorbid conditions than their non-migrant counterparts. The difference between treated and control values in ATT and ATE concerning functional limitations was noted at 2.3 % and 1.9 %, indicating that middle-aged and older adults who migrated were more prone to experiencing functional limitations. The findings from the Average Treatment Effect on the Untreated (ATU) analysis revealed that for individuals who did not migrate, migration would have led to an average rise of 1.7 % in reported poor-SRH, 0.2 % in depression, 4.0 % in multimorbidity, and 0.6 % in functional limitations.

4. Discussion

This study is based on large-scale, nationally representative secondary data on middle-aged and older adults in India. This research delves into health disparities between migrant and non-migrant groups, focusing on four outcome variables: poor self-rated health, depression, multimorbidity, and functional limitations. It analyses associations with demographics, socioeconomics, and health behaviours. Employing propensity score matching on middle-aged and older individuals, the study provides insights into the intricate relationship between migration and health impairments. This study found that migrants were more likely to suffer from poor-SRH, depression, multimorbidity and functional limitation than non-migrants. Migrants' self-rated health is influenced by multifaceted social determinants, including socioeconomic inequalities, restricted healthcare access, language barriers, discrimination, and migration-related stressors (Srivastava, Chauhan, & Patel, 2021; Tsoh et al., 2016). We found migrants likely to report 2.4 percentage points higher poor-SRH, which was in line with the other studies (Lanari & Bussini, 2012; Mandal et al., 2023; Reus-Pons, Mulder, Kibele, & Janssen, 2018). In fact, an elevated risk of depression and chronic morbidity can be seen among the migrant population, which also aligns with the previous literature (Marin et al., 2022). The impact of migration on an individual's mental health and wellbeing is well established in existing literature (Banal et al., 2010; Jurado et al., 2017). Our results are also in line with the existing studies, which suggest that various risk factors are associated with an increased risk of depression in migrants; these include socioeconomic status, encompassing low income and limited education, which shapes vulnerability (Chen et al., 2022; Essayagh et al., 2023; Foo et al., 2018; Gkiouleka et al., 2018; Jang & Tang, 2021; R. Patel, Kumar, & Chauhan, 2022). In addition to that, a combination of inadequate social support, discrimination, and stigma also contributes to depression (Allen, Kunicki, & Greaney, 2023; García-Cid, Gómez-Jacinto, Hombrados-Mendieta, Millán-Franco, &

Table 4
Covariate Balance of baseline characteristics across Treatment and Comparison Groups before and after Matching.

Characteristics	Before matching			After matching		
	Mean Treated	Mean Comparison	StdDif	Mean Treated	Mean Comparison	StdDif
Age- 45-59	0.588	0.523	0.131*	0.581	0.587	−0.012
Age- 60-74	0.325	0.375	−0.104*	0.332	0.327	0.012
Age- 75+	0.086	0.102	−0.053	0.087	0.087	0.001
Sex-male	0.449	0.692	−0.507*	0.466	0.473	−0.013
Sex-female	0.551	0.308	0.507*	0.534	0.527	0.013
Education- illiterate	0.316	0.432	−0.242*	0.328	0.321	0.016
Education- primary	0.180	0.193	−0.032	0.181	0.182	−0.002
Education- secondary	0.312	0.264	0.105*	0.309	0.303	0.013
Education- higher	0.192	0.111	0.227*	0.181	0.194	−0.035
Marital status- married	0.722	0.786	−0.149*	0.726	0.732	−0.016
Marital status- widowed	0.229	0.172	0.143*	0.224	0.216	0.020
Marital Status- others	0.049	0.042	0.034	0.050	0.051	−0.007
Work- never worked	0.321	0.158	0.390*	0.305	0.303	0.006
Work- retired	0.274	0.263	0.024	0.276	0.268	0.017
Work- currently working	0.405	0.579	−0.354*	0.419	0.429	−0.020
Food insecurity- none	0.533	0.566	−0.067	0.538	0.538	0.000
Food insecurity- mild	0.390	0.368	0.046	0.389	0.387	0.006
Food insecurity- moderate	0.024	0.018	0.039	0.022	0.022	−0.001
Food insecurity- severe	0.053	0.048	0.024	0.051	0.053	−0.011
Social participation- no	0.906	0.912	−0.023	0.905	0.902	0.012
Social participation- yes	0.094	0.088	0.023	0.095	0.098	−0.012
MPCE- Poorest	0.132	0.216	−0.223*	0.136	0.135	0.003
MPCE- Poorer	0.169	0.209	−0.102*	0.174	0.179	−0.012
MPCE- Middle	0.196	0.201	−0.013	0.198	0.199	−0.001
MPCE- Richer	0.212	0.193	0.046	0.212	0.207	0.011
MPCE- richest	0.291	0.181	0.262*	0.280	0.280	−0.001
Caste- SC/ST	0.276	0.386	−0.236*	0.284	0.284	−0.001
Caste- others	0.385	0.393	−0.016	0.391	0.391	0.001
Caste- OBC	0.339	0.221	0.265*	0.325	0.325	0.001
Religion- muslin	0.722	0.717	0.011	0.720	0.735	−0.032
Religion- others	0.110	0.113	−0.007	0.113	0.111	0.004
Religion- Hindu	0.168	0.170	−0.007	0.167	0.154	0.035
Physical activity- active	0.567	0.624	−0.117*	0.574	0.576	−0.004
Physical activity- inactive	0.433	0.376	0.117*	0.426	0.424	0.004
Alcohol consumption- never	0.855	0.745	0.278*	0.850	0.850	0.000
Alcohol consumption- frequent	0.052	0.099	−0.178*	0.054	0.055	−0.002
Alcohol consumption- heavy	0.008	0.013	−0.043	0.009	0.009	−0.001
Tobacco consumption – never	0.723	0.547	0.372*	0.713	0.715	−0.003
Tobacco consumption – smoker	0.106	0.166	−0.175*	0.111	0.112	−0.003
Tobacco consumption – smokeless	0.143	0.232	−0.228*	0.148	0.147	0.004
Tobacco consumption- both	0.027	0.055	−0.142*	0.028	0.027	0.004

Note: *Absolute value of mean standardised difference above 10 %; StdDif: Standardised difference (%); SC/ST: Schedule caste/Schedule Tribe; OBC: Other backward class.

Table 5
Propensity Score Matching estimates the impact of migration status on the Health Outcomes.

Variable	Sample	Treated	Controls	Difference	SE.	T-stat
Self-rated Health	Unmatched	0.178	0.148	0.030	0.007	4.410
	ATT	0.178	0.154	0.024	0.007	3.190
	ATU	0.148	0.165	0.017		
	ATE			0.017		
Depression	Unmatched	0.064	0.054	0.010	0.004	2.310
	ATT	0.064	0.054	0.010	0.005	2.100
	ATU	0.054	0.056	0.002		
	ATE			0.003		
Multimorbidity	Unmatched	0.237	0.154	0.083	0.007	11.820
	ATT	0.237	0.195	0.042	0.008	5.120
	ATU	0.154	0.194	0.040		
	ATE			0.040		
Functional limitation	Unmatched	0.212	0.201	0.011	0.008	1.430
	ATT	0.212	0.203	0.010	0.008	1.180
	ATU	0.201	0.195	0.006		
	ATE			0.005		

Note-ATE: Average Treatment Effect; ATT: Average Treatment Effect on the Treated; ATU: Average Treatment Effect on the Untreated; SE: standard error.

Moscato, 2020; Wang, Li, Stanton, & Fang, 2010). Additionally, in a new environment, cultural aspects such as acculturation play a pivotal role in shaping the mental health of migrants, especially during the initial years of migration (Jang & Tang, 2021; Jurado et al., 2017; Marin et al., 2022). We found migrants have an elevated prevalence of multimorbidity than non-migrants. The elevated multimorbidity among migrants may be attributed to limited access to a nutritious diet, lifestyle changes in a new environment, limited healthcare access, and low

health literacy (Ansari, Anand, Singh, & Hossain, 2023; P. Patel, Muhammad, & Sahoo, 2023; Sinha, Kerketta, Ghosal, Kanungo, & Pati, 2022). Additionally, occupational hazards in '3D' work and elevated psychological stress compound the issue of multimorbidity among migrants (Babu, Swain, Mishra, & Kar, 2010; Kreps & Sparks, 2008). With regard to theoretical considerations of the development of health disparities, the findings of this study can be interpreted through the lens of the cumulative disadvantage theory, which posits that the health of migrants is impacted negatively over the course of their lives due to their persistent low socioeconomic status (Dannefer, 2003; O'Rand, 1996). The descriptive analysis showed some relevant socioeconomic and health behavioural differences that might lead to the health disparity between the migrant- and non-migrant populations. Migrants reported higher food insecurity, lower educational attainment, and less physical activity than their non-migrants; in addition, non-migrants were socially more active and currently working. Prior studies indicate that migrants experience adverse health effects due to factors such as material deprivation, poor working and living conditions, cultural and language barriers, social isolation, and limited healthcare access (Borhade Anjali, 2016; María & Arias Uriona, 2020; Nitika, Nongkynrih, & Gupta, 2014).

In what follows, our study indicated that a few crucial factors contributed to the disparity in health between migrants and non-migrants. In developing countries like India, migrants frequently move to other locations to pursue employment opportunities, accepting positions in the "3D" category (dirty, dangerous and demeaning) jobs (Bhagat, Sahoo, Roy, & Govil, 2020; Hirudayaraj, Barhate, & McLean, 2023; Jayaram & Varma, 2020). As a result, occupational elements such as industry, working conditions, working hours, and workplace discrimination may negatively impact the health of these migrants substantially, with these health disadvantages accumulating over time and affecting the health of migrants in their later ages (Jayaram & Varma, 2020; Srinivasan & Ilango, 2013). Extant empirical literature showed that low education levels were positively associated with health disparities (Kimbrough, 2012; Oshio, 2018; Zajacova & Lawrence, 2018), lower levels of education among the migrants resulted in limited health literacy, making it more difficult for them to understand and manage their health conditions. They may also be less likely to engage in preventive health behaviours, such as getting regular check-ups and screenings, are more likely to engage in health-risk behaviours (Lee & Seon, 2019; Margolis, 2013). Limited health literacy results in poor health care utilisation (Groot & Maassen Van Den Brink, 2006; Marques et al., 2022; Raghupathi & Raghupathi, 2020; Srinivasan & Ilango, 2013). Internal migration is frequently employed as a livelihood strategy to combat food insecurity in numerous developing countries, including India, which has the world's largest population of undernourished individuals (McGuire, 2015). The relationship between food-insecurity and migration operates bidirectionally, serving both as a catalyst and a result. Recognising the profound impact of insufficient food security, it has been acknowledged that it can negatively affect chronic, mental, and physical health in various ways (Jones, 2017; Nagata et al., 2019; Seligman, Bindman, Vittinghoff, Kanaya, & Kushel, 2007). Inadequate access to nutritious food can lead to increased vulnerability to chronic diseases, compromised mental wellbeing, and heightened risks for physical health issues (Chung et al., 2023; Fang, Thomsen, & Nayga, 2021; Seligman, Laraia, & Kushel, 2010). In older adults, it is correlated with an elevated risk of diet-related chronic illnesses, sarcopenia, appetite decline, poor psychological status, social isolation, poor health, and poor quality (Choithani, 2017; McGuire, 2015; Orjuela-Grimm et al., 2022; R. Patel et al., 2022). It is also important to recognise that while ageing factors are similar across populations, migration-led risk factors can also affect the health and quality of life in old age. These factors include exposure to adverse events, low acculturation, and lack of social support (Allen et al., 2023; García-Cid et al., 2020). Existing research illustrated that the absence of social support negatively affects the health of migrants (Salinero-Fort et al., 2011; Záleská, Brabcová, & Vacková, 2014). Migration often involves leaving behind family and keens, leading to social isolation, and potentially negatively impacting mental wellbeing and life satisfaction in the new environment (Firdaus, 2017; Hombrados-Mendieta et al., 2019; Marin et al., 2022). Our findings shed light on the influence that socioeconomic, demographic, and behavioural health factors have significant implications on the health status of migrants; this new evidence highlights plausible underlying mechanisms contributing to health disparities between migrant and non-migrant populations. This study is unique in many ways and has several strengths; first, this study examines the migrant and non-migrant heath disparity at a national level, making it a valuable contribution to the field. Second, the study is also unique in its focus on the health of middle-aged and older adults, a population that has not been well studied in the context of migration. Third, this study utilises a large-scale, nationally representative dataset, which allows for reliable results. Fourth, this work employs a robust and advanced methodology, ensuring the generation of reliable and sound estimates. Additionally, the chosen approach is designed to yield dependable outcomes, enhancing the credibility of the findings. Finally, to fully understand the health disparity, the study also considers four outcome variables, which provide a more nuanced understanding of the phenomenon and sets it apart from other existing studies that have relied on single outcome indicators.

The findings of this study should be interpreted considering a few limitations. Estimations in the study are based on self-reported data; therefore, the results may be subject to recall and reporting biases. The study lacked additional migratory variables, such as reasons for migration, which was not available in the dataset. This implies that the study could not comprehensively grasp the various contexts and mechanisms by which migration occurred and its effects on health outcomes. Finally, the study did not explore sex-specific health consequences of migration, as it focused on the Indian context, where almost every female migrates to her husband's home. This may limit the understanding of sex-specific health outcomes in the context of later-life migration.

5. Conclusion

The present study is a pioneering effort to examine and explain the disparities in overall, physical, and psychological health differences between middle-aged and older migrants and non-migrants in the Indian context. The study results indicate a significant disparity in health status between migrant and non-migrant populations. Migrants are found to be in a vulnerable situation across all health indicators. These findings underscore the necessity for improved management of the overall health status of middle- and old-aged migrants in India. This research advocates the necessity of understanding the gender-specific differences in health and health transitions among older migrants and non-migrants. India has no structural health policy or programme separately for the migrant population. Our study suggests that being the home of one of the largest internal migrants, a structural and heterogenous policy and program should be framed, which specifically targets migrant's health issues, especially for old-age migrants. In addition, existing health policies should be modified with targeted interventions to ensure that migrant populations are not left excluded. The specific needs of elderly migrants should be included in the National Policy for Senior Citizens (NPSC), regardless of their place of origin. Finally, this study also recommends intervention strategies to address the social security of old-age migrants and to provide them with the necessary support for healthy ageing. It is essential to implement these policy interventions to ensure that middle and old-aged migrant populations in India receive adequate healthcare services, and can age with dignity, and to do that; it is recommended that greater resources should be allocated towards public health interventions so that India can achieve its goal of "leaving no one behind" in terms of health protection.

Ethical statement

The data is available to the public for free (https://lasi-india.org/) Survey agencies that conducted the field survey for the data collection have collected prior informed written consent from the respondent before data collection. No information could lead the identification of the respondents. We received ethical approvals from these organizations: Indian Council of Medical Research (ICMR) in Delhi, International Institute for Population Sciences (IIPS) in Mumbai, Harvard T.H. Chan School of Public Health (HSPH) in Boston, University of Southern California (USC) in Los Angeles, ICMR-National AIDS Research Institute (NARI) in Pune, and Regional Geriatric Centres (RGCs) under the Ministry of Health and Family Welfare, Government of India. Our study followed the guidelines for protecting human subjects outlined in the Declaration of Helsinki.

CRediT authorship contribution statement

Bittu Mandal: Writing – review & editing, Writing – original draft, Visualization, Resources, Methodology, Formal analysis, Data curation, Conceptualization. **Kalandi Charan Pradhan:** Supervision, Validation, Conceptualization.

Declarations of competing interest

None.

Data availability

Data is publicly available on request from -https://iipsindia.ac.in/sites/default/files/LASI_DataRequestForm_0.pdf

Appendix

Table A1
Description of the covariates

Variables	Categories	Description of the category
Age	45-59; 60–74;≥75	
Sex	Male; Female	
Religion	Hindu; Muslim; Christian; Others	
Caste	Scheduled castes (SC)/scheduled tribe (ST); Other backward classes (OBC); Others	
Education	No education; up to primary; up to secondary; higher	
Marital Status	Currently married; widowed; others	
Wealth	Poorest; poorer, middle; richer; richest	
Employment Status	Never worked; retired; currently working	
Social Participation	Yes; no	
Food Insecurity	Mild	if the respondent reduced the size of your meals or skipped meals because there was not enough food at its household If the respondent did not eat enough food of his/her choice (excluding fasting/food-related restrictions due to religious or health-related reason
	Moderate	if the respondent reduced the size of your meals or skipped meals because there was not enough food in the household
	Severe	if the respondent 'was hungry but did not eat or 'did not eat for a whole day' because there was not enough food in its household (excluding fasting/food-related restrictions due to religious or health-related reasons
Physical Activity	Active	Those who were either engaged in moderate physical activity (at least 150 min throughout the week) or, vigorous physical activity (at least 75 min throughout the week) or an equivalent combination of both
	Inactive	Those who are not engaged in any type of moderate or vigorous physical activity for a given time throughout the week.
	Never	Those who have never been involved in any physical activities
Consumption of tobacco	Never consumed tobacco	Never consumed tobacco, neither smoking nor smokeless tobacco.
	Currently smoking	Currently smoking but not smokeless tobacco.
	Currently consumed smokeless tobacco	Consumers of smokeless tobacco only
	Consumed both smoking and smokeless tobacco	Using both smoking and smokeless tobacco
Consumption of alcohol	Never consumed alcohol	Never consumed alcohol
	Frequently consumed but not heavy drinker	Those who consumed 1–3 days/month
	Infrequently consumed but not heavy drinker	Those who consumed 1–4 days/week but not more than 5 drinks on any occasion
	Heavy drinker	Those who consumed more than 5 drinks on any occasion in past 30 days

Table A2
Socio-demographic profile of respondents stratified by migration status

Background characteristics	Migrant		Non-migrant	
	Sample	Percentage	Sample	Percentage
Age				
45–59	1825	54.71	13549	49.62
60–74	1010	32.23	9712	39.11
75+	268	13.06	2638	11.27

(*continued on next page*)

Table A2 (*continued*)

Background characteristics	Migrant		Non-migrant	
	Sample	Percentage	Sample	Percentage
Sex				
Male	1393	45.8	17926	74.36
Female	1710	54.2	7973	25.64
Education				
Higher	596	15.75	2879	12.76
Secondary	967	26.72	6838	25.32
Primary	560	17.82	4996	19.11
Illiterate	980	39.71	11186	42.82
Marital Status				
Married	2239	71.06	20345	78.92
Widowed	711	25.58	4459	17.53
Others	153	3.37	1095	3.55
Employment status				
Never worked	996	29.3	4082	12.22
Retired	849	34.95	6809	27.9
Currently Working	1258	35.75	15008	59.88
Social participation				
Yes	293	5.61	2272	6.47
No	2810	94.39	23627	93.53
Food insecurity status				
No food insecurity	1653	57.03	14656	56.9
Mild food insecurity	1210	33.99	9522	34.52
Moderate food insecurity	74	2.74	471	1.98
Severe food insecurity	166	6.24	1250	6.6
MPCE quintile				
Richest	409	13.71	5590	21.99
Richer	525	16.62	5413	22.28
Middle	607	20.05	5198	19.92
Poorer	658	20.34	5008	18.63
Poorest	904	29.28	4690	17.19
Caste				
Others	1051	30.28	5718	23.74
OBC	1196	52.9	10182	47.2
SC/ST	856	16.82	9999	29.07
Religion				
Hindu	2241	79.26	18,576	82.99
Muslim	342	13.37	2914	10.92
Others	520	7.36	4409	6.09
Physical activity				
Active	1759	60.26	16161	63.12
Inactive	1344	39.74	9738	36.88
Alcohol consumption				
Never consumed	2652	88.81	19283	76.77
Infrequent	263	6.43	3718	13.67
frequent	162	4	2568	8.36
heavy drinker	26	0.75	330	1.19
Tobacco consumption				
Non consumer	245	73.34	14173	50.65
Currently smoking	330	10.7	4301	17.23
Smokeless tobacco	445	14.03	6009	26.68
Both smoking and smokeless	83	1.94	1416	5.44
Total	**3103**	**10.7**	**25899**	**89.3**

SC/ST: Schedule caste/Schedule tribe, OBC: Other backward caste, MPCE: Monthly per capita consumption expenditure.

Table A3
Matching statistics

Treatment assignment	Off support	On support	Total
Untreated	22,796	3103	25,899
Treated	0	3103	3103
Total	**22,796**	**6206**	**29,002**

Table A4
Logistic regression estimates of Poor-self-rated health and Depression stratified by migration status

	Poor-SRH				Depression			
	Migrant		Non-Migrant		Migrant		Non-Migrant	
	OR	95 %CI	OR	95 %CI	OR	95 %CI	OR	95 %CI
Age								
45–59	Ref		Ref		Ref		Ref	
60–74	1.48	[0.93, 2.35]	1.49***	[1.30, 1.70]	0.76	[0.42, 1.39]	0.83	[0.70, 0.99]
75+	1.99	[0.95, 4.16]	1.95***	[1.58, 2.40]	0.54	[0.20, 1.48]	0.85	[0.60, 1.21]
Sex								
Male	Ref		Ref		Ref		Ref	
Female	0.71	[0.37, 1.35]	1.18	[0.99, 1.41]	0.43*	[0.19, 0.99]	0.84	[0.65, 1.09]
Education								
Higher	Ref		Ref		Ref		Ref	
Secondary	2.70***	[1.41, 5.15]	2.01***	[1.53, 2.63]	1.81***	[1.68, 2.11]	1.19***	[0.86, 1.65]
Primary	4.87***	[2.44, 9.71]	2.36***	[1.78, 3.10]	4.63***	[2.33, 5.98]	1.62***	[1.13, 2.33]
Illiterate	4.93***	[2.28, 10.65]	2.39***	[1.84, 3.10]	5.30***	[1.80, 15.62]	1.44***	[1.04, 2.01]
Marital Status								
Married	Ref		Ref		Ref		Ref	
Widowed	0.83	[0.52, 1.33]	1.00	[0.84, 1.18]	1.14	[0.59, 2.19]	1.34*	[1.06, 1.70]
Others	0.62	[0.29, 1.33]	1.47**	[1.12, 1.93]	0.79	[0.28, 2.22]	0.90	[0.58, 1.38]
Employment status								
Currently working	Ref		Ref		Ref		Ref	
Never worked	1.65	[0.96, 2.84]	1.64***	[1.32, 2.06]	2.11*	[1.00, 4.46]	1.32	[0.97, 1.80]
Retired	2.87***	[1.65, 5.01]	2.12***	[1.83, 2.45]	2.61*	[1.23, 5.55]	1.44***	[1.17, 1.75]
Social participation								
Yes	Ref		Ref		Ref		Ref	
No	0.57	[0.27, 1.2]	1.15	[0.93, 1.44]	1.15	[0.46, 2.9]	1.06	[0.80, 1.40]
Food insecurity status								
No food insecurity	Ref		Ref		Ref		Ref	
Mild food insecurity	1.31	[0.86, 2.00]	1.28***	[1.14, 1.45]	1.01	[0.60, 1.72]	1.27	[1.06, 1.53]
Moderate food insecurity	1.68	[0.59, 4.79]	2.32***	[1.62, 3.34]	6.25***	[2.09, 18.74]	2.18***	[1.45, 3.27]
Severe food insecurity	2.41***	[1.33, 4.36]	2.42***	[1.93, 3.03]	4.41***	[2.19, 8.89]	3.73***	[2.86, 4.86]
MPCE quintile								
Richest	Ref		Ref		Ref		Ref	
Richer	0.86	[0.47, 1.57]	1.08	[0.91, 1.28]	1.18	[0.48, 2.89]	0.88	[0.69, 1.11]
Middle	0.81	[0.44, 1.50]	1.04	[0.86, 1.23]	1.28	[0.53, 3.09]	1.18	[0.91, 1.53]
Poorer	1.28	[0.69, 2.36]	1.23*	[1.03, 1.45]	1.61	[0.67, 3.86]	1.34	[1.05, 1.71]
Poorest	1.69	[0.84, 3.36]	1.11	[0.91, 1.36]	3.23*	[1.32, 5.91]	1.59*	[1.23, 2.05]
Caste								
Others	Ref		Ref		Ref		Ref	
OBC	0.52***	[0.32, 0.87]	0.86	[0.73, 1.02]	0.53	[0.25, 1.14]	1.17	[0.93, 1.49]
SC/ST	0.90	[0.58, 1.39]	1.03	[0.90, 1.18]	1.07	[0.55, 2.06]	1.24	[1.02, 1.50]
Religion								
Hindu	Ref		Ref		Ref		Ref	
Muslim	2.67***	[1.31, 5.41]	0.88	[0.73, 1.06]	3.87***	[1.96, 7.65]	0.85	[0.62, 1.18]
Others	1.25	[0.68, 2.29]	0.75**	[0.60, 0.94]	1.33	[0.51, 3.43]	0.87	[0.62, 1.21]
Physical activity								
Active	Ref		Ref		Ref		Ref	
Inactive	1.17	[0.8, 1.70]	1.47***	[1.31, 1.67]	1.04	[0.64, 1.68]	1.21*	[1.03, 1.43]
Alcohol consumption								
Never consumed	Ref		Ref		Ref		Ref	
Infrequent	0.94	[0.47, 1.90]	1.11	[0.94, 1.3]	0.68	[0.25, 1.85]	1.09	[0.89, 1.35]
frequent	0.39*	[0.18, 0.87]	0.86	[0.70, 1.06]	0.52	[0.19, 1.46]	0.85	[0.65, 1.11]
heavy drinker	1.60	[0.29, 8.81]	0.73	[0.44, 1.21]	4.62	[0.89, 23.87]	1.39	[0.82, 2.34]
Tobacco consumption								
Non consumer	Ref		Ref		Ref		Ref	
Currently smoking	0.33*	[0.13, 0.85]	1.14	[0.96, 1.34]	0.52	[0.2, 1.31]	1.25	[0.98, 1.58]
Smokeless tobacco	0.66	[0.39, 1.12]	0.90	[0.78, 1.04]	1.19	[0.6, 2.37]	1.46***	[1.19, 1.80]
Both smoking and smokeless	0.42	[0.14, 1.22]	1.26	[0.94, 1.69]	1.76	[0.44, 7.05]	1.70***	[1.22, 2.36]
Pseudo R^2	**0.1694**		**0.0844**		**0.2544**		**0.0827**	

Note: Ref: Reference, OR: Odds ratio, CI: Confidence Interval, SC/ST: Schedule caste/Schedule tribe, OBC: Other backward caste, MPCE: Monthly per capita consumption expenditure, ***$p \leq 0.001$, **$p < 0.01$ and * $p \leq 0.05$.

Table A5Logistic regression estimates of Multimorbidity, and functional limitation stratified by migration status

	Multimorbidity				Functional limitation			
	Migrant		Non-Migrant		Migrant		Non-Migrant	
	OR	95 %CI	OR	95 %CI	OR	95 %CI	OR	95 %CI
Age								
45–59	Ref		Ref				Ref	
60–74	2.05***	[1.34, 3.16]	1.81***	[1.54, 2.13]	1.33	[0.88, 2.02]	1.81***	[1.55, 2.12]
75+	1.81	[0.90, 3.62]	1.37**	[1.09, 1.73]	2.79***	[1.40, 5.55]	3.80***	[3.04, 4.75]

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(*continued*)

	Multimorbidity				Functional limitation			
	Migrant		Non-Migrant		Migrant		Non-Migrant	
	OR	95 %CI	OR	95 %CI	OR	95 %CI	OR	95 %CI
Sex								
Male	Ref		Ref		Ref		Ref	
Female	0.78	[0.46, 1.34]	1.50*	[1.10, 2.03]	1.70	[0.86, 3.36]	1.81***	[1.51, 2.18]
Education								
Higher	Ref		Ref		Ref		Ref	
Secondary	1.90**	[1.17, 3.09]	1.97***	[1.36, 2.86]	2.21***	[0.05, 0.22]	1.96**	[1.32, 2.91]
Primary	1.97*	[1.51, 3.40]	1.84***	[1.43, 2.36]	4.89***	[0.12, 0.43]	2.30***	[1.62, 3.27]
Illiterate	1.29	[0.69, 2.41]	1.28*	[1.07, 1.54]	9.61***	[4.55, 20.29]	3.61***	[2.57, 5.06]
Marital Status								
Married	Ref		Ref		Ref		Ref	
Widowed	0.70	[0.46, 1.08]	0.99	[0.77, 1.28]	1.29	[0.84, 1.98]	1.13	[0.91, 1.40]
Others	0.62	[0.29, 1.30]	0.49***	[0.35, 0.70]	1.40	[0.64, 3.05]	0.97	[0.76, 1.23]
Employment status								
Currently working	Ref		Ref		Ref		Ref	
Never worked	1.95**	[1.21, 3.14]	2.02***	[1.44, 2.83]	2.00**	[1.19, 3.36]	2.25***	[1.69, 2.98]
Retired	2.84***	[1.72, 4.69]	2.21***	[1.87, 2.60]	3.86***	[2.25, 6.62]	2.88***	[2.48, 3.35]
Social participation								
Yes	Ref		Ref		Ref		Ref	
No	0.68	[0.37, 1.23]	1.11	[0.88, 1.41]	1.46	[0.70, 3.05]	1.04	[0.75, 1.43]
Food insecurity status								
No food insecurity	Ref		Ref		Ref		Ref	
Mild food insecurity	0.72	[0.49, 1.06]	1.16*	[1.00, 1.33]	0.77	[0.50, 1.18]	0.94	[0.82, 1.07]
Moderate food insecurity	0.80	[0.37, 1.72]	1.34	[0.94, 1.92]	1.68	[0.69, 4.11]	1.53	[1.07, 2.19]
Severe food insecurity	2.21	[1.24, 3.93]	1.79**	[1.07, 2.98]	1.29	[0.70, 2.38]	1.97***	[1.58, 2.46]
MPCE quintile								
Richest	Ref		Ref		Ref		Ref	
Richer	0.70	[0.40, 1.23]	1.27	[1.04, 1.56]	1.02	[0.57, 1.80]	0.93	[0.78, 1.11]
Middle	0.88	[0.51, 1.52]	1.38*	[1.14, 1.68]	0.71	[0.39.1.27]	0.90	[0.75, 1.09]
Poorer	1.56	[0.90, 2.69]	1.92***	[1.57, 2.35]	1.35	[0.76, 2.39]	1.00	[0.83, 1.18]
Poorest	3.24***	[1.78, 5.90]	2.77***	[2.10, 3.66]	1.78	[0.89, 3.54]	1.01	[0.74, 1.37]
Caste								
Others	Ref		Ref		Ref		Ref	
OBC	1.25	[0.79, 1.97]	1.28*	[1.05, 1.56]	0.79	[0.49, 1.27]	0.91	[0.76, 1.1]
SC/ST	1.63**	[1.06, 2.50]	1.35***	[1.15, 1.59]	0.68	[0.44, 1.05]	1.27***	[1.1, 1.47]
Religion								
Hindu	Ref		Ref		Ref		Ref	
Muslim	2.68**	[1.41, 5.13]	1.75***	[1.25, 2.46]	3.77***	[1.80, 7.87]	0.83	[0.67, 1.04]
Others	1.36	[0.74, 2.50]	1.19	[0.96, 1.48]	0.77	[0.44, 1.35]	1.05	[0.80, 1.38]
Physical activity								
Active	Ref		Ref		Ref		Ref	
Inactive	0.88	[0.63, 1.22]	1.27***	[1.09, 1.48]	1.71***	[1.19, 2.45]	1.23**	[1.06, 1.42]
Alcohol consumption								
Never consumed	Ref		Ref		Ref		Ref	
Infrequent	0.94	[0.51, 1.72]	1.32***	[1.10, 1.58]	0.69	[0.32, 1.52]	0.92	[0.78, 1.08]
frequent	0.54	[0.21, 1.36]	1.00	[0.81, 1.23]	0.61	[0.28, 1.32]	0.89	[0.73, 1.08]
heavy drinker	0.80	[0.11, 5.81]	0.58	[0.31, 1.07]	0.42	[0.06, 2.88]	0.65	[0.37, 1.14]
Tobacco consumption								
Non consumer	Ref		Ref		Ref		Ref	
Currently smoking	0.26**	[0.12, 0.56]	0.72***	[0.59, 0.87]	1.21	[0.55, 2.63]	0.99	[0.84, 1.17]
Smokeless tobacco	0.54**	[0.34, 0.85]	0.71***	[0.61, 0.84]	0.87	[0.52, 1.44]	1.28***	[1.1, 1.49]
Both smoking and smokeless	0.27**	[0.09, 0.83]	0.92	[0.70, 1.21]	3.10	[0.81, 11.83]	1.18	[0.92, 1.52]
Pseudo R^2	**0.1955**		**0.1042**		**0.2685**		**0.1693**	

Note: Ref: Reference, OR: Odds ratio, CI: Confidence Interval, SC/ST: Schedule caste/Schedule tribe, OBC: Other backward caste, MPCE: Monthly per capita consumption expenditure, ***$p \leq 0.001$, **$p < 0.01$ and * $p \leq 0.05$.

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