Weathering the Drought: Risks and Resilience Patterns in Functional Health of Older Adults Across Rural India

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Research Article

Keywords:

Posted Date: November 12th, 2025

DOI: https://doi.org/10.21203/rs.3.rs-7862195/v1

Additional Declarations: No competing interests reported.

Abstract

As climate change accelerates, its health risks are not evenly distributed. They follow entrenched systems of social and economic stratification. Social capital acts as a resilience resource, potentially buffering the adverse health effects of recurring climate shocks. This paper examines how repeated droughts shape the risk of functional health deterioration among older adults in rural India and whether social capital enhances resilience to these impacts. Using longitudinal data from two waves of the India Human Development Survey (2004–05 and 2011–12), the analysis follows 32,248 adults aged 40 and older to assess changes in functional limitations over time. Results show that exposure to two or more droughts increases the risk of functional deterioration by 18% compared to no drought exposure, while single droughts show no effect. Economic position and social capital both shape resilience. The poorest households experience deterioration in functional limitations after exposure to repeated droughts, whereas the richest did not see a decline. Social capital operated as a crisis-activated resource rather than a general health advantage, mitigating drought-related health deterioration primarily among disadvantaged groups.

Introduction

Natural disasters are often viewed as solely the result of natural forces. While events like hurricanes, floods, and earthquakes trigger disasters, the resulting crises reflect the interactions between these forces and prevailing social and economic conditions. (Peek et al., 2021). Both disaster risks and outcomes are distributed unequally across society, reflecting pre-existing social and economic inequalities that Matthewman (Matthewman, 2016, p. 13) describes as “vastly uneven landscapes of risk.” Marginalized communities consistently face greater challenges in disaster preparation and suffer worse physical and mental health outcomes, higher displacement, and slower recovery (Arcaya et al., 2020). Social capital can serve as a crucial resource, fostering resilience by mitigating adverse health effects through access to information, resources, and support, and is positively associated with all stages of disaster preparedness, response, and recovery (Meyer, 2017). Using longitudinal data from the Indian Human Development Survey (IHDS), the paper addresses two questions: (1) How does social and economic stratification shape the risks of functional limitations among older adults in rural India following droughts? (2) To what extent does social capital strengthen resilience by buffering these risks, and does its effect differ across social and economic groups?

The paper aims to make several meaningful contributions to the scholarship. It applies the frameworks of environmental justice and social capital to India, where rapid demographic and economic changes are intersecting with persistent social inequalities. India is now the world’s most populous country and has the second-largest population of adults over 65, estimated at 90 million and growing rapidly (Mishra, 2020). This shift unfolds in a context where, despite rising incomes, traditional forms of stratification such as caste and religion continue to shape life chances alongside newer, class-based divisions rooted in widening economic inequality (Desai & Dubey, 2011; Deshpande, 2011). Next, the paper emphasizes functional limitations as an early and sensitive indicator of health decline, one that can offer insight into long-term and often invisible impacts of climate events. Functional limitations, such as impaired walking speed and grip strength, are early markers of cognitive decline and are associated with higher risks of mortality and chronic disease (Clouston et al., 2016; Newman et al., 2006). While research on the topic remains limited, evidence from recent disasters suggests that natural events can accelerate functional decline in older adults. For example, psychological distress following the 2011 Great East Japan Earthquake was linked to increased risk of disability (Tanji et al., 2017), and older adults in disaster-affected areas saw faster increases in disability prevalence (Tomata et al., 2015). Similarly, post-disaster hardship and peri-traumatic stress from Hurricane Sandy negatively affected functional health in older Americans (Pruchno et al., 2020). Evidence from once-in-a-generation extreme climate events has shown that floods in urban areas of India lead to an increased risk of developing functional limitations (Rendall, 2024).

This study shifts the focus from single, once-in-a-generation extreme events to recurring and compounding climate shocks, particularly droughts. The relationship between functional limitations and recurring climate events is more complex and less understood than in the case of isolated disasters. While previous studies have documented clear links between extreme events and increased functional limitations among older adults, a nationally representative longitudinal study in the U.S. found no association between multiple low-intensity disaster exposures and changes in functional limitations (Brilleman et al., 2017). This paper contributes to the limited body of work examining the intersection of cumulative effects of repeated low-intensity climate events and the functional health of older adults, an area of study often overlooked (Tipaldo et al., 2024)

Similarly, this paper advances the understanding of social capital in the context of slow-onset, recurring events, a dimension often overlooked in scholarship that typically focuses on extreme disasters (Meyer, 2017). Whereas sudden-onset events may compel immediate collective action, slow-onset events, such as droughts, unfold gradually, activating different forms and mechanisms of social capital disasters (Meyer, 2017). Finally, this paper examines the differential returns of social capital as a buffer against climate-related events.

Uneven Risks: Class, Caste, and Climate Change

Since 1990s, the average annual real income has grown by nearly 5% per annum (Chancel & Piketty, 2019). Although rising incomes and a shift toward a market-based economy were expected to erode caste-based inequalities, these disparities persist (Deshpande, 2011); while their forms may have changed, differences in outcomes remain substantial (Desai & Dubey, 2011). Thus, both class and caste remain critical in determining health outcomes. Caste-based health disparities are particularly pronounced at lower socioeconomic levels and tend to narrow only among the wealthiest (Uddin et al., 2020). Borooah (2010) found that caste affects age at death, healthcare-seeking behavior, and maternal care even after accounting for class. Gupta and Coffey (Po & Subramanian, 2011), document worse mental health among the Scheduled Castes and Muslims. At the same time, some scholars argue that class is now the primary driver of health inequality (Po & Subramanian, 2011).

As India ages, inequalities in the health and well-being of older adults become increasingly visible. Life expectancy in India is predicted to increase from 64.9 to 69.4 years for men and from 68.2 to 72.8 years for women between 2011 and 2020. As a result, India's elderly population is growing rapidly. India is home to the world's second-largest population of individuals aged 65 and older. This group accounted for 10.8% of the world's population over 65 and 5% of India's population as of January 2011 (Mishra, 2020). Between 2005 and 2012, the share of adults aged 60 and above with at least one functional limitation rose from 9.4% to 36.6% (Paul et al., 2021). An estimated 44% of people who are 50 and older reported having functional limitations in 2017-18 (Malik, 2020). The prevalence is higher in rural areas (47.8%) than in urban areas (36.9%). By caste, the prevalence was higher among the Scheduled Castes at 47.8% compared to the forward castes at 42.1%. Religious differences follow a similar trend, with 48.9% of Muslims and 43.9% of Hindus reporting any functional limitation. Economic status is another key factor—46.2% of individuals in the poorest quintile reported functional limitations, compared to 40.6% of the wealthiest quintile (Malik, 2022).

Stratifications along these lines not only shape health disparities but also influence how different groups experience and recover from climate-related events. In India, the intensity and frequency of droughts have increased markedly over the past 60 years, and climate models project these trends will persist and worsen, with droughts becoming both more frequent and severe (Mujumdar et al., 2020). Rural India is an agriculturally dependent economy that bears the brunt of increasingly frequent droughts (Mujumdar et al., 2020). Adverse natural events have a significant impact on consumption expenditures (Tamuly & Mukhopadhyay, 2022). The most common coping strategy adopted by rural people during drought conditions is reducing consumption across various food categories, including nutritious options such as meat, poultry, and dairy products (Sam et al., 2020). Social and economic inequalities exacerbate the situation; children from marginalized groups experienced worse educational outcomes in the wake of adverse natural events compared to their non-marginalized counterparts (Khalid et al., 2024). Additionally, the gendered nature of disaster impacts is evident: women experience higher flood-related fatalities (Chowdhury, Parida, and Goel, 2021). Early-life exposure to disasters has lasting effects; young girls experienced stunted growth following an earthquake (Dhamija & Sen, 2023). Economically vulnerable groups have been disproportionately affected by disasters like the Kosi floods, which not only hindered educational attainment but also impacted marriage prospects (Khanna and Kochhar, 2023). Limited evidence exists connecting adverse climate events and functional limitations in India. Residing in a coastal city that experienced an extreme flooding event was associated with higher odds of acquiring a functional limitation compared to residing in a similar inland city (Rendall, 2024).

Resilience: Social Capital, Health and Climate Change

Given these documented vulnerabilities to climate events, understanding potential protective factors becomes crucial. One important resource that may act as a buffer against negative health effects is social capital. Social capital refers to the resources embedded within social networks that facilitate coordination, information exchange, and collective action among individuals and groups. Among the various conceptualizations, two distinct approaches stand out: individual and collective social capital (Portes, 2000). The individual social capital approach, which forms the focus of this paper, views social capital as resources available through social networks that affect individuals (Bourdieu, 1986; Lin, 1999). Bourdieu (1986) conceptualizes social capital as the sum of resources (both actual and potential) that a person can access through their network of relationships. These relationships may be informal or formally recognized. This wealth enables the individual to exert power and mobilize resources (Bourdieu, 1986). Although embedded within broader social structures, this form of capital is accessible only to those who possess it, can be mobilized to pursue individual goals, and is unequally distributed across society.

Building on these foundations, a growing body of research has examined how social capital shapes health outcomes. The majority of research finds that social capital generally improves health outcomes (Ehsan et al., 2019), though the effect sizes are modest (Xue et al., 2020). Scholarship has also identified a "dark side" of social capital, highlighting potential negative effects. These adverse outcomes, rather than being a universal phenomenon, typically occur within specific contexts (Villalonga-Olives & Kawachi, 2017). Various causal mechanisms link social capital to health (Berkman & Glass, 2000; Thoits, 2010; Zhang & Centola, 2019). Established social networks facilitate the efficient flow of health information, influencing health behaviors through knowledge acquisition (Viswanath et al., 2006). Norm adoption process forms another significant pathway. Individuals evaluate the appropriateness of their attitudes, beliefs, and behaviors against standards set by the members of their groups, typically shifting their attitudes, beliefs, and behaviors to align with group norms (Thoits, 2010). An extension of normative influence is social control, which refers to overt efforts by members of a social network to monitor, encourage, persuade, or pressure individuals to adopt or adhere to (predominantly positive) health practices (Berkman & Glass, 2000).

These general health benefits of social capital become particularly noticeable in older adults who face increased dependency and health challenges. Increased dependence in old age creates a critical relationship between social capital and health outcomes throughout later life. Individual-level social capital is crucial for older adults, who often rely on others to access health benefits, such as regular medical attention and ongoing care support (Cagney & Wen, 2008). Higher levels of individual and community social capital are associated with increased quality of life for older adults (Nilsson et al., 2006). Social capital is demonstrated to be significantly more important for the health of older adults (60 and above) than for younger people (Muckenhuber et al., 2013).

Social Capital can function as a protective resource both before and after a climate event, playing a role in mitigation, preparedness, response, and recovery (Meyer, 2017). It is argued that social capital facilitates recovery more effectively than greater economic resources or external assistance, as strong networks enable survivors to coordinate, share resources, and rebuild more efficiently (Aldrich, 2012, p. 12). Notably, unlike physical or financial resources that are depleted in disasters, social capital is often “renewed and enhanced during the emergency period,” making it a reliable resource in climate events (Dynes, 2002). During the Great East Japan Earthquake, higher social cohesion was linked to lower prevalence of functional disabilities among older adults in disaster-stricken areas (Tanji et al., 2017).

Several mechanisms explain these effects. First, networks provide essential emotional and psychological support that helps individuals cope with trauma and stress, reducing the burden on personal coping resources and lowering the risk of posttraumatic stress and other mental health impacts (Wind & Komproe, 2012). Second, social networks facilitate the diffusion of critical information about environmental risks, available resources, and recovery opportunities (Aldrich, 2012, p.53). Finally, social capital serves as an intermediary between communities and the state, enhancing adaptive capacity through collective action and coordination (Adger, 2010; Aldrich, 2010). Furthermore, in resource-constrained settings, social capital can serve as a substitute for absent or ineffective governmental support in the aftermath of a climate-related event. When disasters exceed the state's response capacity, households rely on support from family, friends, and neighbors to find shelter and safety for displaced individuals (Brouwer & Nhassengo, 2006).

In the Indian context, social capital was positively associated with the Likelihood of being "on pace" in schooling as well as completing schooling (Myroniuk et al., 2017). Specific forms of social capital were associated with a lower likelihood of underweight children (Vikram, 2018). Additionally, social capital was associated with higher utilization of maternal and child health services (Story, 2014). While social capital offers important benefits, access to it and the returns from it are uneven across social groups. Disadvantaged communities often face both a capital deficit, that is, a smaller and less diverse network. In addition to a return deficit, where comparable networks yield fewer benefits due to structural inequalities tied to race, class, caste, or gender (Lin, 2000). For instance, caste and gender in India significantly shaped both the quality of social capital and the ability to access it (Bosher et al., 2007). Marginalized communities also tend to be systematically excluded from decisionmaking and aid distribution organized by social networks (Aldrich, 2011). Wealth has also been shown to amplify the benefits of linking social capital, particularly in reducing child undernutrition (Story & Carpiano, 2017).

With this background, the paper asks: (1) How does social and economic stratification shape the risks of functional limitations among older adults in rural India following droughts? The paper hypothesizes that exposure to droughts increases the risk of functional limitation. The paper further hypothesizes that an advantageous social and economic position can mitigate this effect. The paper then asks: (2) To what extent does social capital strengthen resilience by buffering these risks, and does its effect differ across social and economic groups? The paper hypothesizes that social capital helps buffer the adverse effects of droughts on functional limitations. The paper further hypothesizes that this protective effect is uneven, with individuals in more privileged social and economic positions receiving more protection.

Data

The paper utilizes data from two rounds of the India Human Development Survey (IHDS), a nationally representative longitudinal dataset. The first wave of the survey was conducted in 2004-05, and the second wave was conducted in 2011-12. The first wave of IHDS covered 41,544 households in 1,503 villages and 971 urban neighborhoods in India. The paper restricts the sample to adults who were at least 40 years of age in the first wave. Given the seven-year interval between survey waves, respondents were at least 47 years old at the time of the second wave. The village-level questionnaire, administered at the Primary Sampling Unit (PSU) level, included questions about natural disasters faced by rural communities. The analysis focuses on individuals from households in rural PSUs with available data for both survey rounds. This results in a sample size of 32,248 individuals. Of these, 27,592 (85.6%) individuals were re-interviewed, and 4,656 (14.5%) individuals died between the two waves.

Key Variables

Information about the ability to perform activities of daily living was collected for individuals in the household. The question asks, “Does anyone in the household have a problem [ACTIVITY]?”. The list of seven activities includes “walking 1 km, going to the toilet without help, dressing without help, hearing normal conversation, speaking normally, seeing distant things, and seeing near objects such as reading/sewing.” If the answer is ‘Yes,’ a follow-up question is asked: “Can [NAME] still do it with some trouble or is she/he unable to do it?” The response is coded as either “can do with difficulty” or “unable to do it”.

Each of the seven activities is assigned a value: 0 signifies no difficulty, 1 indicates difficulty, and 2 represents the inability to perform the activity. The individual’s total score is calculated by summing up these values across all seven activities, resulting in a score ranging from 0 to 14 for each person. A higher score indicates a higher functional limitation and is reflective of worse health. The paper uses the difference between the scores in the second round and the first round as the outcome variable, to focus on the change in individuals’ functional limitation scores over time. The outcome variable is a categorical variable that takes the value zero if the functional limitation score remains the same or decreases (indicating health stability or improvement) between the two survey waves. It takes the value one if the score increases, that is, if the health deteriorates between the two waves. Finally, the variable takes the value two if the individual passes away between two rounds of the survey. Of the 32,248 individuals surveyed in Wave 1, 22,509, or 69.8%, did not experience an increase in functional impairments between the waves. 5,083 individuals, or 15.8%, saw an increase in functional limitation, whereas 4,656 individuals, or 14.5%, died.

The village schedule of the IHDS Wave 2 fielded questions about the adverse natural events the village experienced between the two survey waves. The instrument captured both multiple occurrences of the same event type and the co-occurrence of multiple distinct event types. Droughts were classified into three categories: no occurrence, single occurrence, and two or more occurrences between survey waves. This covers all the major and minor incidents of droughts that the village might have faced.

Social capital was measured as a dichotomous variable based on the association of household members with various organizations. The variable was coded 1 if anyone in the household belonged to any of the following organizations: religious, caste, or festival organizations; women's groups; youth clubs; sports groups; reading rooms; trade unions; business or professional groups; self-help groups; credit or savings groups; development NGOs; or agricultural cooperatives. The variable was coded 0 if no household member belonged to any of these organizations (Cronbach's alpha = 0.60). 65.2% of individuals had no social capital through organizational membership, while the remaining 34.8% had some form of social capital through their household members' organizational affiliations.

Social Groups are categorized into three groups. The first category, “Forward Castes,” includes individuals from Hindu-dominant castes as well as religious minorities such as Christians, Jains, and Sikhs, who are traditionally not considered to be socially disadvantaged. The second category, “Scheduled Castes and Scheduled Tribes (SC/ST),” comprises historically marginalized communities recognized by the Indian constitution as socially and economically disadvantaged. The third category, “Muslims,” includes individuals identifying as Muslim, a group that also faces structural disadvantages in the Indian context. Asset Tertiles are used as a proxy for class and are constructed based on a household asset index comprising 33 items. Households are divided into three groups—low, middle, and high—based on their total asset holdings.

Analytical Strategy

To answer the first research question, “How does stratification (social and economic) influence the severity of the impacts of natural disasters on the functional limitations of older adults in rural India?” the paper uses multinomial logistic regression, with the outcome variable categorized into three categories: no change in functional limitations, worsening functional limitations, or death between survey waves. The first model includes the main effects of drought exposure and socioeconomic variables independently. Results are expressed as predicted probabilities with 90% confidence intervals and in Relative Risk Ratios (RRR). The paper then introduces the interactions between the two main stratifiers—class and social groups—and exposure to droughts. The results of all interactions are expressed in predicted probabilities with 90% confidence intervals. These are referred to as risk models, which help illustrate the differences in health risks associated with exposure to droughts.

To answer the second research question, “Does social capital mitigate these impacts?”—the paper uses a multinomial logistic regression with the same outcome variable. The analytical approach begins with a main effects model that includes drought exposure, key stratifiers (class and social groups), and social capital. The paper then introduces interactions between drought exposure and social capital to test whether social capital moderates the effects of droughts. Finally, the sample is stratified by class and social groups to examine heterogeneity in the relationship between drought exposure and social capital. These are referred to as resilience models; they help us understand how social capital may function as a protective factor, buffering the adverse health effects of drought exposure across different sociodemographic groups.

All models employ multinomial logit regression; however, the results primarily focus on the health deterioration outcome to maintain conciseness. Given the older adult population, the sample exhibits a high mortality rate between survey waves. Although mortality was included in the models, it failed to achieve statistical significance in both risk and resilience models. Full models are available in the appendix. The controls used in all the models include age, sex, education, marital status, baseline functional limitation score, and state of residence.

Results

Table 1 presents the changes in functional limitations across the two waves of the IHDS. Outcomes remained relatively stable across drought exposure: 69.8% of individuals without drought exposure maintained or improved their condition, compared to 71.5% of those experiencing one drought and 68.8% of those exposed to two or more droughts. Mortality rates were nearly identical across these groups, ranging from 14.4% to 14.5%. Among those without social capital, 68.9% maintained or improved their condition, 16.0% deteriorated, and 15.1% died. In contrast, individuals with social capital fared better, with 71.6% maintaining or improving, 15.3% deteriorating, and only 13.1% dying. The poorest tertile recorded the highest deterioration (16.5%) and mortality (15.2%), while the richest had better outcomes, with 71.4% stable or improved and only 13.3% mortality. Forward Castes reported a mortality rate of 13.9% and a deterioration rate of 16.7%. Scheduled Castes and Tribes experienced the highest mortality (15.9%) but a lower deterioration rate (14.5%), while Muslims and other minorities had the most favorable outcomes overall, with 72.7% maintaining or improving, 13.7% deteriorating, and 13.6% dying.

Risk Models

Table 2 presents the results of a multinomial logistic regression analysis, comparing individuals whose functional limitations deteriorated with a base group of individuals whose functional limitations remained the same or improved. Results are expressed as relative risk ratios (RRRs). Table 3 presents the predicted probabilities of functional limitation deterioration, along with standard errors and 90% confidence intervals. Experiencing one drought is not statistically significantly associated with a higher risk of deterioration in functional limitations (RRR = 0.98, $p = 0.83$), but exposure to two or more droughts is linked to an 18% increase in risk (RRR = 1.18, $p = 0.01$). This translates to a rise in the predicted probability of functional health deterioration from 13.8% (CI 13.1%, 14.5%) with no drought to 15.6% (CI 14.6%, 16.6%) with two or more droughts.

Table 1
Changes in Functional Limitations by Drought Exposure, Socioeconomic, and Demographic Characteristics (IHDS, wave 1 to wave 2).

	Same or Improved		Deteriorated		Death	
	Percentage	Number	Percentage	Number	Percentage	Number
Droughts						
No Drought	69.81	11566	15.74	2607	14.45	2394
One Drought	71.50	4069	14.09	802	14.41	820
Two or More Droughts	68.81	6874	16.76	1674	14.43	1442
Social Capital						
No	68.85	14474	16.01	3366	15.13	3181
Yes	71.57	8035	15.29	1717	13.14	1475
Asset Tertile						
Poorest Tertile	68.35	7882	16.48	1900	15.17	1749
Middle Tertile	69.81	7125	15.37	1569	14.82	1513
Richest Tertile	71.38	7502	15.36	1614	13.26	1394
Social Groups						
Forward Castes	69.46	13699	16.69	3292	13.85	2731
Schedule Castes & Tribes	69.67	6826	14.46	1417	15.87	1555
Muslims & Others	72.73	1984	13.71	374	13.56	370
Gender						
Male	70.64	11562	13.10	2145	16.26	2661
Female	68.94	10947	18.50	2938	12.56	1995
Income Source						
Agriculture as Primary Source	69.71	13975	15.95	3198	14.34	2875
Some Agriculture Income	70.22	4069	16.13	935	13.65	791
No Agriculture Income	69.71	4465	14.83	950	15.46	990
Education						
No Formal Educ	65.65	12902	17.61	3462	16.74	3290
Upto Primary	71.87	4228	14.84	873	13.29	782
Primary and Above	80.15	5379	11.15	748	8.70	584
Marital Status						

	Same or Improved		Deteriorated		Death	
	Percentage	Number	Percentage	Number	Percentage	Number
Droughts						
Married	74.45	19526	14.38	3772	11.17	2929
Widowed/Divorced/Separated	49.54	2983	21.77	1311	28.68	1727
Age						
Mean	51.19	22509	58.53	5083	65.32	4656
Number	22509	22509	5083	5083	4656	4656
Baseline Functional Limitation Score						
Mean	0.16	22509	0.11	5083	0.59	4656
Number	22509	22509	5083	5083	4656	4656
Sources: Author's Calculations						

In the baseline model (Model 1, Table 2), household assets are statistically significantly associated with a deterioration in functional health when exposed to droughts. Compared to those in the poorest asset tertile, individuals in the middle tertile are less likely to experience deterioration in functional limitations (RRR = 0.87, $p = 0.04$). Individuals in the richest tertile have substantially lower risk, with significantly reduced odds of reporting functional health decline (RRR = 0.71, $p < 0.001$). In a model with interaction terms between asset tertiles and drought exposure, the poorest tertile exhibits a statistically significant increase with drought exposure. The poorest tertile shows an increase from 14.7% (CI 13.3%, 16.1%) with no drought to 17.6% (CI 16.1%, 19.2%) with two or more droughts. The middle tertile shows an increase with drought exposure, although the confidence intervals overlap. The middle tertile shows an increase from 13.8% (CI 12.6%, 14.9%) with no drought to 15.8% (CI 14.1%, 17.6%) with two or more droughts. In contrast, the richest tertile shows minimal change from 12.4% (CI 11.2%, 13.6%) with no drought to 12.1% (CI 10.5%, 13.6%) with two or more droughts.

In model 1, individuals belonging to Scheduled Castes and Scheduled Tribes (SC/ST) exhibit a lower relative risk of deterioration in functional health compared to Hindu Forward Castes (RRR = 0.82, $p < 0.01$). Similarly, Muslims also show a lower risk of deterioration (RRR = 0.81, $p = 0.02$). For functional health deterioration, none of the social groups show statistically significant increases with drought exposure due to overlapping confidence intervals. Forward Castes show the smallest increase from 15.0% (CI 14.0%, 16.0%) with no drought to 16.1% (CI 14.9%, 17.4%) with two or more droughts. SC/ST groups show an increase from 12.0% (CI 10.8%, 13.2%) with no drought to 14.5% (CI 12.9%, 16.1%) with two or more droughts. Muslims/Other groups show an increase from 12.9% (CI 10.8%, 15.0%) with no drought to 15.8% (CI 13.0%, 18.7%) with two or more droughts.

Of the controls in the model, age, unsurprisingly, is consistently and significantly associated with a higher risk of both functional decline and mortality across all models. For each additional year of age, the risk of functional limitation deterioration increases by approximately 8% (RRR 1.08, p *< *0.001). A higher baseline limitation is associated with a reduced risk of further deterioration (RRR = 0.82, $p < 0.001$). Possibly indicating a ceiling effect, individuals with higher functional limitations have less room to deteriorate further. Women have a higher risk of functional health deterioration compared to men (RRR = 1.34, $p < 0.001$). Compared to those with no formal education, individuals with above-primary education are less likely to experience deterioration in functional health (RRR = 0.84, $p < 0.05$), while those with education up to the primary level show no significant protective effect (RRR = 0.92, $p = 0.24$). Individuals who are widowed, separated, or divorced have a higher risk of functional health deterioration compared to those who are married (RRR = 1.16, $p < 0.05$). There is no statistically significant association between income source and functional health deterioration, with neither some agricultural income (RRR = 0.99, $p = 0.94$) nor agriculture as the primary source (RRR = 0.88, $p = 0.07$) showing statistically significant effects compared to those with no agricultural income.

Table 2
Multinomial Logistic Regression of Functional Limitation Deterioration by Drought Exposure, Socioeconomic, and Demographic Characteristics. (IHDS, wave 1 to wave 2)

	Model 1			**Model 2**		
	R.R.R	S.E.	P value	R.R.R	S.E.	P value
Droughts						
No Drought	1	(.)	.	1	(.)	.
One Drought	0.98	0.07	0.98	0.98	0.07	0.95
Two or More Droughts	1.17	0.07	0.01	1.17	0.07	0.01
Wealth Tertiles						
Poorest Tertile	1	(.)	.	1	(.)	.
Middle Tertile	0.87	0.06	0.04	0.88	0.06	0.04
Richest Tertile	0.71	0.05	0	0.72	0.06	0
Social Groups						
Forward Castes	1	(.)	.	1	(.)	.
Schedule Castes & Tribes	0.82	0.05	0	0.83	0.05	0
Muslims	0.81	0.07	0.02	0.81	0.07	0.02
Gender						
Men	1	(.)	.	1	(.)	.
Women	1.34	0.08	0	1.34	0.08	0
Education						
No Formal Education	1	(.)	.	1	(.)	.
Upto Primary	0.92	0.07	0.24	0.92	0.07	0.25
Above Primary Education	0.84	0.07	0.04	0.84	0.07	0.04
Income Source						
No Agriculture Income	1	(.)	.	1	(.)	.
Some Agriculture Income	0.99	0.08	0.94	1	0.09	0.97
Agriculture as Primary Source	0.88	0.06	0.07	0.89	0.06	0.08
Marital Status						
Married	1	(.)	.	1	(.)	.
Widowed, separated and divorsed	1.16	0.08	0.03	1.16	0.08	0.03
Age	1.08	0	0	1.07	0	0

	Model 1			Model 2		
Baseline Functional Limitation score	0.82	0.02	0	0.82	0.02	0
Social Capital						
No				1	(.)	.
Yes				0.95	0.05	0.38

Source: Author's Calculation

Note: Select Variables and Outcome reported, full regression in appendix.

Table 3
Predicted probabilities of functional limitation deterioration by drought exposure, wealth tertiles, and social groups among adults aged 47 and older, rural India (IHDS, wave 1 to wave 2

	Pred. probability	**S.E**	**Lower C.I**	**Upper C.I**
No Drought	0.138	0.004	0.131	0.145
One Drought	0.136	0.007	0.124	0.148
Two or More Droughts	0.156	0.006	0.146	0.166
Wealth Tertiles				
Poorest X No Drought	0.147	0.009	0.133	0.161
Poorest X One Drought	0.154	0.011	0.136	0.172
Poorest X Two or more Droughts	0.176	0.01	0.16	0.192
Middle X No Drought	0.138	0.007	0.126	0.149
Middle X One Drought	0.127	0.014	0.104	0.15
Middle X Two or more Droughts	0.158	0.01	0.141	0.176
Richest X No Drought	0.124	0.007	0.112	0.136
Richest X One Drought	0.12	0.014	0.097	0.144
Richest X Two or more Droughts	0.121	0.01	0.105	0.136
Social Groups				
Hindu Forward Castes X No Drought	0.15	0.006	0.14	0.16
Hindu Forward Castes X One Drought	0.153	0.011	0.135	0.171
Hindu Forward Castes X Two or More Drought	0.161	0.008	0.149	0.174
SC/ST X No Drought	0.12	0.007	0.108	0.132
SC/ST X One Drought	0.12	0.01	0.103	0.137
SC/ST X Two or more Droughts	0.145	0.01	0.129	0.161
Muslims/Others X No Drought	0.129	0.013	0.108	0.15
Muslims/Others X One Drought	0.085	0.017	0.057	0.114
Muslims/Others X Two or more Droughts	0.158	0.017	0.13	0.187

Note: Predicted probabilities are from multinomial logistic regressions containing all variables included in Model 1 (Table 2), as well as two-way interactions between social groups, asset tertiles, and drought exposure. Standard errors (S.E.) and 90% confidence intervals (C.I.) are reported.

Resilience Models

The resilience model (model 2, Table 2) adds the social capital variable to the risk model to assess the resilience and protective effect of social capital. Adding social capital variables does not change the effect of two or more droughts, which still has 17 percent higher risk of health deterioration (RRR 1.17, $p = 0.01$). Having social capital shows no significant protective effect compared to those without any social capital (RRR = 0.95, $p = 0.38$). The predicted probability of functional health deterioration (reported in Table 4) is 14.5% (CI 13.8%, 15.1%) for those without social capital and 14.0% (CI 13.1%, 14.9%) for those with social capital, indicating no significant difference in baseline health outcomes. Adding interaction between drought and social capital reveals important differential effects. For individuals with no social capital, the predicted probability of functional health deterioration increases significantly from 13.5% (CI 12.6%, 14.4%) with no drought to 16.7% (CI 15.4%, 18.0%) with two or more droughts. Those with social capital show no statistically significant change, with probabilities remaining stable from 14.2% (CI 13.1%, 15.4%) with no drought to 13.7% (CI 12.3%, 15.2%) with two or more droughts. This suggests that social capital functions as a crisis-activated protective resource, buffering against drought-related health deterioration rather than providing general health benefits under normal conditions.

For higher caste individuals with no social capital, the predicted probability of functional health deterioration increases from 14.8% (CI 13.6%, 16.0%) with no drought to 17.0% (CI 15.4%, 18.7%) with two or more droughts, though this change is not statistically significant due to overlapping confidence intervals. Higher-caste individuals with social capital show no statistically significant change, with probabilities remaining stable, ranging from 16.3% (CI 14.7%, 17.8%) with no drought to 15.0% (CI 13.0%, 17.1%) with two or more droughts. For scheduled castes and tribes with no social capital, predicted probabilities increase significantly from 11.1% (CI 9.6%, 12.6%) with no drought to 16.4% (CI 14.0%, 18.8%) with two or more droughts, representing a statistically significant rise with non-overlapping confidence intervals. Those with social capital show no statistically significant change, with probabilities remaining relatively stable from 11.9% (CI 10.0%, 13.9%) with no drought to 12.4% (CI 10.1%, 14.6%) with two or more droughts. For Muslim individuals with no social capital, predicted probabilities increase from 10.5% (CI 8.1%, 12.9%) with no drought to 12.1% (CI 8.9%, 15.3%) with two or more droughts, though this change is not statistically significant due to overlapping confidence intervals. Muslims with social capital show no statistically significant change, with probabilities remaining stable from 7.2% (CI 4.8%, 9.5%) with no drought to 7.6% (CI 4.7%, 10.5%) with two or more droughts.

For individuals in the lowest quintile with no social capital, the predicted probability of functional health deterioration increases significantly from 14.0% (CI 12.3%, 15.6%) with no drought to 17.0% (CI 15.1%, 18.9%) with two or more droughts, representing a statistically significant rise with non-overlapping confidence intervals. Those with social capital show no statistically significant change, with probabilities going from 12.5% (CI 10.5%, 14.5%) with no drought to 13.0% (CI 10.9%, 15.1%) with two or more droughts. For middle tertile individuals with no social capital, predicted probabilities increase significantly from 12.3% (CI 10.9%, 13.7%) with no drought to 17.7% (CI 15.3%, 20.1%) with two or more droughts, showing a statistically significant rise with non-overlapping confidence intervals. Those with social capital show no statistically significant change, with probabilities remaining relatively stable from 14.2% (CI 12.0%, 16.3%) with no drought to 14.7% (CI 12.0%, 17.4%) with two or more droughts. For the richest tertile individuals with no social capital, predicted probabilities show no statistically significant change from 13.1% (CI 11.5%, 14.6%) with no drought to 12.8% (CI 10.8%, 14.9%) with two or more droughts due to overlapping confidence intervals. Those with social capital also exhibit no statistically significant change, with probabilities remaining stable from 14.5% (CI 12.7%, 16.2%) with no drought to 12.9% (CI 10.3%, 15.5%) with two or more droughts.

Table 4

Predicted probabilities of functional limitation deterioration by drought exposure, wealth tertiles, and social groups, adults aged 47 and older, rural India (IHDS, wave 1 to wave 2)

		All		
	Pred. probability	S.E	Lower C.I	Upper C.I
No Social Capital	0.145	0.004	0.138	0.151
Yes Social Capital	0.140	0.005	0.131	0.149
Interactions				
No Social Capital X No Drought	0.135	0.006	0.126	0.144
No Social Capital X One Drought	0.133	0.009	0.119	0.147
No Social Capital X Two or more Droughts	0.167	0.008	0.154	0.180
Yes Social Capital X No Drought	0.142	0.007	0.131	0.154
Yes Social Capital X One Drought	0.144	0.014	0.122	0.167
Yes Social Capital X Two or more Droughts	0.137	0.009	0.123	0.152
		Higher Castes		
No Social Capital X No Drought	0.148	0.007	0.136	0.160
No Social Capital X One Drought	0.150	0.013	0.129	0.170
No Social Capital X Two or more Droughts	0.170	0.010	0.154	0.187
Yes Social Capital X No Drought	0.163	0.010	0.147	0.178
Yes Social Capital X One Drought	0.164	0.020	0.132	0.197
Yes Social Capital X Two or more Droughts	0.150	0.012	0.130	0.171
		Schedule Castes and Tribes		
No Social Capital X No Drought	0.111	0.009	0.096	0.126
No Social Capital X One Drought	0.121	0.013	0.100	0.141
No Social Capital X Two or more Droughts	0.164	0.014	0.140	0.188
Yes Social Capital X No Drought	0.119	0.012	0.100	0.139
Yes Social Capital X One Drought	0.120	0.019	0.089	0.150
Yes Social Capital X Two or more Droughts	0.124	0.014	0.101	0.146

	All			
		Muslims		
No Social Capital X No Drought	0.105	0.015	0.081	0.129
No Social Capital X One Drought	0.067	0.014	0.044	0.090
No Social Capital X Two or more Droughts	0.121	0.019	0.089	0.153
Yes Social Capital X No Drought	0.072	0.014	0.048	0.095
Yes Social Capital X One Drought	0.041	0.021	0.007	0.074
Yes Social Capital X Two or more Droughts	0.076	0.017	0.047	0.105
		Poorest Tertile		
No Social Capital X No Drought	0.140	0.010	0.123	0.156
No Social Capital X One Drought	0.137	0.011	0.118	0.156
No Social Capital X Two or more Droughts	0.170	0.012	0.151	0.189
Yes Social Capital X No Drought	0.125	0.012	0.105	0.145
Yes Social Capital X One Drought	0.157	0.023	0.118	0.196
Yes Social Capital X Two or more Droughts	0.130	0.013	0.109	0.151
		Middle Tertile		
No Social Capital X No Drought	0.123	0.008	0.109	0.137
No Social Capital X One Drought	0.127	0.017	0.099	0.155
No Social Capital X Two or more Droughts	0.177	0.015	0.153	0.201
Yes Social Capital X No Drought	0.142	0.013	0.120	0.163
Yes Social Capital X One Drought	0.125	0.019	0.094	0.156
Yes Social Capital X Two or more Droughts	0.147	0.016	0.120	0.174
		Richest Tertile		
No Social Capital X No Drought	0.131	0.009	0.115	0.146
No Social Capital X One Drought	0.134	0.018	0.104	0.165
No Social Capital X Two or more Droughts	0.128	0.012	0.108	0.149
Yes Social Capital X No Drought	0.145	0.011	0.127	0.162

		All			
Yes Social Capital X One Drought	0.129	0.028		0.084	0.175
Yes Social Capital X Two or more Droughts	0.129	0.016		0.103	0.155

Source: Author’s calculations.

Note

Predicted probabilities are from multinomial logistic regressions containing all variables included in Model 1 (Table 2), as well as two-way interactions between social groups, asset tertiles, and drought exposure.

Conclusions and discussions

The first set of hypotheses focused on risks, proposing that exposure to droughts increases the risks of functional health deterioration among older adults in rural India. Results show that exposure to two or more droughts is associated with an 18% higher risk of deterioration, whereas exposure to a single drought shows no difference from exposure to no drought at all. This pattern suggests that, unlike once-in-a-generation disasters, which have immediate impacts, repeated, lower-intensity events exert a cumulative effect that becomes evident only after multiple exposures have occurred. This study helps address the critical gap in scholarship that connects climate events to the health of older adults by shifting attention from extreme, episodic events to recurring climate stressors (Brilleman et al., 2017; Tipaldo et al., 2024). The nationally representative survey used here had relatively few respondents exposed to over two droughts within the seven-year window, limiting the ability to examine the association between finer gradients of exposure and functional limitation. Future research could address this issue by oversampling populations that face repeated climate shocks in dedicated climate resilience surveys. The paper further hypothesized that an advantageous social and economic position can mitigate these risks. Economic position plays a crucial role in determining the risks associated with drought impacts. The poorest asset tertile exhibits a statistically significant increase in functional deterioration following drought exposure. In contrast, the richest tertile shows no statistically significant change in functional deterioration regardless of drought exposure. These results further reinforce the notion that climate events systematically amplify pre-existing inequalities. Economically disadvantaged populations face disproportionate impacts due to limited adaptive capacity and restricted access to resources for recovery.

The second set of hypotheses focuses on resilience, proposing that social capital helps buffer the negative effects of droughts on functional limitations. Social capital itself is not statistically significantly associated with better baseline health outcomes under normal conditions. While most literature links social capital with better outcomes, some studies have shown no significant change (Ehsan et al., 2019). However, the paper does find that social capital acts as a crisis-activated protective resource, effectively buffering against health deterioration related to drought. For individuals with no social capital, the predicted probability of functional health deterioration increases significantly from no drought to two or more droughts. Those with social capital show no statistically significant change, with probabilities remaining stable. Combining the two results, we see that social capital is as important a resource as wealth in buffering against the adverse effects of climate events. Just as wealth provides households with financial insurance, social capital provides *informal insurance* by mobilizing networks. Further research could explore the precise mechanisms through which social capital is activated during crises and the extent to which it substitutes for wealth.

In seeking to understand the mechanisms through which social capital fosters resilience, this study encounters a limitation: the use of a binary measure of social capital. This approach does not distinguish between bonding and bridging forms of social capital, which operate in different ways. Bonding capital, rooted in caste, religion, or kinship, tends to reinforce in-group loyalty and may perpetuate exclusionary practices (Putnam, 2000). Bridging capital, by contrast, links individuals across diverse groups, often through development organizations, and facilitates access to external resources and opportunities (Putnam, 2000). This distinction is especially important in India, where empirical studies using IHDS data show that bridging capital improves child health outcomes such as nutrition and immunization, while bonding capital often shows null or negative effects (Story & Carpiano, 2017; Vikram, 2018; Vikram et al., 2012). Given this evidence, incorporating a disaggregated measure that distinguishes between bonding and bridging social capital would have strengthened the analytical precision of this study. Unfortunately, a limited analytic sample size prohibited this level of differentiation in the modeling strategy. Future research would benefit from larger or more targeted samples, or from mixed-methods approaches that enable more granular assessments of how different forms of social capital influence health in the face of climate-related shocks.

Finally, the paper hypothesizes that the protective effect of social capital is uneven, with individuals in more privileged social and economic positions receiving higher levels of protection. The results provide only partial confirmation. Among the poorest and middle asset tertiles, as well as SC/ST households, functional health deteriorated with repeated droughts when social capital was absent but remained stable when it was present, showing a clear protective effect. In the richest tertile, however, there was little evidence of deterioration to begin with, leaving no scope for social capital to demonstrate additional benefits. This pattern suggests that resilience among the wealthiest may primarily rely on material resources, making it challenging to determine whether social capital enhanced resilience in privileged groups. Taken together, these findings would suggest that disadvantaged groups often rely more heavily on social capital to achieve similar outcomes, while privileged groups derive resilience largely from economic and structural advantages.

Declarations

Author Contribution

N.D wrote the main manuscript text, and prepared the figures.

Data Availability

The datasets used for analysis are available for public use at the Inter-university Consortium for Political and Social Research (ICPSR).Wave 1: India Human Development Survey (IHDS), 2005 (ICPSR 22626)Desai, Sonalde, Vanneman, Reeve, and National Council of Applied Economic Research, New Delhi. India Human Development Survey (IHDS), 2005. Inter-university Consortium for Political and Social Research [distributor], 2018-08-08. https://doi.org/10.3886/ICPSR22626.v12Wave 2: India Human Development Survey-II (IHDS-II), 2011-12 (ICPSR 36151)Desai, Sonalde, and Vanneman, Reeve. India Human Development Survey-II (IHDS-II), 2011-12. Inter-university Consortium for Political and Social Research [distributor], 2018-08-08. https://doi.org/10.3886/ICPSR36151.v6

Funding Declaration:

None.

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