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Rural child health in India: the persistent nature of deprivation, undernutrition and the 2030 Agenda

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Abstract
The 2030 Agenda for sustainable development was launched to achieve Sustainable Development Goals (SDGs) across the globe. This paper is based on the primary database to assess the nutritional status of 5–10 years children and the incidence of deprivation in their households of a backward district (Purulia), India in the context of the first two SDGs, *e.g.,* no poverty and zero hunger. We conclude that around 74% of children are undernourished. The proportion of households multidimensionally deprived is 90%, and the majority of them live on less than $1.25 a day. Results reveal that the BMI of mother and the education of father are the two most statistically significant predictors of child malnutrition. Purulia has long been witnessing the persistent nature of deprivation, which is well reflected in the child's health. The district is quite far from the national targets in achieving the SDGs. Government, private sector, and civil society must come together to accelerate the progress of SDGs.

Keywords Child health · Undernutrition · Multidimensional deprivation · Poverty · Sustainable development goals

1 Introduction

The Global Hunger Index (GHI) of 2020 reveals that India ranks 94th (*'serious'* condition as per GHI score) out of 107 countries of the world based on the four indicators, such as undernourishment, wasting, stunting and mortality rate of under 5 years children; and India is much behind than Sri Lanka (64th), Nepal (73rd), Bangladesh (75th), Myanmar

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(78th) and Pakistan (88th), while the global average of hunger in terms of GHI is assessed as *'moderate'* level. Globally, there are 690 million people are found to be undernourished (Global Hunger Index, 2020). In the case of under 5 years children, around 144 million (21.30%) and 47 million (6.90%) children suffer from stunting (prolonged malnutrition) and wasting (acute malnutrition), respectively, where India records the highest prevalence of wasted children in the world (Global Hunger Index, 2020; UNICEF et al., 2020). There were 149 million (21.90%) stunted and 49 million (7.30%) wasted children in 2018, and a declining global trend is observed for both cases. It was reported that Asia was the home to the highest number of wasted (68%) and stunted (55%) children under 5 years of age in the world in 2018 (UNICEF et al., 2019). Around 5.3 million children died in 2018 before completing their fifth birthday, in several cases as a result of severe undernutrition (Global Hunger Index, 2020). The Human Development Report (HDR), 2020 of the United Nations Development Programme (UNDP) unveils that the average Human Development Index (HDI) of the world is 0.737 and belongs to the *'high human development'* category, while India slips two steps down from its earlier position and belongs to *'medium human development'* category with the rank of 131st (0.645) out of 189 countries. These statistics indicate the incidence of poverty, hunger, and malnutrition mainly in developing countries of the world (UNDP, 2020a).

Several global, national, and regional organizations set up several goals at different times to eradicate different types of inequalities and deprivations from the world. The 'Millennium Development Goals' (MDGs) of the United Nations (UN) came into being in September 2000 with 8 goals for the world to be achieved by the year 2015. All the signed nations agreed and committed to fighting against poverty and hunger, illiteracy, gender inequality, child mortality, poor maternal health, diseases, environmental degradation, and developing global partnership for development (Binagwahoet al., 2011; Manyike et al., 2014; Pomati & Nandy, 2019). This initiative yielded success by rescuing millions of people from the paw of severe poverty and hunger, illiteracy, diseases, and other unpleasant situations, but the work was not completed within the time frame of 15 years. Thus, the 2030 Agenda came up with 17 'Sustainable Development Goals' (SDGs) to be achieved by 2030. Among those goals of SDGs, no poverty and zero hunger are mainly common between MDGs and SDGs (Abbott & Bernstein, 2015; Blanc, 2015; Pomati & Nandy, 2019).

In the case of India, the National Family Health Survey (NFHS-4) of 2017 reveals that the proportion of stunted, wasted, and underweight children under 5 years was 38.40%, 21%, and 35.80%, respectively, while the child mortality rate was 50 per thousand live births. Only the percentage of wasted children increased in NFHS-4 (2021) compared to NFHS-3 (19.80%) of 2005-06. In the case of West Bengal (a state of India), under 5 stunted, wasted, and underweight children were 32.50%, 20.30%, and 31.60%, respectively. Here, also the percentage of wasted children is higher than the NFHS-3. The under 5 child mortality rate was found to be 32 for West Bengal, while it was 38 for rural Bengal (IIPS, 2017). It is quite clear from NFHS reports that the phenomenon of undernutrition is very much prevalent in India, and West Bengal is no exception (IIPS, 2017, 2021).

It is observed from NFHS-3 and NFHS-4 reports that the scenario of child malnutrition in West Bengal is lower than the national average, but the prevalence of malnutrition is not evenly distributed across the districts of the state (IIPS, 2017, 2021). Moreover, there are different studies done considering the role of bio-demographic factors in the prevalence of child malnutrition across the country (Kanjilal et al., 2010; Bisai et al., 2014; Panigrahi & Das, 2014; Amruth et al., 2015; Rengma et al., 2016; Ansuya et al., 2018; Roy et al., 2018; De & Chattopadhyay, 2019; Agarwal et al., 2021). In the present research

work, Purulia, one of the poorest districts in terms of Gender Development Index (GDI) and HDI (Government of West Bengal, 2004), and Multidimensional Poverty Index (MPI) in West Bengal (National Institute for Transforming India [NITI] Aayog, 2021a), has been considered to study the prevalence of child malnutrition (Fig. 1). The proportion of rural populations in the district is 87.26%, which is quite high. The literacy rate of the district is 64.48%, whereas the female literacy rate is 50.52%. The majority of the working population (60.90%) is associated with agricultural activities (Government of West Bengal, 2014, 2015). Purulia has a long history of poverty and deprivation, and the majority of the people live a life of hand-to-mouth. The adverse geophysical conditions directly impact their socioeconomic status (Ghosh et al., 2021; Mandal & Ghosh, 2019; Mandal et al., 2017, 2018a; Roy & Jana, 2019). National and international organizations assess child malnutrition, mainly for under 5 years (UNICEF et al., 2016, 2018, 2019, 2020; IIPS, 2017, 2021). So, we can access the data and observe the status of this age group. But the condition of other age groups also needs to be discovered. There are several works conducted in the Purulia district to assess the nutritional level of children of a specific community or age group, and no such significant work was carried out on a large scale taking into account the bio-demographic and socio-economic perspectives of children and their households (Chowdhury et al., 2008; Dasgupta and Chattopadhyay 2008; Bose and Das, 2009; Chowdhury et al., 2010; De & Chattopadhyay, 2019; Mandal et al., 2017; Mandal & Ghosh, 2019; Ghosh et al., 2021; Mandal, 2021). It is already documented that Purulia is tangled with poverty for decades (Government of West Bengal, 2004; IIPS, 2017, 2021; NITI Aayog, 2021a), but the incidence of undernutrition is not studied well in the context of poverty in the district. The present study attempts to assess the incidence of child malnutrition of 5 to 10 years of the district in terms of bio-demographic and socio-economic perspectives. It will help out to document new data and information on child malnutrition and its possible

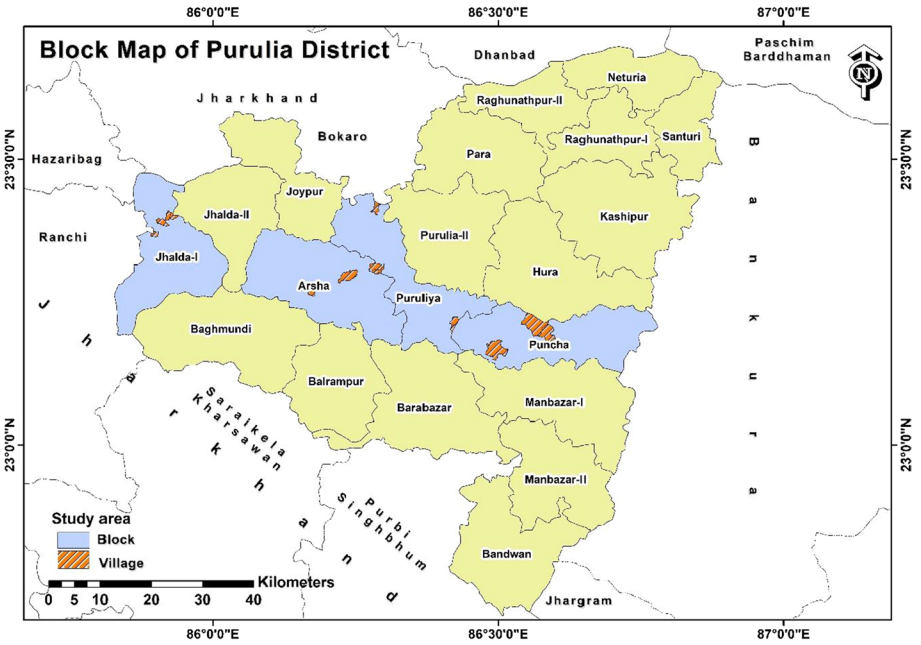

Fig. 1 Location map of the study area

responsible factors. This study also seeks to perceive the status of the first two goals of SDGs (1. End of poverty in all forms, and 2. Zero hunger). All the countries of the world are committed to achieving success in obtaining SDGs within the stipulated time frame, thus, monitoring and frequent assessment are required in this respect. The Government of India has consistently been trying to obtain SDGs (NITI Aayog, 2021b), but it is also important to know how far the SDGs are successful at the regional level. Based on the story of the success and impediment of SDGs in the context of Purulia, more suitable policies may be adopted to reduce the incidence of poverty and malnutrition in the district to achieve the 2030 Agenda.

2 Materials and methods

2.1 Purulia and its persistent nature of deprivation and undernutrition

The story of deprivation and misery of the people of Purulia can well be traced from the book entitled *'A Statistical Account of Bengal'* long before the independence of India, written by W.W. Hunter and published in 1877. The poor peasants were deprived by the *Zamindars*, *Mahajans*, village rice-merchant, and money lenders. Thus, poverty was an integral part of their life (Hunter, 1877). During the British reign, the people of Purulia also experienced deprivation and not received the facility of basic needs (Bhattacharya, 1986). After the independence, the increasing rate of population growth and the constant pressure on agricultural lands, less chance of employability in other sectors, and low level of income keep the incidence of poverty almost constant. Ultimately the poor quality of life is experienced by the inhabitants, which is well reflected by the status of child malnutrition (Ghosh et al., 2021; Mandal, 2021; Mandal & Ghosh, 2019; Mandal et al., 2018a). Bagli and Tewari (2019) reveal that the incidence and extent of multidimensional poverty in the Purulia district are found to be much higher than the national average, whereas the breadth of poverty is seen as almost the same for the district in comparison with India. To date, Purulia is an agrarian society, and the majority of the people are associated with agricultural activities (Census of India, 2011). It is quite unfortunate that agriculture is still gambling on *Monsoon* in India (Ghosh et al., 2020a); and in the case of Purulia, poor soil quality, undulating hard rock terrain with a high degree of slope (Ghosh et al., 2020a, 2020b) and limited facility and access to irrigation (Government of West Bengal, 2015) impede the all-round the year agricultural production (Fig. 2). This situation clearly portrays the low-income status of the district, which ultimately impacts the livelihood pattern of people (Mandal, 2021; Mandal & Ghosh, 2019; Mandal et al., 2018a; Roy & Jana, 2019).

It is also reported by the NITI Aayog (2021a) that the Purulia district ranks first in MPI in the state of West Bengal. The report of NFHS-4 indicated the prevalence of stunting, wasting, and underweight was 45.50%, 34.60%, and 58.20%, respectively (IIPS, 2017). All these values, unfortunately, cross the critical value of public health significance of WHO, 1995 (WHO, 2010). The NFHS-4 report also indicated that around 47.50% of women in the district suffered from below-normal BMI. Pregnant and all women found to be anemic were 80.70% and 80%, respectively. Only 23.50% of mothers received full antenatal care in the district (IIPS, 2017). Only 3.60% of pregnant mothers took iron folic acid tablets for 180 days or more. The proportion of children, who were exclusively breastfed for six months after birth, was only 50.70%. It was revealed that 66.80% of children aged between 6 to 59 months were found to be anemic (IIPS, 2017). The distress condition of mothers

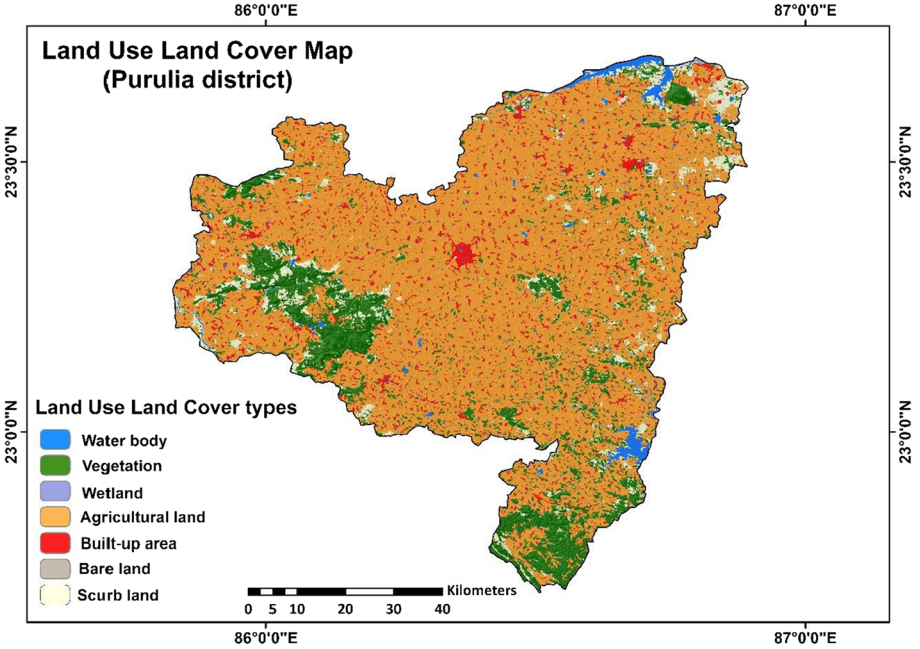

Fig. 2 Land use and land cover map of Purulia

and children is persistent and is related to place and its continuous journey through deprivation. A brief profile on malnutrition and socio-economic conditions of the district and the state of West Bengal is also presented in Table 1.

2.2 Data and anthropometric assessment

The study was carried out at 16 villages of Purulia district including 671 children aged 5 to 10 years from 504 households adopting a multi-stage sampling technique. Of the total sample size of children, the respective male and female children were 360 and 311. The study was conducted from January to April 2019. A pre-tested questionnaire was framed to collect data on socio-economic and bio-demographic parameters. Only the willing participants were included in the sample. Anthropometric techniques are the most widely popular and suitable instruments to determine the nutritional status of children (Government of India, 2013; UNICEF et al., 2016, 2018, 2019, 2020; Mandal & Ghosh, 2019; Ghosh et al., 2021). Measurements of height and weight and records of age were obtained for children and mothers to assess their nutritional status. In order to determine the type of undernutrition, stunting *(Height-for-Age Z-Score/HAZ)*, wasting (Body Mass Index *[BMI]-for-Age Z-Score/BAZ)*, and underweight *(Weight-for-Age Z-Score/WAZ)* were computed using 'WHO Anthro-Plus Software' following the 'World Health Organization Child Growth Standards, 2006' (de Onis et al., 2006; World Health Organization [WHO], 2010, 2018). Stunting is the short height of a child in terms of his/her age, and it negatively impacts physical and cognitive development. In contrast, wasting refers to the thinness of a child compared to his/her height. The risk of mortality is increased if the child is found to be moderately or severely wasted (UNICEF et al., 2020). When a child is unable to gain an

Table 1 Malnutrition and socio-economic profile of Purulia and West Bengal *Source:* National Family Health Survey- 1, 2, 3, 4, 5, Government of India, 1995, 2001, 2008, 2017, 2021; NITI Aayog, 2021a, 2021b

West Bengal													
NFHS report	Neonatal mortality rate	Post-neonatal mortality rate	Infant mortality rate	Child mortality rate	Under 5 mortality rate	HAZ (%)	WHZ (%)	WAZ (%)	HH with improved drinking water source (%)	HH with electricity (%)	HH with improved sanitation facility (%)	HH using clean cooking fuel (%)	MPI, 2021 (based on NFHS-4)
1 (1992–93) under 4 years	51.80	23.50	75.30	26.0	99.30	NA	NA	56.80	84.90	NA	NA	NA	0.097
2 (1998–99) under 3 years	31.90	16.80	48.70	19.90	67.60	41.50	13.60	48.70	89.30	36.70	NA	NA	
3 (2005–06) under 3 years	37.60	10.40	48.0	12.20	60.0	44.60	16.90	38.70	93.70	52.50	34.70	16.80	
4 (2015–16) under 5 years	22.0	NA	27.50	NA	31.80	32.50	20.30	31.60	94.60	93.70	50.90	27.80	
5 (2019–20) under 5 years	15.50	NA	22.0	NA	25.40	33.80	20.30	32.20	97.50	97.50	68.0	40.20	
Purulia													
4 (2015–16) under 5 years	NA	NA	NA	NA	NA	45.50	34.60	58.20	82.70	79.30	12.13	6.80	0.236

Table 1 (continued)

West Bengal													
NFHS report	Neonatal mortality rate	Post-neonatal mortality rate	Infant mortality rate	Child mortality rate	Under 5 mortality rate	HAZ (%)	WHZ (%)	WAZ (%)	HH with improved drinking water source (%)	HH with electricity (%)	HH with improved sanitation facility (%)	HH using clean cooking fuel (%)	MPI, 2021 (based on NFHS-4)
5 (2019–20) under 5 years	NA	NA	NA	NA	NA	36.90	29.40	46.30	87.60	88.60	29.20	23.20	

NA refers to not available

expected weight at a particular age is called underweight. The risk of death gets increased for severely underweight children (Government of India, 2013). To compute overall undernutrition, a Composite Index of Anthropometric Failure (CIAF) is constructed, introduced by Peter Svedberg in 2000, for this study following the specified methodology (Nandy & Svedberg, 2012).

2.3 Multidimensional deprivation index

To reveal the socio-economic status of the studied households, the Multidimensional Deprivation Index (MDI) is computed based on the basic methodology of MPI of UNDP (UNDP, 2020b). To compute the MDI, a number of socio-economic variables are taken into consideration (Table 2). All the parameters are given the same weight to keep the result simpler. To compute the MDI, the following equations are adopted, where *'H'* indicates headcount ratio, the proportion of households who are multidimensionally deprived; *'q'* refers to the number of multidimensionally deprived households; *'n'* depicts total sample households; *'A'* is the intensity of multidimensional deprivation; *'c'* denotes total deprivation of deprived households in respect to parameters; *'d'* is the total adopted parameters.

$$H = \frac{q}{n} \tag{1}$$

$$A = \frac{\sum_1^q c}{qd} \tag{2}$$

$$MDI = H \times A \tag{3}$$

2.4 Bio-demographic and socio-economic determinants of child malnutrition

The prevalence of malnutrition in children is closely associated with different bio-demographic and socio-economic factors. Specifically, the undernutrition scenario of children in underdeveloped and developing countries results from the vicious circle of poverty and disease (de Onis & Blossner, 1997; Mandal et al., 2017; Mandal & Ghosh, 2019; Ghosh et al., 2021). But in this globalized world of the twenty-first century, the incidence of undernutrition is experienced by a wide range of pockets across the globe (UNICEF et al., 2019). Several studies observed that the bio-demographic and socio-economic factors, such as BMI of mother, marriage age of mother, child birth weight, number of siblings, birth order, food intake, family income, education of parents, sanitation facility, source of drinking water, have a direct bearing in the prevalence of malnutrition of children (de Onis & Blossner, 1997; Cummins, 1998; Phillips, 2006; Kanjilal et al., 2010; Panigrahi & Das, 2014; Amruth et al., 2015; Rengma et al., 2016; Ansuya et al., 2018; De & Chattopadhyay, 2019; Islam & Biswas, 2020; Agarwal et al., 2021). In this present study, a total number of fifteen bio-demographic and socio-economic parameters are adopted as independent variables to find out the significant predictors of child malnutrition (Table 3). All these parameters are taken in view of the socio-economic and bio-demographic conditions of the district. The reports of NFHS & NITI Aayog (MPI) on socio-economic and bio-demographic conditions of Purulia clearly highlight the serious situation of the district, and most of the parameters of this

Table 2 Socio-economic profile of studied households. **Source**: Computed by authors based on primary database

Variables	Classes	District (HH-504)
Monthly family income (₹)	< 5 k	216 (42.86)
	5 k–10 k	219 (43.45)
	10 k–15 k	49 (9.72)
	15 k–20 k	9 (1.78)
	> 20 k	11 (2.19)
Education of father	Illiterate	133 (26.39)
	Primary	156 (30.95)
	Madhyamik	148 (29.36)
	Higher secondary	47 (9.32)
	Bachelor degree	18 (3.57)
	Master degree	2 (0.41)
Education of mother	Illiterate	171 (33.93)
	Primary	186 (36.90)
	Madhyamik	98 (19.45)
	Higher secondary	30 (6.55)
	Bachelor degree	15 (2.98)
	Master degree	1 (0.19)
Occupation of father	Agriculture labourer	167 (33.13)
	Government job	18 (3.57)
	Private job	21 (4.17)
	Daily labourer	246 (48.81)
	Business	84 (10.32)
Occupation of mother	Agriculture labourer	211 (41.86)
	Government job	1 (0.20)
	Private job	4 (0.79)
	Daily labourer	115 (22.82)
	Business	3 (0.59)
	House wife	170 (33.74)
House type	Kancha	362 (71.82)
	Pucca	142 (28.18)
Source of drinking water	Tube well	343 (68.05)
	Tap water	35 (6.90)
	Common well	121 (24.01)
	Dari	5 (0.99)
Source of light	Electricity	429 (85.12)
	Kerosene	75 (14.88)
Fuel used for cooking	Wood	426 (84.52)
	Coal	2 (0.39)
	Tree leaves	1 (0.20)
	LPG	74 (14.69)
	Kerosene	1 (0.20)
Toilet facility	Indoor pucca	49 (9.72)
	Indoor katcha	

Table 3 Summary of selected bio-demographic and socio-economic determinants of child malnutrition

Indicators	HAZ	BAZ	WAZ	CIAF
Mother BMI (kg/m^2)				
Underweight (< 18.5)	155 (47.40)	161 (49.24)	233 (71.25)	257 (78.59)
Normal (≥ 18.5 to 24.99)	128 (41.42)	133 (43.04)	195 (63.11)	225 (72.82)
Overweight/Obese (≥ 25)	8 (22.86)	6 (17.14)	11 (31.43)	14 (40.0)
Marriage age of mother				
< 18 year	155 (41.89)	163 (44.05)	233 (62.97)	265 (71.62)
≥ 18 year	136 (45.18)	137 (45.51)	206 (68.44)	231 (76.74)
Age of mother during birth				
Teen mother (≤ 19)	92 (43.40)	93 (43.87)	134 (63.21)	154 (72.64)
Normal (> 19)	199 (43.36)	207 (45.10)	305 (66.45)	342 (74.51)
Birth order				
1st	105 (42.34)	114 (45.97)	172 (69.35)	188 (75.81)
2nd	102 (41.63)	114 (46.53)	150 (61.22)	177 (72.24)
3rd & more	84 (47.19)	72 (40.45)	117 (65.73)	131 (73.60)
Child birth weight				
< 2.5 kg	60 (51.28)	60 (51.28)	84 (71.79)	94 (80.34)
≥ 2.5 kg	231 (41.70)	240 (43.32)	355 (64.08)	402 (72.56)
No. of siblings				
3 & more	152 (45.78)	143 (43.07)	214 (64.46)	241 (72.59)
2	124 (40.52)	142 (46.41)	202 (66.01)	230 (75.16)
1	15 (45.45)	15 (45.45)	23 (69.70)	25 (75.76)
Education of mother				
Illiterate	140 (48.44)	136 (47.06)	200 (69.20)	224 (77.51)
Literate	151 (39.53)	164 (42.93)	239 (62.57)	272 (71.20)
Education of father				
Illiterate	103 (58.19)	83 (46.89)	133 (75.14)	148 (83.62)
Literate	188 (38.06)	217 (43.93)	306 (61.94)	348 (70.45)
Family income				
BPL	113 (35.99)	154 (48.89)	207 (65.71)	227 (72.06)
APL	177 (49.72)	146 (41.01)	232 (65.17)	269 (75.56)
Occupation of mother				
Non-working	85 (44.97)	91 (48.15)	127 (67.20)	145 (76.72)
Working	206 (42.74)	209 (43.36)	312 (64.73)	351 (72.82)
Occupation of father				
Daily labour	258 (44.48)	262 (45.17)	384 (66.21)	433 (74.66)
Non labour	33 (36.26)	38 (41.76)	55 (60.44)	63 (69.23)
House type				
Katcha	236 (44.61)	224 (42.34)	342 (64.65)	386 (72.97)
Pakka	55 (38.73)	76 (53.52)	97 (68.31)	110 (77.46)
Sanitation type				
Non-scientific	268 (44.15)	271 (44.65)	396 (65.24)	448 (73.81)
Scientific	23 (35.94)	29 (45.31)	43 (67.19)	48 (75.0)
Drinking water				
Unsafe	35 (46.67)	27 (36.0)	44 (58.67)	51 (68.0)
Safe	256 (42.95)	273 (45.81)	395 (66.28)	445 (74.66)
ICDS food				
No	15 (31.25)	26 (54.17)	32 (66.67)	36 (75.0)
Yes	276 (44.30)	274 (43.98)	407 (65.31)	460 (73.84)

Values in parenthesis are in percentage

Table 4 Prevalence of child malnutrition based on height-for-age z-score (HAZ), body mass index-for-age z-score (BAZ), and weight-for-age z-score (WAZ). **Source**: Computed by authors based on the primary database

Category of malnutrition	Total prevalence (< 2 z-score)	Moderate (< -2 z-score to -3 ≤ z-score)	Severe (< -3 z-score)
Stunting/HAZ			
Total (671)	291 (43.37)	176 (26.33)	115 (17.14)
Male (360)	165 (45.83)	99 (27.50)	66 (18.33)
Female (311)	126 (40.51)	77 (24.76)	49 (15.75)
Wasting/BAZ			
Total (671)	300 (44.71)	177 (26.38)	123 (18.33)
Male (360)	156 (43.33)	82 (22.78)	74 (20.55)
Female (311)	144 (46.30)	95 (30.55)	49 (15.75)
Underweight/WAZ			
Total (671)	439 (65.42)	236 (35.17)	203 (30.25)
Male (360)	236 (65.55)	125 (34.72)	111 (30.83)
Female (311)	203 (65.27)	111 (35.69)	92 (29.58)

Values in parenthesis are in percentage

study are taken from those reports to make the present study more fruitful. Testing these variables may bring out the association of different independent variables with child malnutrition.

3 Results

3.1 Prevalence of stunting (HAZ scenario)

The prevalence of stunting is observed to be 43.37% among the children at the district level, of which male and female children are 45.83% and 40.51%, respectively. The cut-off value of WHO, 1995, for public health significance indicates *'very high prevalence (≥ 40%)'* of stunting among the children in the study area (WHO, 2010). Moderate stunting (26.23%) is more dominant than severe stunting (17.14%). Both the male (27.50%) and female (24.76%) children are more at risk of moderate stunting compared to severe stunting. The lowest incidence of stunting is noticed for the age group of 84 to 96 months (37.96%) followed by 60 to 72 months (41.67%) and 96 to 108 months (41.96%), while 72 to 84 and 108 to 120 months age groups experience stunting 46.83% and 50.96%, respectively (Table 4).

3.2 Prevalence of wasting (BAZ scenario)

The proportion of wasted children in the study area is 44.71%, of which male and female children are 43.33% and 46.30%, respectively. The share of wasted children is observed to be very high compared to the cut-off value for public health significance, i.e.,

Table 5 Sex-wise composite index of anthropometric failure of children. **Source**: Computed by the authors based on the primary database

Category	Total	Male children	Female children
Normal	176 (26.23)	91 (25.28)	85 (27.33)
Undernutrition (CIAF)			
Stunting	33 (4.92)	16 (4.44)	17 (5.47)
Wasting	26 (3.87)	15 (4.17)	11 (3.54)
Underweight	21 (3.13)	13 (3.61)	8 (2.57)
Stunting & wasting	0 (0.0)	0 (0.0)	0 (0.0)
Stunting & underweight	143 (21.31)	84 (23.33)	59 (18.97)
Wasting & underweight	153 (22.80)	77 (21.39)	76 (24.44)
Stunting, wasting & underweight	119 (17.74)	64 (17.78)	55 (17.68)
Total undernourished children	495 (73.77)	269 (74.72)	226 (72.67)
Total	671 (100)	360 (100)	311 (100)

Values in parenthesis are in percentage

'critical (≥15%)' of WHO, 1995 (WHO, 2010). Severe wasting (18.33%) is less prevalent than moderate wasting (26.38%). Female children are more at risk of moderate wasting compared to severe wasting, while male children experience almost equally moderate and severe wasting. The proportion of wasted children is found to be lowest in 108 to 120 months (38.46%), and the remaining age groups endure wasting between 43 and 48% (Table 4).

3.3 Prevalence of underweight (WAZ scenario)

The underweight is more prevalent among the children of the study area compared to stunting and wasting. The total proportion of underweight children is 65.42%, of which male and female children are 65.55% and 65.27%, respectively. The prevalence of underweight children is found to be *'very high prevalence (≥30%)'* as per the cut-off value of WHO, 1995 (WHO, 2010). Moderate underweight (35.17%) is more prevalent than severe underweight (30.25%) for both sexes. It is found that the prevalence of underweight is high among all age groups, and it ranges from 63 to 67% (Table 4).

3.4 Composite index of anthropometric failure

The overall undernutrition or CIAF of children is observed to be 73.77%. The proportion of male and female children is 74.72% and 72.67%, respectively. The category of wasting & underweight (22.80%); stunting & underweight (21.31%); and stunting, wasting & underweight (17.74%) mainly dominates the event of undernutrition among the children. The male children experience a high rate of stunting & underweight (23.33%) followed by wasting & underweight (21.39%); and stunting, wasting & underweight (17.78%). In

the case of female children, the category of wasting & underweight (24.44%) is found to be more effective compared to stunting & underweight (18.97%); and stunting, wasting & underweight (17.68%). All the age groups experience a high rate of CIAF, which varies between 72 and 76% (Table 5).

4 Discussion

4.1 Prevalence of stunting and contemporary scenario

GHI (2020) reported that the global prevalence of under 5 children was 144 million (21.30%), while the national average of stunted children in India is 35.50% in 2019–21 (IIPS, 2021) and it was 38.40% in 2015–16 (IIPS, 2017). In the case of West Bengal, the figure is 33.80% in 2019–20 (IIPS, 2021). It is evident that the proportion of stunted children aged between 5 and 10 years in the Purulia district is higher (43.37%) than the global, national, and state averages. Moreover, it crosses the cut-off value of WHO, 1995 for public health significance (WHO, 2010). There are several studies conducted across India found different levels of stunting among several age groups of children, such as Arambag, West Bengal (2 to 6 years) 26.60% (Mandal et al., 2008); Paschim Medinipur, West Bengal (2 to 13 years) 49.60% (Bisai & Mallick, 2011); Paschim Medinipur, West Bengal (1 to 14 years) 26.10% (Bisai et al., 2008b); Bhubaneswar, Orissa (3 to 9 years) 57.40% (Panigrahi & Das, 2014); Bijapur, Karnataka (6 to 12 years) 25% (Shashank & Chethan, 2016); Sullia, Karnataka (5 to 11 years) 19.22% (Amruth et al., 2015); Odisha (1 to 6 years) 32.40% (Goswami, 2016). Several factors in reality influence the variation in the prevalence of stunting among children, namely: biological determinants, socio-economic and demographic characteristics of households, ethnic and cultural diversity, healthcare facilities, etc., (Alemayehu et al., 2015; Amruth et al., 2015; Bisai et al., 2008b, 2012; Islam & Biswas, 2020; Kanjilal et al., 2010; Panigrahi & Das, 2014; Rengma et al., 2016; Singh, 2020). Our study does not observe any statistically significant role of sex and age of children in the prevalence of stunting at the district level. The persistent nature of poverty (Government of West Bengal, 2004; IIPS, 2017; UNDP, 2020b; NITI Aayog, 2021a) and unemployment in the district is well imitated by the incidence of child undernutrition (Ghosh et al., 2021; Mandal, 2021; Mandal & Ghosh, 2019; Mandal et al., 2017, 2018a). Stunting among children is mainly the outcome of insufficient food intake, inappropriate food practices, frequent infections, and poverty (Government of India, 2013; Mandal et al., 2017; UNICEF et al., 2019). To overcome such a situation, much stress is required to encourage in a balanced diet and proper medical care (Mandal & Ghosh, 2019; UNICEF et al., 2019; Ghosh et al., 2021; Mandal, 2021).

4.2 Prevalence of wasting and contemporary scenario

There were 47 million (6.90%) under 5 wasted children in 2019 in the world (UNICEF et al., 2019), whereas the national average of India is 19.30% in 2019–21 (IIPS, 2021), which was 21% in 2015–16 (IIPS, 2017). The under 5 wasted children in West Bengal is 20.30% in 2019–20 (IIPS, 2021). This study records higher wasted children (44.17%) than the global, national, and state averages. Even the figure of wasted children exceeds the cut-off value of *'critical (≥ 15%)'* for public health significance of

WHO, 1995 (WHO, 2010). The prevalence of wasted children is observed in several works in different proportions across India, such as Arambag, West Bengal (2 to 6 years) 50% (Mandal et al., 2008); Paschim Medinipur, West Bengal (2 to 13 years) 22.70% (Bisai & Mallick, 2011); Paschim Medinipur, West Bengal (1 to 14 years) 19.40% (Bisai et al., 2008b); Darjeeling, West Bengal (5 to 12 years) 26.50% (Debnath et al., 2018); Odisha (1 to 6 years) 25% (Goswami, 2016); Assam (5 to 12 years) 17.15% (Mondal et al., 2016); Bhubaneswar, Orissa (3 to 9 years) 23.29% (Panigrahi & Das, 2014); Sullia, Karnataka (5 to 11 years) 26.50% (Amruth et al., 2015). It was documented in different studies that the variation in the prevalence of wasting mainly results from socio-economic-backgrounds and growth patterns of different age groups of children (Alemayehu et al., 2015; Amruth et al., 2015; Bisai et al., 2008a, 2008b; Das & Bose, 2009; Debnath et al., 2018; Islam & Biswas, 2020; Kanjilal et al., 2010; Panigrahi & Das, 2014; Rengma et al., 2016; Singh, 2020; Stiller et al., 2020). The study does not observe any statistically significant difference in sex and age groups of children in the prevalence of wasting; it may be due to the low socio-economic profile of the households (Ghosh et al., 2021; Mandal, 2021; Mandal & Ghosh, 2019; Mandal et al., 2017). The high incidence level of wasting is primarily associated with inadequate food intake, incorrect feeding practices, repeated infections, and diseases. Early interventions, in this case, may check the severity of wasting (Government of India, 2013; WHO, 2018).

4.3 Prevalence of underweight and contemporary scenario

The global estimation of underweight children was 113.40 million in 2015, which was 17.60% of total children aged below 5 years (de Onis et al., 2004). India records under 5 underweight children in 2019–21 as 32.10% (IIPS, 2021), while it was 35.80% in 2015–16 (IIPS, 2017). In 2019–20, the figure was 32.20% for West Bengal (IIPS, 2021). On the contrary, the share of underweight children in this district (65.42%) is not only high compared to the global, national, and state averages, rather it is almost double. The prevalence of underweight children even breaches the critical value of WHO, 1995 (WHO, 2010). Much literature on malnutrition documented that the proportion of undernourished children was found in Arambag, West Bengal (2 to 6 years) 63.30% (Mandal et al., 2008); Bhubaneswar, Orissa (3 to 9 years) 45.40% (Panigrahi & Das, 2014); Bijapur, Karnataka (6 to 12 years) 34.15% (Shashank & Chethan, 2016); Sullia, Karnataka (5 to 11 years) 26.50% (Amruth et al., 2015); Paschim Medinipur, West Bengal (2 to 13 years) 52.90% (Bisai & Mallick, 2011); Paschim Medinipur, West Bengal (1 to 14 years) 33.90% (Bisai et al., 2008b); Odisha (1 to 6 years) 42.60% (Goswami, 2016). It is often seen that factors like space and time, socio-economic, age groups, food habits, etc., determine the variations in the occurrence of child underweight (Bisai et al., 2008b; Das & Bose, 2009; Gupta et al., 2015; Nandy et al., 2005; Rengmaet al., 2016). In several cases, acute or chronic malnutrition results in underweight children, and the risk of mortality may be enhanced if a child is mildly underweight. This chance of mortality gets accelerated for severely underweight children (Government of India, 2013; WHO, 2018).

4.4 Prevalence of CIAF and contemporary scenario

Several studies mentioned that undernutrition is mainly the product of poverty and deprivation and is well reflected in child malnutrition (Ghosh et al., 2021; Government of India, 2013; Mandal & Ghosh, 2019; Mandal et al., 2017; Nandy et al., 2005). It is estimated that the proportion of undernourished children in India is 14% (Global Hunger Index, 2020), but few studies reported that 50% of children in West Bengal were undernourished (Biswas et al., 2018; Bose et al., 2008). Globally, 690 million (8.90%) people were undernourished in 2019, which was 10 million higher than in 2018 (Global Hunger Index, 2020). Our study finds the prevalence rate of undernourished children in Purulia based on CIAF is more than the global and national averages. Several studies carried out across India documented the proportion of undernourished children in different magnitudes. The risk of child morbidity

Table 6 Multiple Regression analysis to predict test indicator for nutritional status

Dependent variable	Model	Independent variable in the model	adjusted R^2	R^2 change	Unstandardized coefficient (B)	Standardized coefficient (Beta)	t	Sig
HAZ	1	(Constant)	0.031	0.032	0.418			
		Education of father			0.201	0.179	4.707	0.000
	2	(Constant)	0.043	0.014	0.491			
		Education of father			0.188	0.167	4.393	0.000
		Family income			−0.118	−0.119	-3.137	0.002
BAZ	1	(Constant)	0.014	0.015	0.494			
		BMI of mother			0.104	0.124	3.228	0.001
	2	(Constant)	0.023	0.011	0.516			
		BMI of mother			0.113	0.134	3.495	0.001
		House type			−0.128	-0.105	−2.734	0.006
WAZ	1	(Constant)	0.025	0.027	0.271			
		BMI of mother			0.132	0.164	4.299	0.000
	2	(Constant)	0.038	0.014	0.177			
		BMI of mother			0.130	0.162	4.273	0.000
		Education of father			0.129	0.120	3.155	0.002
CIAF	1	(Constant)	0.023	0.024	0.196			
		BMI of mother			0.116	0.156	4.079	0.000
	2	(Constant)	0.038	0.017	0.101			
		BMI of mother			0.114	0.154	4.053	0.000
		Education of father			0.129	0.130	3.419	0.001

and mortality is high among undernourished children (Nandy et al., 2005; Rice et al., 2000; Schroeder & Brown, 1994) than the well-off children (Tomkins & Watson, 1989; Pelletier et al., 1995; Latham, 1997; WHO, 1997; Cunha, 2000; Gillespie & Haddad, 2003; Nandy et al., 2005). The high prevalence of undernourished children is the result of poor socio-economic conditions, which in turn are responsible for diseases and further undernutrition (WHO, 1997; Wagstaff & Watanabe, 2000; Nandy et al., 2005). It is worth mentioning that there is no role of age and sex in the prevalence of CIAF or undernutrition of children in the study area. This situation emerges due to the low level of the socio-economic background of the district resulting from unfavorable geophysical settings, which impede agricultural activities, and ultimately extend the path of unemployment and misery (Bhattacharya, 1986; Ghosh et al., 2021; Mandal, 2021; Mandal & Ghosh, 2019; Mandal et al., 2017, 2018b).

4.5 Association of significant independent parameters in the prevalence of undernourishment

To determine the impact of bio-demographic and socio-economic variables on the nutritional status of children, multiple regression analysis is undertaken using IBM SPSS Statistics 26 software (Table 6). Results reveal that the education of father is the most statistically significant predictor ($p< 0.000$) of stunting in model 1 followed by family income ($p< 0.002$) in model 2. Several past studies found the education of father a significant predictor of child malnutrition (Kamiya, 2011; Meshram et al., 2012b; Alemayehu et al., 2015), while family income also plays a vital role to combat poverty and malnutrition (Kanjilal et al., 2010; Meshram et al., 2012b; Agu et al., 2019; Ahmad et al., 2020). In the case of child wasting, the BMI of mother is the most significant parameter ($p< 0.001$) of child malnutrition in model 1. Many research works documented the BMI of mother is an important reflector of child undernourishment (Cesare et al., 2015; Kang & Kim, 2019; Rahman et al., 2019). The incidence of underweight is also observed to be associated with the BMI of mother ($p< 0.000$) and the education of father ($p< 0.002$). Both the predictors have a direct bearing on underweight children (Nahar et al., 2010; Biswas & Bose, 2011; Meshram et al., 2012b; Cesare et al., 2015; Agu et al., 2019; Farooq et al., 2020). There are two important predictors observed to be statistically significant in models 1 and 2 for CIAF of children as it is highly determined by the BMI of mother ($p< 0.000$), which is well recorded by earlier research works (Ansuya et al., 2018; Wong et al., 2014). Education of father also plays a statistically significant ($p< 0.002$) role in the prevalence of CIAF among

Table 7 Extent of multidimensional deprivation index (MDI) of studied sample households ($n=504$) of Purulia district. **Source:** Computed by the authors based on the primary database

Cut-off value of MDI	No. of households	Headcount ratio (H)	Intensity of deprivation (A)	MDI	Remarks
< 0.4	42 (8.33)				Non-deprived household
0.4–0.7	342 (67.86)	0.92	0.68	0.62	Deprived household
> 0.7	120 (23.81)				Highly deprived household
Total	504 (100)				

Values in parenthesis are in percentage

children. The relevance of paternal education is seen as statistically significant in the works of Ansuya et al. (2018) in rural Karnataka, Sabu et al., (2020) in Kerala, and Khanra et al. (2020) in Purba Medinipur, India. Thus, more importance must be given to bio-demographic and socio-economic parameters to reduce the prevalence of child undernutrition.

5 Computation of multidimensional deprivation index of households

The MDI is an important instrument to assess the different forms of deprivation at an individual level as it employs microdata obtained from household surveys (UNDP, 2018). This study attempts here to compute the MDI of the studied households of the district. It is found that 92% of households are multidimensionally deprived based on the selected socio-economic indicators. In the case of India, the calculated MPI in 2018 value was 27% (UNDP, 2018), while it was 27.90% in 2020 (UNDP, 2020b). The differences in results between the present study and others are due to selected parameters and their outcomes. The reports of HDR (Government of West Bengal, 2004) and NFHS-4 (IIPS, 2017) have already mentioned the very poor socio-economic status of the district Purulia in West Bengal. In contrast, the value of the intensity of multidimensionally deprivation of deprived households of the district is found to be 0.68. The intensity of deprivation in India in 2020 was around 0.44 (UNDP, 2020b). The estimated value of MDI of Purulia district is calculated to be 0.62, *i.e.,* deprived conditions of households (Table 7), while the multidimensional poverty index of the district is computed as 0.21 by Bagli and Tewari (2019). The national average of multidimensional poverty index of India was 0.123 in 2020 (UNDP, 2020b). It is worth mentioning here Purulia, undoubtedly, is one of the deprived districts in India depending upon the findings of the present study and different other studies. It is to be noted that there is a close relation between MDI of households and the proportion of undernourished children.

6 Achievements and impediments of SDGs

6.1 Global level

The main aim of SDGs is to bring sustainable development in the economy, society, and environment. The 17 global goals with 169 targets of UN build on MDGs focus on completing the unfinished works of MDGs by 2030 (UN, 2020). Smith (2020) mentions the crucial role of SDGs in achieving global equality and their implementation achieved significant success in eradicating poverty and hunger. The global number of people living in extreme poverty came down to 10% in 2015 from 16% in 2010 (UN, 2019). In 2019, the global poverty estimation was 8.20%, and 6% of the world's population will be living in extreme poverty in 2030 (UN, 2020). The incidence of poverty is high among low-income countries and around 736 million people in the world lived on less than $1.90 a day in 2015. In rural areas, the poverty was 17.20% and there lived about 79% of poor people in the world. Surprisingly, 46% extremely poor were children aged less than 14 years (UN, 2019). Undernourishment and food security remain global challenges. In 2014, around 630 million people were found to be undernourished, which rose to about 690 million in 2019. Estimation indicated moderate or severe food insecurity was experienced by 2 billion people (25.90%) in 2019, which was 22.40% in 2014.

Eradicating hunger does not ensure that everyone has the access to sufficient nutritious food. Prior to the coronavirus outbreak, the progress rate in achieving SDGs started to slow down due to economic fallout, violent conflicts, climate change, socio-economic and political complexities in different areas (UN, 2020). The incidence of poverty and hunger may be tackled by the government adopting policies and social protection schemes (UN, 2019).

6.2 National and state level

In India, NITI Aayog, a nodal body overseeing the progress of SDGs, in partnership with UN and other stakeholders of the society strives to achieve the global goals of 2030. The SDG India Index 3.0, based on the SDGs goals and targets, is constructed by adopting 115 indicators (directly from the national indicator framework) to cover 70 targets of 16 SDGs. A composite score, ranging from 0 to 100 (0 to 49- aspirant; 50 to 64- performer; 65 to 99- front runner; 100- achiever), explains the overall performance in achieving targets of different SDGs by states and union territories. India itself scores 66 (front runner), while West Bengal ranks 18th (score- 62, performer) out of 28 states of India in 2020–21. Performance in the case of individual goal, West Bengal scores 59 (performer) in SDG-1 and 46 (aspirant) in SDG-2 and ranks 20th and 18th, respectively, among the states (NITI Aayog, 2021b). If we try to understand the performance of West Bengal in terms of selected indicators of SDGs 1 and 2, it shows around 20% of the population of the state lives below the national poverty line, the headcount ratio as per MPI is 26.30% (NITI Aayog, 2021b), and only 29.30% households with any usual member are covered under any health insurance. In contrast, the proportion of under 5 underweight and stunted children is 32.20% and 33.80%, respectively, while anemic pregnant women aged 15 to 49 years are 62.30% (IIPS, 2021). Moreover, 45.50% of adolescents (10 to 19 years) are also found anemic (NITI Aayog, 2021b). Unfortunately, any of these indicators do not meet their targets by 2020.

6.3 Regional level: Purulia

Though the SDG India Index 3.0 is not available at the district level, the situation remains unchanged for Purulia district. In order to assess the success rate of SDG-1 for Purulia, three indicators are mentioned here. The proportion of people who are multidimensionally poor in the district is 49.69% (headcount ratio) with MPI value of 0.236 (global SDG target- 1.2), and Purulia records itself as the poorest district in the state (NITI Aayog, 2021a). The national target in this regard is to bring down the value to 13.95%, but the goal is far away. Households with any usual member covered under any health insurance are only 35.60% (global SDG target- 1.3) in the district (IIPS, 2021). It is targeted as to attain the global SDG target- 1.4 that no household should live in a *katcha* (non-concrete) house. The national and state averages in this regard are 4.20% and 6%, respectively (NITI Aayog, 2021b), while 70.83% of people live in *katcha* houses in the district (Mandal, 2021), and it was also documented by Bagli and Tiwari (2019) around the same proportion. In contrast, the performance of Purulia in SDG-2 is not found satisfactory. The proportion of under 5 underweight and stunted children in the district was 46.30% and 36.90%, respectively (IIPS, 2021), while the national target has been set to reduce the share of underweight and stunted to 1.90% and 6%, respectively (NITI Aayog, 2021b). The anemic pregnant

women aged 15–49 years were recorded at 72.20% (IIPS, 2021), where the national target is 25.20% (NITI Aayog, 2021b).

7 Conclusion

It is to be noted that the per capita monthly average income of the studied households is ₹1455, which is just above the estimated poverty line (₹1118.12) for rural West Bengal for the year 2018–19 (Mandal, 2021). The end of extreme poverty (SDG-1), the value measured for those people living a day on less than $1.25 (Leal Filho et al., 2019; UN, 2019), is quite hard to achieve for the district. This proportion of average earnings cannot assure a good livelihood for an individual. Moreover, the majority of the people are associated with low-profile economic activities in unorganized sectors, like daily wage occupations in agricultural and non-agricultural sectors, and disguised unemployment is also another serious issue in the district. The majority of the households still use smoking fuel for cooking, go for open defecation, and live in *katcha* houses. The education level of parents is not up to the mark, and food they take is not well balanced in terms of required amount of calorie. In a nutshell, it may be said that the poor nutritional status mainly of children is highly associated with poor socio-economic characteristics of households, and BMI of mother are education of father are the two most statistically significant predictors of child malnutrition. Thus, the success rate of SDG-1 & 2 is not so profound and not reflected through the livelihood pattern of households. More emphasis needs to be given at local level to enhance the purchasing capacity of poor to enjoy a decent life. In order to overcome this situation, employment generation both for skilled and unskilled labourer must be given highest priority. Locally available potential employment generating resources, such as sericulture, shellac, handicraft, tourism based on geo-morphosites need to encouraged and supported. Rainwater harvesting in large scale will definitely reduce the water scarcity of the district during the lean season, and such water may be used in domestic and agriculture purposes. Policies like these framed on ground reality may be proved more effective for Purulia district in a long run.

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Declarations

Conflict of interest Authors declare that they do not have any conflict of interest.

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