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Does coal mining affect household food security? An empirical study of Dhanbad, India

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Abstract

Background: Mining industries have enormous potential to improve food shortage by providing employment opportunities in its mining vicinity. But, simultaneously, these areas also suffer from 'resource curse' due to detrimental effects of mining. Hence, this study examined the effects of coal mining on household food availability and food access among proximate population residing in resource-rich but economically backward mining region of Dhanbad district, Jharkhand, India. The primary data was collected from two compare groups, viz. households from exposed versus non-exposed villages of mining effect under the cross-sectional research design using structured questionnaire between September, 2014, and February, 2015. Both bivariate and multivariate statistics were used to assess the study objectives.

Results: Finding shows that households from non-mines affected villages were at 40% higher risk of food shortage than household from mines affected villages. Furthermore, odds ratio shows that rise in percentage of expenditure on food also increases the food shortage vulnerability. Female-headed households, below poverty line households and MNREGA card holders households were significantly positively related to food shortage. In contrast, households with membership of any socio-political organization and more than 2 acres of farmland were significant negatively associated with food shortage. Procurement of food on credit from ration shops was found to be a predominant strategies to cope with food shortage, followed by borrowing food from neighbours and relatives.

Conclusion: In nutshell, the study shows that households from non-mines affected villages were at high risk of food shortage. However, percentage expenditure on food indicator reveals that household from mines affected villages was comparatively more vulnerable to food shortage than its counterpart. The membership of any socio-political organization emerges as a main factor which reduces the risk of food shortage.

Keywords: Mining, Food availability, Food access, Food vulnerability, Coping strategies

Background

Access to food is one of the fundamental rights under article 25 of the 'Universal Declaration of Human Rights' [1]. Governments around the globe are continuously working in this direction and trying to increase the production of food. In spite of consistent global efforts to eradicate hunger, still it is pervasive in a large proportion of the population, and consequently, they suffer with the 'shortage of food'. In order to deal with food crisis, World Food Summit (WFS) was conducted in 1974 and during the discussion, the concept of food security was originated. This summit primarily focused on food supply, making availability and price stability of basic foodstuffs at the domestic and international levels, the cornerstones of food security [2]. Over the time, different agencies had also attempted to modify the definition of food security to cover the broader perspectives of food security. This concept got a comprehensive definition during the second World Food Summit (1996), later, it was redefined in the preceding 2002 summit, and concurrently, a forward step had also been taken in the direction to make 'right to food'. According to the 2002 definition, 'Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and

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food preferences for an active and healthy life [3].' This globally accepted definition comprises four dimensions of food security, namely availability of food, economic and physical access to food, utilization of food, and its stability over the time [2, 4].

In the context of global food crisis, United Nations (UN) had also taken a punitive action by making one of its primary objectives in the Millennium Development Goals to 'eradicate hunger and achieve food security' (MDGs, 1990). But due to this unfinished goal, UN again incorporated it into Sustainable Development Goals (SDGs, 2015). Hence, access to food for all (FFA) people around the year now becomes one of the prime goals for governments around the globe [5]. Estimates show that prevalence of the undernourished (PoU) population has declined over the period from 18.6% in 1990–1992 to 10.9% in 2014–2016 across the world [7]. Yet, one in every nine people around the world (821 million) was undernourished in 2017 [6]. Among the undernourished population, significant proportion (780 million) belongs to the developing countries that are not self-sufficient in food production. Besides, there are vast regional differences in the prevalence of the problems of hunger and malnourishment.

In the Indian context, around 15.2% population was undernourished during 2014–2016 while, this marked a significant decline of 36% from 1990–1992. But, the absolute number of malnourished persons has not dropped much (from 210.1 million to 194.6 million) during the last 25 years. This fact proved that India had failed to achieve the MDG as well as the WFS target to eradicate hunger by 2015. India is still home of the second-highest number of undernourished people in the world [7]. A recent report on hunger by International Food Policy Research Institute (IFPRI) [8] indicated that India ranked 97th out of 118 listed countries in the Global Hunger Index (GHI), behind Nepal, Sri Lanka, and Bangladesh. The current food security situation in India is an outcome of the slow and low level of inclusive economic growth caused by political and administrative recklessness [9]. Also, the benefits of rapid economic growth have not been translated into higher and equitable food consumption. Consequently, millions of people are dying of endemic hunger and starvation due to unequal access to food despite the availability of a sufficient buffer food stock in the country [10]. A previous study has shown that buffer stock of food grains considerably increased over time 1993 to 2011. Sometimes the availability of the said buffer stock is affected with the seasonality of food production. However, in spite of this phenomenon the country has always had optimal availability of food stock [11].

Nevertheless, there are several risk factors that independently influence the accessibility of food at the household or individual level unevenly [12] such as difficult geographical terrain, drought-proneness, dominance of mining activities, and to some extent lack of political and administrative determination. According to the hunger index of India, which has been calculated for the major states of the country, Jharkhand comes at second position while Madhya Pradesh stands first [13]. In Jharkhand, among different agricultural risk factors coal is most important particularly in its mining areas [14]. The coal extraction work causes, loss of productive layer of soil, vegetation, and underground water table which poses a negative effect on ecology [15]. Therefore, changes comes in the utility of land from agricultural to non-agricultural which finally hampers the availability of food [14, 16, 17]. Further, use and restoration of land for agriculture are not only very expensive but also very risky in terms of production benefits [13, 17, 18]. Although previous research confirms that mining industry increases the level of income by generating high wage job opportunities in the mining vicinity. So, the transfer of labour from agriculture to mining industries occurs which is the another cause of loss of agricultural production [17, 19, 20].

These food productions-related vulnerabilities motivated to conduct a coal mining risk-specific study in context of food availability to household. As such, this study has been carried out with the following objectives as to assess the prevalence of food shortage, to examine the level of food deprivation, and to understand the main factors of food shortage and its coping mechanism.

Results

Characteristics of the sample households

Table 1 shows that characteristics of the household heads in study area. It was found that approximately 50% household was headed by middle-age group (i.e., 36–55 years) peoples. The percentage of female household heads was almost half in the mines affected villages compared to non-mines affected villages. However, approximately 90% household was headed by males in the study villages. Almost 50% households in the study villages having 4–5 members household size followed by 6 or more members household size. The study area was dominated by Hindu population, and only 1.9% population belongs to Muslim community. The percentage of Muslim household was comparatively higher (2.4%) in mines affected villages than the non-mines affected villages. Overall, scheduled caste (SC) were the dominated social group followed by other backward caste (OBC) and other caste group in the both residential settings. Specifically, SC were more concentrated in non-mines affected villages, whereas OBC were more concentrated in mines affected villages. The scheduled tribe (ST) households were only one in mines

Table 1 Characteristics of sample households in the study villages of Dhanbad, India, 2015. *Source*: Fieldwork

	Villages not affected by mining activity		Villages affected by mining activity		Total	
	%	(*N*)	%	(*N*)	%	(*N*)
Household head age						
21–35 years	29.8	62	21.6	45	25.7	107
36–55 years	48.6	101	46.2	96	47.4	197
56–65 years	21.6	45	32.2	67	26.9	112
Household head sex						
Male	86.1	179	93.3	194	89.7	373
Female	13.9	29	6.7	14	10.3	43
Household size						
1–3 members	16.8	35	16.8	35	16.8	70
4–5 members	52.4	109	48.1	100	50.2	209
6 or more members	30.8	64	35.1	73	32.9	137
Religion						
Hindu	98.6	205	97.6	203	98.1	408
Muslim	1.4	3	2.4	5	1.9	8
Social group						
Scheduled tribes	7.2	15	0.5	1	3.9	16
Scheduled castes	47.6	99	33.2	69	40.4	168
Other backward castes	29.3	61	46.6	97	38	158
Other castes	15.9	33	19.7	41	17.8	74
Media exposure	52.9	110	62.5	130	57.7	240
BPL card possession	6.3	13	5.8	12	6.0	25
MGNERGA card possession	30.8	64	28.9	60	29.8	124
Household head occupation						
Not working	17.8	37	24.0	50	20.9	87
Regular salaried jobs	18.3	38	22.1	46	20.2	84
Self-employed jobs	7.7	16	19.2	40	13.5	56
Agriculture and Wage labour jobs	56.3	117	34.6	72	45.4	189
MPCE						
Low	31.7	66	35.1	73	33.4	139
Medium	37	77	29.8	62	33.4	138
High	31.3	65	35.1	73	33.1	138
Total (*N*)	100	208	100	208	100	416
Mean year of schooling (± SD)	6.9 (± 5.2)		6.2 (± 4.5)		6.5 (± 4.9)	

N total household sample, ± *SD* standard deviation

affected villages, whereas in the non-mines affected villages, it was 15. Household heads having media exposure were almost 10% higher in mines affected villages compared to its counterpart. The percentage possession of below poverty line (BPL) card was slightly less in households from mines affected villages compared to its counterpart. Similarly, percentage possession of MGNERGA card was slightly less in the households from mines affected villages compared to its counterpart. The percentage of agriculture- and wage labour-related household were 35% in mines affected villages and 56% in non-mines affected villages, respectively. The more percentage of households from mine affected villages belong to higher monthly per capita expenditure (MPCE) category than the non-mines affected village.

Scenario of food shortage in the study villages

Table 2 shows the self-reported food shortage scenario of the households. The households reporting to have three square meals in a day in the mines affected villages was around 96%, whereas in non-mines affected villages, it was only 90%. It means that most of the households

Table 2 Prevalence of household's food accessibility, food shortage and mean days of food shortage by village type (30 days preceding the date of survey), Dhanbad, Jharkhand, 2015. *Source*: Fieldwork

	Villages not affected by mining activity	Villages affected by mining activity	Total
Food accessibility			
Two square meals a day	9.1	3.8	6.5
Three square meals a day	90.9	96.1	93.5
Prevalence of Food shortage	51.9	39.4	45.7
Mean days of food shortage [± S.D]	5.1 [± 3.3]	7.4 [± 4.9]	6.1 [± 4.2]
N	208	208	416

N total household sample, *SD* standard deviation

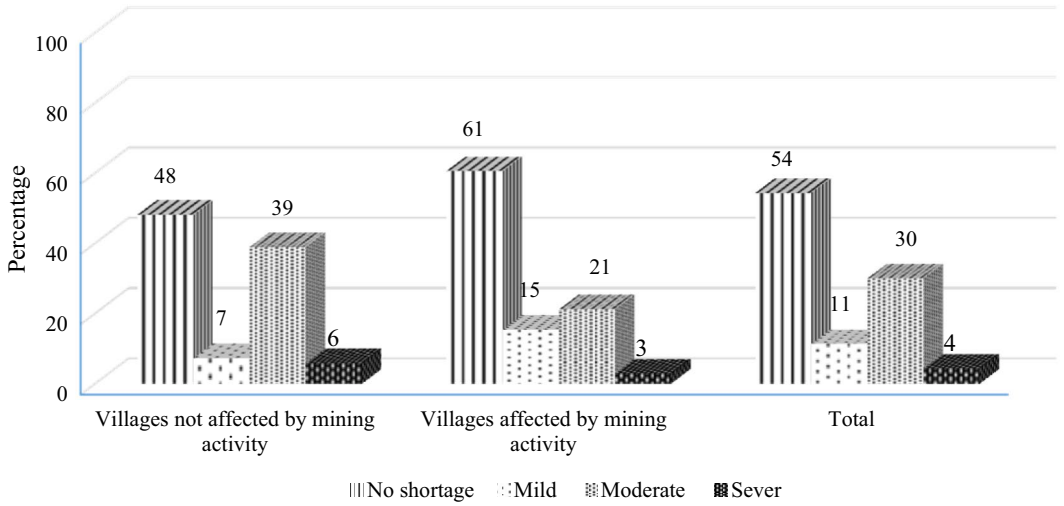

Fig. 1 Prevalence of different levels of food shortage among households by village type in Dhanbad, Jharkhand, 2015 (30 days preceding the date of survey)

who had only two square of food belong to non-mines affected villages. The prevalence of food shortage among household was 39% in mines affected villages and 52% in non-mines affected villages, respectively. Overall, the prevalence of food shortage in study area was around 46%. The mean (SD ±) days of food shortage of household was 7 days (± 4.9) in the mines affected villages and 5 days (± 3.3) in the non-mines affected villages.

Figure 1 shows the prevalence of food shortage of different levels among households. It was found that around 11% less household from mines affected villages suffered with food shortage, but at the same time here, comparatively 8% more households suffered with mild food shortage too than its counterpart. In case of moderate and sever food shortage, households from mines affected villages suffer less by 18% and 3%, respectively, compared to non-mines affected villages.

Prevalence of household's food shortage by background characteristics

Table 3 shows the patterns of prevalence of household's food shortage by selected background characteristics and village type. The female-headed household from both residential settings faces more food shortage than male counterpart, and the food shortage prevalence gap between male- and female-specific household was 20% for non-mines affected villages and 19% for mines affected villages, respectively. However, by the comparison between both residential settings, female-headed household of the mines affected villages suffer 12% lesser than the female-headed household of the non-mines affected villages. Household heads of 21–34 age group suffered more with food shortage than the rest age group household heads, followed by older heads in both the residential settings. However, in general households from mines affected villages less suffer with food shortage than households of non-mines affected villages. Households

Table 3 Prevalence of food insecure households by selected household characteristics and villages status, Dhanbad, Jharkhand 2015. *Source*: Fieldwork

	Villages not affected by mining activity	Villages affected by mining activity	Total
Sex of household head			
Male	49.2	38.1	43.4
Female	69.0	57.1	65.1
Age of the household head			
21–34 years	66.7	53.3	61.3
35–54 years	46.8	39.2	43.1
55 or more years	50.0	34.2	40.8
Household size			
1–3 members	45.7	40.0	42.9
4–5 members	45.9	47.0	46.4
6 or more members	65.6	28.8	46.0
Caste group			
SCs/STs	59.7	37.1	51.1
OBCs	52.5	39.2	44.3
Forward castes	24.2	43.9	35.1
Schooling of the household head			
No schooling	67.7	46.4	57.6
1–9 years	59.2	45.6	51.6
10 + years	32.0	24.2	28.5
Farmland			
No land	58.7	46.9	51.1
Less than 2 acres	56.9	31.6	48.6
More than 2 acres	17.2	29.0	23.9
BPL	84.6	50.0	68.0
MGNERGA	67.2	51.7	59.7
Total (*N*)	51.9 (108)	39.4 (82)	45.7 (190)

from mines affected villages having six or more members suffered with food shortage almost 37% lesser than corresponding category of villages not affected by mining activity. The SC/ST households from mines affected villages faces almost 23% less food shortage than SC/ST households from counterpart villages. Further, forward caste households from the mines affected villages reported approximately 20% higher food shortage than forward cast households from the non-mines affected villages. High education was seen to play a decisive role in the reduction of food shortage. The increase in years of schooling of household head shows a gradual reduction in food shortage in the both residential settings. Hence, it was found that absolutely 50% decline was recorded in food shortage from no schooling to 10 or more years of schooling in both residential settings. The household of 10 or more year schooled head from mines affected villages reported 8% less food shortage than household of 10 or more years schooled head from counterpart residential setting. Farmland is the assurance of food sufficiency, as it was observed that with the increase in its size, the percentage of households that reported food shortages reduced sharply in the both residential settings. However, households having no land and less than 2 acres of land had reported lesser food shortage than the corresponding categories of households from non-mines affected villages. Those households who have more than two acres of land in the mines affected villages suffered 12% more food shortage than their counterpart's household of non-mines affected villages. The prevalence of BPL and MGNERGA possession among food insecure household was less in mines affected villages compared to non-mines affected villages.

Linkages of food shortage and livelihood capitals

The livelihood capabilities and assets (comprising various forms of livelihood capitals) represent the stock of resources available with a household based on which the household generates its income, meets its basic needs, manages risks, and copes with stresses and shocks. A more extensive asset base translates into greater livelihood opportunities, which prevents from food shortage and insecurity [21]. Table 4 reveals the pattern of household food shortage by high capital level and village type. It was found that those household who reported food shortage, overall, utilized a less percentage of economic capital, followed by physical capital, human capital, social capital, and natural capital. Further, it was observed that food insecure households from the mines affected villages were slightly less deprived to the use of the capitals (that is, social, economic, human, and physical capitals) than household from the non-mines affected villages. However, household which reported food shortage from the mines affected villages utilized 24% less natural capital compared to its counterparts. However, at the aggregate level utilization of capitals (that is, all kinds of capital), households from the mines affected villages faced significantly slightly less deprivation than those from the non-mines affected villages.

Linkages of household food shortage and percentage expenditure of food

Table 5 shows the percentage of households according to food expenditure-related vulnerability. As far as all households in both types of villages are concerned, the household expenditure on food is more or less similar except in the case of households that incur medium and high expenditure on food. There exists a difference of 4 percentage points between households in the non-mines affected and in the mines affected villages, with 4% less households in the mines affected villages incurring a

medium expenditure on food, and 4% more households in the mines affected villages incurring a high expenditure on food than their respective counterparts.

Nevertheless, the expenditure scenario among the households which reported food shortage in both residential settings is entirely different. The expenditure pattern shows a consistently sharp increase in the percentage expenditure on food among the households that reported food shortage from 17 to 39% from medium-to-very high expenditure ranges in the mines affected villages. By contrast, the percentage expenditure on food among those household who reported food shortage in the non-mines affected villages shows a gradual increase with fluctuation from one expenditure range to another.

In continuation of Table 5 which shows that those household who reported about food shortage spent a large share of their income on food. However, the negative value of *t* test [*t* test: −2.09**] shows that households from mines affected villages significantly spent more percentage of their earning on food compared to households from non-mines affected villages (Table 6).

The reason behind this is that mining has destroyed local agriculture and made native people dependent on buying food from the market. Moreover, the uncertain supply of food in this area is one of the major reasons of price fluctuations of food. It was also ascertained by the qualitative information from 'Gram Sabha president' (age 50 year) 'After opening of mines in this area, agricultural activity has gradually stopped because of its detrimental effects. Now, this area is dependent on imported food stuffs from non-mines affected area. Although household income has substantially increased by the multiplier effect of mining, at the same time household expenditure on food and other activities has also increased. Hence, poor were hardly able to save any money from their earning, and through it, they can only able to manage hand-to-mouth existence' (Table 6).

Determinants of food shortage

The binary logistics regression analysis was carried out in order to understand the factors affecting the household food shortage. The adjusted odd ratio shows that households from mines affected villages had significantly 37% ($p < 0.1$) less chance to affect with food shortage. The female-headed households (FHH) were significantly 3.8 times ($p < 0.01$) more likely to suffer with food shortage. The age of the household head was found to be main predictor of food shortage. Those household head who

Table 4 Households reported food shortage according to high index value of different livelihood capitals, Dhanbad, India, 2015. *Source*: Fieldwork

High index	Villages not affected by mining activity		Villages affected by mining activity		Total	
	%	[χ^2]	%	[χ^2]	%	[χ^2]
Natural capital	63.9	[11.9***]	40.2	[5.7**]	53.7	[21.1***]
Social capital	34.3	[2.1]	45.1	[3.7*]	39.0	[7.3***]
Economic capital	12.0	[32.4***]	13.4	[33.5***]	12.6	[67.8***]
Human capital	28.7	[13.7***]	30.5	[4.5**]	29.5	[16.6***]
Physical capital	18.5	[27.1***]	22.0	[47.1***]	20.0	[77.1***]
All capital	19.4	[29.7***]	18.3	[54.4***]	19.0	[85.8***]
N	108		82		190	

Livelihood capital indexes (High level + Low level = 100%), the high value means higher the utilization level and vice versa; level of significance: *p value < 0.1, **p value < 0.05, ***p value < 0.01; *N* total household sample

Table 5 Percentage household reported food shortage by expenditure on food and village type, Dhanbad, India, 2015

Percentage of household expenditure on food	Villages not affected by mining activity		Villages affected by mining activity		Total	
	All households	Food insecure households	All households	Food insecure households	All households	Food insecure households
< 50: Low	32.2	25.0	31.3	13.4	31.7	20.0
50–65: Medium	26.0	25.9	22.6	17.1	24.3	22.1
65–75: High	16.4	18.5	20.2	30.5	18.3	23.7
75 +: Very high	25.5	30.6	26.0	39.0	25.7	34.2
Total (*N*)	100 (208)	100 (108)	100 (208)	100 (82)	100 (416)	100 (190)

Table 6 Household's mean percentage of household expenditures on food among food insecure households by village status, Dhanbad, India, 2015 *Source*: Fieldwork

	N	Percentage expenditure on food	SD
Villages type	[*t* test: − 2.09**]		
Villages not affected by mining activity	108	62.19	18.88
Villages affected by mining activity	82	68.13	20.04
Total	190	64.75	19.56

Level of significance: *p value < 0.1, **p value < 0.05, ***p value < 0.01

belong to age group of 35–54 years have significantly 44% ($p < 0.1$) less chances of food shortage. It supposed that possession of BPL card supports the owner during a time of food shortage, but odds ratio reports that they had significantly 5.3 times ($p < 0.01$) more chance to face food shortage. The membership of any sociopolitical organization helps the household; therefore, there were significantly 74% ($p < 0.1$) less chance of food shortage. Households having a chronically ill patient reported significantly (40%) less chances of food shortage. The MNREGA scheme was initiated with the intention to support a poor or needy household by providing a job on demand. However, it was observed that households having a MNREGA card had significantly 2.3 times ($p < 0.001$) more chances of food shortage. The Agriculture and wage labour work activity related household had a significantly 2.5 times ($p < 0.05$) more chances of food shortage than other working categories household. The ownership of farmland is an assurance of food availability at household. Similarly, it was found that those households who had a more than 2 acres of land were significantly 53% ($p < 0.01$) less chance of food shortage. With the rising level of percentage expenditure on food, the chances of food shortage had increased significantly by 2.3 times ($p < 0.05$) and 2.8 times ($p < 0.01$) for those households whose expenditure was 65–75% and more than 75%, respectively (Table 7).

Coping strategies of households for food shortage

Table 8 reveals the strategies used by households to cope with food shortage. The most common strategy includes buying food on credit from private ration shops, followed by borrowing food from a neighbour, borrowing food from a relative, and skipping food. Around 10% more households in the mines affected villages depend upon buying food on credit from ration shops compared to their counterparts in the non-mines affected villages. On the other hand, households from the mines affected villages depend less upon borrowing food from neighbours, followed by relatives' 6% and 3%, respectively, compared to non-mines affected villages. The percentage of households used to skip food as a coping mechanism was comparatively lesser in the mines affected village than the non-mines affected villages.

Table 7 Adjusted odds ratio for food shortage in household by background characteristics, Dhanbad, India, 2015 ($N = 416$) *Source*: Fieldwork

	OR	[95% C.I]	
Village type			
Villages not affected by mining activity®			
Villages affected by mining activity	0.637*	[0.376	1.08]
Sex of household head			
Male®			
Female	3.893***	[1.495	10.141]
Age of household head			
21–34 years®			
35–54 years	0.563*	[0.293	1.081]
55 or more years	0.898	[0.388	2.077]
BPL card possession			
No®			
Yes	5.334***	[2.809	10.128]
Membership of any socio/political organization			
No®			
Yes	0.262***	[0.143	0.482]
Any chronic disease patient in household			
No®			
Yes	0.599*	[0.350	1.025]
MNREGA card possession			
No®			
Yes	2.372***	[1.382	4.074]
Working status of head of household			
Not working®			
Salaried/business	1.48	[0.641	3.416]
Agriculture and wage labour	2.598**	[1.167	5.783]
Farmland			
No land®			
Less than 2 acres	0.769	[0.450	1.315]
More than 2 acres	0.475*	[0.218	1.031]
Percentage of household expenditure on food			
< 50: Low®			
50–65: Medium	1.248	[0.646	2.410]
65–75: High	2.366**	[1.148	4.874]
75 +: Very high	2.872***	[1.477	5.586]
Log likelihood	− 217.068		

Level of significance: *p value < 0.1, **p value < 0.05, ***p value < 0.01; ®Reference category; predictor variables such as caste, years of schooling of household head, and household size are also controlled for logistic regression

Discussion

The present study tried to make a comprehensive assessment of food shortage status of households in the villages affected and not affected by mining activities. The findings of the study show a sharp difference in the food

shortage status between both the residential settings. Households from the mines affected villages suffer less with food shortage, and the percentage of households affected with food shortage for severely and moderately category are comparatively less than the non-mines affected villages. The odds ratio suggests that households from the mines affected villages were significantly (37%) less risk of food shortage compared to their non-mines affected counterparts. However, the mean days of food shortage for households were slightly more in the mines affected villages.

The empirical evidence shows that mining activities increase the household disposable income through different channels by compromising the local agriculture production system in the mines vicinity, which directly inflates the household expenditure on food consumption [22]. This direct income-expenditure function in the mining areas adversely affects the food purchasing ability of household at inflated price in non-mines affected area. Moreover, it may create hindrance to the access of sufficient food in reach of the poor [23]. Further, odds ratio of percentage of household expenditure on food indicates that poor households were more penalized by the rising of food price than the richest households. They have not only to spend more than three-fifth of their income on food but also has a significantly more than twice risk of food shortage [24]. Consequently, non-mines affected villages were considered as more vulnerable with consistent food shortage.

The demographic characteristics of the household head were seen to play a significant role in determining household food shortage. Findings show that female-headed households (FHH) face more than three times food shortage than male-headed households. Previous literature indicates that female-headed households (FHH) are usually poor due to income earning disparities. Moreover, they have an additional burden of household chores and higher family liabilities, which consume their main working hours [25]. They also have a low level of social capital, which prevents the household from food shortage [26]. The present study shows the inverse relation between increasing age of household head with household food shortage. These findings have been found consistent with another study conducted in West Bengal [27]. Despite households being headed by salaried or business working heads, insignificant odds ratio shows no assurance about food sufficiency; besides, odds ratio value of agriculture and wage labour shows significant twice risk of food shortage in comparison with the non-working households. The food shortage for non-working households head can be explained on account of their complete dependency on remittances or family support for their feeding [28]. The integrative support of any socio-political organization gives a continuous support to the household [29]. Hence, member households of such organizations have a 64% less risk of food shortage. The household possession of BPL and MNREGA card is highly associated with food shortage. The government of India, on the one hand, tries to provide subsidy on food items to the poor households through the BPL card initiative, and on the other hand, it tries to help unemployed need person by giving opportunity to earn income from MNREGA program. However, empirical evidence shows that both government programs have malfunctioned and failed to provide desired outcomes [30]. Interestingly, the present study found that households having a patient suffering with chronic disease had 40% less risk of food shortage. Typically, empirical evidence shows the positive relationship between chronic disease and household food shortage; however, the present study found a contrary relationship. There could be three probable reasons for this: first, most of the households could have belonged to the affluent economic class. Secondly, these households could have been getting government subsidies on treatment. Thirdly, food shortage is positively associated with only a few chronic diseases [31, 32]. Increasing level of land holding significantly minimizes the risk of food shortage for household. A previous studies also support this positive relationship [33].

The most common strategy to cope with food shortage was buying food on credit from the ration shop in the mining region. This finding is consistent with evidence reported in previous studies on household prime coping strategies [34–36]. Borrowing food from relatives or friends and skipping meals on that particular day were the other coping strategies against food shortage [27, 37].

Conclusion

In nutshell, the study shows that household in non-mines affected villages was at high risk of food shortage than mines affected villages. Although spending a larger share of household income on food items, non-mines affected household could not able to eliminate the problem of food shortage. Additionally, food shortage has been seen severe among female-headed household, household with below poverty line (BPL), and MNREGA card hold holders' households. Moreover, the positive sign of food availability has been seen among household with membership of any sociopolitical organization, and having farmland more than two acres. Prominently, it is found that procurement of food on credit from ration shop was major strategy to cope with food shortage. Household also borrow from neighbours and relatives in the time of need to cope with food shortage.

Table 8 Percentage of household suffer with food shortage by their coping strategies and village type, Dhanbad, India, 2015 *Source*: Data collected by author

	Villages not affected by mining activity	Villages affected by mining activity	Total
Coping strategy for food shortage			
Borrow food from relative	8.3	4.9	6.8
Borrow food from neighbour	37.9	31.7	35.3
Buying food items on credit from ration shop	49.0	59.8	53.7
Skip meals	4.6	3.7	4.2
Total (*N*)	100 (108)	100 (82)	100 (190)

N total household sample

Limitations of the study

A weak monsoon, resulting in less rain, during the 2 years preceding the survey may have resulted in over-reporting of food shortage in study area. Besides, the household monthly expenditure on food as over-reported by the heads of the households is another possible limitation of this study.

Methods

Study setting and study location

The study was conducted in the Baghmara block of the Dhanbad district (known as 'the coal capital of India') of Jharkhand, India. It is the only block of the Dhanbad district where approximately half (33 out of 71) of the panchayats have coal-bearing capacity and have coal mines, which are mainly operated by Bharat Coking Coal Limited (BCCL). This geographical variation in the location of mines within the block provided us opportunity to conduct a cross-sectional comparative study. In addition, the demographic and socio-economic characteristics of this block as per Census of India (2011) show that out of the total population 334,309, as much as 33.4% people live in the urban areas. The majority of its population is composed of Hindus (87.5%), followed by Muslims (10.6%). The caste composition of this block shows that 26% of the population belongs to the SCs/STs community. The working-age population is nearly 39.5%, while the remaining population is composed of the dependent population in the age groups of 0–15 and 60 + years.

Sample group

The targeted population for this study consisted households from villages affected by mining activities and villages not affected by mining activity. The households from mines affected villages were selected by using multilevel sampling technique. In the first stage, whereby we obtained a list of 34 villages which were affected by the mining activity of BCCL from initiation year of mines to the year 2015. Thereafter, we matched obtained villages list with the village-level information from the Census of India (2011) to know the present status of the villages. The matching exercise revealed that only 20 out of 34 villages presently exist; the remaining villages were either become extinct or converted from villages to towns. The existing 20 villages were then categorized according to the mining activity as: open-cast mining (5), underground mining activity (12), and discontinued mining (3). According to purpose of this study, we selected only open-cast mining and underground mines affected villages. From these two categories, we choose two villages each (that is, four mines affected villages) by using the probability proportional to size (PPS) sampling technique.

As the comparative nature of this study, hence, we further selected four villages not affected by the mining activity based on two criteria: firstly, the villages should be located at least 5 km (aerial distance) away from coal mines. Secondly, the villages should have an approximately similar proportion of scheduled caste (SCs) population corresponding to the selected mines affected villages for the study.

After the selection of 8 villages, the quota of 52 households was fixed for interview from each village with the help of systematic random sampling (that is, the total number of the households in the village divided by the total number of the desired household sample) from the sampling frame of a village. In this way, the study collected complete data from 416 households (see the flow chart below). This total sample size has been drawn by the study to fulfil the desired quota of the sample because of two reasons. Firstly, this study is not only dealing with the estimation of prevalence rate. Secondly, while pretesting of study scheduled it was observed that fixed sample size this study is enough to achieve aforesaid objectives in the context of time and money constraint.

Hierarchical flow chart for sample selection

Selection	Study area	Criteria/rationale
State	Jharkhand	State affected profoundly by coal mining activities in the country
District	Dhanbad	Known as the coal capital of India due to the highest production of coal
Block	Baghmara	Nearly one-half panchayats of the block have the coal-bearing capacity
Village	Four mines affected villages	Two affected villages each from the underground and open-cast mining categories
	Four non-mines affected villages	Selected corresponding to mines affected villages based on the criteria of distance from coal mines and proportion of SC population
Household	52 HH/village	Systematic random sampling based on a sampling frame

Total sample size 416

Data collection

To achieve the study objectives the concurrent mixed method of data collection were opted with a belief that this research strategy comprehensively assesses the all research questions. The data collection exercise were conducted during the period of September 2014 to February 2015. For the collection of quantitative data related to availability and access of food, we formulated standard indicator with the motivation to 'Household Food Insecurity Access Scale (HFIAS)' developed by the Food and Nutrition Technical Assistant Project (FANTA). The adapted instrument was modified accordingly to suit the local conditions. The close-ended questions were translated from English into Hindi. The following four elements were probed from each household:

- How many times a day does the household have food?
- Has the household faced or experienced a food shortage in the last 30 days?
- For how many days in the last 30 days did the household face food shortage?
- How does the household manage the food shortage problem?

The survey instrument was pretested with 30 household samples to check the suitability of the tool. After necessary modifications during the primary survey, all the questionnaires and data forms were reviewed by the researcher for accuracy, consistency, and completeness, and, where necessary, the researcher made additional field visits to clarify data entries. After the completion of the fieldwork and the necessary data checks to ensure data quality, the data were entered in the CSPro 6.2 (The Census and Survey Processing System) database, which has been developed and is supported by the U.S. Census Bureau and ICF Macro. The analysis of the data was done on Stata 13.1.

For the collection of qualitative information on different mining led issues, we did key informant interview (KIs) with different stakeholders (that is, BCCL officers, a local administrative officer, NGO workers, political leaders, school teachers, Rozgar Sevaks). In-depth interviews (IDIs) were conducted with all the four gram sabha presidents to know village-level problems. Besides, four focus group discussions (FGDs) were done with a pre-existing 5 to 8-member group of people of heterogeneous ages for better interaction in the mines affected villages using a pre-structured interview schedule. All the standard guidelines of FGDs were duly followed. The collected qualitative information was coded and analyzed with the help of the Atlas.ti 5.0 software.

Methods

The study followed the livelihood approach for the analysis of the data. In the first step, bivariate analyses were carried out to estimate the magnitude of food shortage in both the residential settings (that is, villages affected and not affected by mining activity). The tri-variate analysis was conducted to see the pattern of food shortage socio-economic and demographic household characteristics. Next tri-variate analysis was done to see the food shortage vulnerability by percentage household expenditure on food. The *t* test was carried out to see the mean difference of percentage household expenditure on food between the two residential settings. The Chi-square test was carried out to see the relationship of the utilization of different livelihood capitals among both residential settings. The binary logistic regressions were carried out to identify significant determinants of household food shortage.

Definition of household food insecurity and its outcome indicator

In this study, household food insecurity was assessed using a short and modified version of HFIAS tool to measure availability and access of food to household. It is a basic domain of food security. Hence, study initially created four levels of dependent with the help of the interaction of aforementioned probed questions. The description of interaction has given below:

- Food sufficient = 3 meals a day + no food shortage in last 30 days
- Mild food shortage = 3 meals a day + struggle with food shortage for 1 to 7 days
- Moderate food shortage = 3 meals a day + struggle with food shortage for 7 or more days
- Sever food shortage = 2 meals a day + struggle with food shortage for 7 or more days

Further, among four level of dependent variable categorized into dichotomous form, 1 denotes the 'food shortage household' which comprises mild, moderate and severe categories of food shortage, whereas 0 denotes status of 'food sufficient household'.

Explanatory variables

The household background characteristics which influence the food security status of a household are as follows:

1. *Village type* This refers to whether a village is affected by mining activity or not.

2. *Economic capital* This is a composite index created by using principal component analysis (PCA) with the help of variables like per capita household income (that is, 0 = less than thirty thousand and 1 = more than and equal to thirty thousand) and household's ownership of insurance.
3. *Natural capital index* This is a composite index created by using principal component analysis with the help of variables like access to farmland, selling of forest product, and household use of forest product.
4. *Physical capital index* This is also a composite index created by using principal component analysis with the help of information on 26 household durable items like Pucca house structure, 4 or more rooms, liquid petroleum gas (LPG) connection, kitchen facility, and latrine facility.
5. *Social capital index* This is a composite index created by using principal component analysis with the help of variables like easy access to a member of legislative assembly (MLA), participation in sociopolitical gatherings, and membership of a socio/political organization.
6. *Human capital index* This is a composite index created using principal component analysis with the help of variables like schooling of head of household (that is, 0 = less than 10 years of schooling and 1 = 10 or more years of schooling), any member of household having at least 10 or more years of schooling, and vocational education training of head of household (that is, 0 = no training and 1 = ITI or other).
7. *All Capital Index (CI)* This is a composite index created by using principal component analysis with the help of information on the availability and accessibility of a household to livelihood capitals such as physical capital, economic capital, human capital, social capital, and natural capital.
8. *Percentage of expenditures on food* (Food shortage vulnerability index) This is a percentage of total household expenditures devoted to food over the reference period of 30 days. This indicator is created to assess the current economic vulnerability which affects the household expenditure on food. Smith and Subandoro [24] stated that poorest households in the world spend more than 75% of their income on food, whereas the richest households spend only less than half of their income on food. As such, food shortage vulnerability varies between these parameters in the following way: 75+: very high, 65–75: high, 50–65: medium, <50: low. The method to calculate this is given below:

$$\text{Percentage of expenditure on food} = \frac{\text{expenditure on food}}{\text{total expenditure}} \times 100$$

Abbreviations

HH: household; WFS: World Food Summit; MDGs: Millennium Development Goals; SDGs: Sustainable Development Goals; PoU: prevalence of the undernourishment; IFPRI: International Food Policy Research Institute; GHI: Global Hunger Index; SC: scheduled caste; OBC: other backward caste; ST: scheduled tribe; MPCE: monthly per capita expenditure; SD: standard deviation; BPL: below poverty line; MNREGA: Mahatma Gandhi National Rural Employment Gurantee Act; PDS: public distribution system; BCCL: Bharat Coking Coal Limited; PPS: probability proportional to size; HFIAS: Household Food Insecurity Access Scale; FANTA: Food and Nutrition Technical Assistant; CSPro: The Census and Survey Processing System; NGO: non-governmental organization; KIs: key informant interview; IDIs: in-depth interviews; FGDs: focus group discussions; PCA: principal component analysis; LPG: liquid petroleum gas; MLA: member of legislative assembly; FAO: Food and Agriculture Organization; FHH: female-headed households; FFA: food for all.

Authors' contributions

The AKY developed the questionnaire, collected the data, contributed in acquisition of data, concept and design of the paper, literature searches, statistical analysis of data, and wrote the manuscript. RBB contributes to enhance the questionnaire, concept and design of the paper, and critically revised the manuscript. VY contributes to improve the content and write up of the paper. All the authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Availability of data and material

Data will not be shared in order to protect the participant's identities.

Consent for publication

Not applicable.

Ethical approval

The study was conducted with the approval of the Students Research Ethics Committee (SREC) of the International Institute for Population Sciences (IIPS), Mumbai, India. The ethics committee examined the methodological, technical, and ethical soundness of the study. In addition, before conducting the interviews, we obtained the informed consent of all the participants and assured them of confidentiality.

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