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One Health intervention for elimination of anthrax in an endemic district of Odisha: A baseline and endline study

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ABSTRACT

Background: This study was to compare a baseline and endline survey which were conducted to assess the changes in knowledge, attitude and practices about anthrax disease among the communities after One Health intervention for the elimination of human anthrax in an endemic district of Odisha.
Methods: A total of 2670 respondents were interviewed during the baseline and 2511 for the endline survey using a structured questionnaire by multi-stage sampling method. Descriptive statistics were used and logistic regression was performed to estimate the relationship between the variables and knowledge of anthrax.
Results: Out of the total participants in the study, males were about 76.25% in baseline and 72.08% in endline and about half of the total respondents were illiterate. Majority of the respondents had reported agriculture as their main occupation during both surveys. More than 50% of the respondents had livestock in their houses and farming was the main purpose for keeping them in both surveys. Around 20.26% of respondents knew about anthrax in baseline which raised to 53.64% after One Health intervention. Almost 21.29% of livestock owners had vaccinated their animals against anthrax disease throughout baseline, which increased to 66.5% during the endline survey.
Conclusion: This study highlights a significant surge in both knowledge and practices related to anthrax within the community after the implementation of intervention packages based on the One Health approach. The outcome of our study signified the importance of One Health interventions to address the health challenges related to zoonotic diseases in tribal communities. The data could be useful for local Governments to incorporate such an approach in their health policy to eliminate human anthrax.

1. Introduction

Anthrax is an ancient disease that may be transferred between human and animals. *Bacillus anthracis* is the causal agent of anthrax. While it mostly affects herbivores, there have been isolated reports of human infection [1,2]. Although anthrax occurs naturally and is still a major health problem in low- and middle-income nations, there is still a potential that it will be used as a biological weapon, posing a hazard to all communities [1,3,4]. Herbivores become infected from polluted soil or water during grazing [5]. Human infection is transmitted through direct contact with animals and animal products like meat, skins, and hide [6]. *Bacillus anthracis* is a Gram-positive, aerobic, rod-shaped

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bacillus that may generate spores but lacks autonomous motility. The organism can be found in two physical forms: the biologically active vegetative form, which produces illness symptoms, and the biologically inactive spore form. These spores allow the bacterium to survive until it can infect a new host [7].

Cutaneous anthrax is the most common form of human anthrax disease which accounts over 95% of all human cases. This occurs when individuals come into contact with infected animals or contaminated animal-derived products [8]. Typically, cutaneous anthrax manifests as a localized skin infection on areas such as the face, neck, arms, or hands. The initial symptom is an itching papule that eventually transforms into a vesicle before forming the characteristic black necrotic eschar. When appropriately treated, uncomplicated cutaneous anthrax has a mortality rate of <2% [9]. However, if localized cutaneous anthrax progresses to systemic anthrax, the fatality rate can rise to 30% [8]. By contrast, gastrointestinal (GI) anthrax is often contracted by consuming contaminated meat. There are two variations of anthrax ingestion. The oropharyngeal type, which is less common, affects the oropharynx, leading to neck swelling and breathing difficulties [10]. When spores germinate and infect the lower GI system, GI anthrax emerges. Symptoms of gastrointestinal anthrax include fever, chills, abdominal discomfort, nausea, vomiting, ascites, lethargy, bloody diarrhea, and headache [11]. Although the reported mortality rate for GI anthrax infections is approximately 74%, early treatment can significantly reduce the risk of fatality [12].

Anthrax cases have been documented in various states of India, including Karnataka, Tamil Nadu, Jammu & Kashmir, Andhra Pradesh and Odisha. In Odisha, over the past 15 years, outbreaks of anthrax have occurred repeatedly in 14 out of 30 districts, impacting a total of 1208 individuals. The majority of these cases were attributed to cutaneous anthrax, and 436 deaths were reported in Odisha alone [13,14]. Certain regions within the state have become endemic for anthrax, with frequent outbreaks observed. The districts most frequently affected are Kandhamal, Sundargarh, Malkanagiri, Rayagada and Koraput. Among these, Koraput district stands out with >300 reported human cases and over 10 confirmed deaths due to anthrax infection within the past six years [15].

Prior to the One Health intervention in the Koraput district, a baseline survey was conducted by our team (February 2020 to October 2020), to understand the current knowledge, attitude and practices prevalent in the community regarding anthrax. The aim of the endline survey (June 2022 to December 2022) was to identify the impact of One Health intervention over a three-year intervention period.

2. Methodology

2.1. Study design

This study was designed based on One Health approach for elimination of human anthrax in a tribal endemic district of Odisha. For assessment of the impact of interventions, the baseline and endline surveys were conducted among the randomly selected villages, which involved a repeated cross-sectional survey from February 2020 to October 2020 for baseline and from June 2022 to December 2022 for endline.

2.2. Study settings

The study was conducted within the Koraput district, located in southern Odisha, covering an area of 8807 km^2 and encompassing 14 administrative blocks along with 2028 revenue villages. This district is situated between 18.8561° N latitude and 82.7347° E longitude.

2.3. Sample size

The sample size was determined using the formula presented in Bhattacharya et al. [16]. Assuming that the community's awareness of anthrax was 5%, with a design effect of 1.3 and a 95% confidence interval, and aiming for a relative precision of 20% while accounting for a 10% non-response rate, the total sample size for the baseline survey was calculated to be 2608, which was rounded to 2640. For the endline survey, the community's awareness of anthrax was estimated to be 11% based on the baseline data. With a design effect of 1.3, a 95% confidence interval, a relative precision of 12%, and a 10% non-response rate, the total sample size was calculated to be 2471, which was rounded to 2470.

2.4. Sampling method

We employed a multistage simple random sampling approach to choose participants for our study across all 14 administrative blocks within the Koraput district using data from the 2011 census. A block, in this context, represents a sub-division of the district. From each administratively divided block, we selected two Gram Panchayats. A Gram Panchayat serves as the fundamental governing body for villages in India, typically comprising multiple villages. Next, we selected four villages from each Gram Panchayat, utilizing a random number generation method. In cases where a Gram Panchayat had fewer than four villages, we randomly selected another Gram Panchayat from the same block. This process resulted in the selection of 112 villages for data collection within the district. Within each chosen village, we systematically picked households, and from each selected household, we enrolled an adult for the study. When a household had two or more adults, we applied a simple random sampling method to choose one individual for inclusion in the study. The same methodology was followed for the selection of participants during the baseline and endline surveys.

2.5. Data collection

We developed an 85-item questionnaire, deriving its content from the framework outlined in Bhattacharya et al. [16]. This structured questionnaire primarily consisted of semi-open questions and was categorized into distinct domains. These domains encompassed socio-demographic characteristics (such as age, gender, education level, occupation, household size, and animal ownership), information pertaining to domestic animals (including types of livestock, grazing practices, and years of experience in animal management), procedures for handling deceased animals, dietary habits (covering meat consumption and its sources), and an evaluation of the respondent's knowledge and awareness of anthrax disease. This evaluation encompassed aspects like its signs, symptoms, modes of transmission, precautions, and preventive measures. We then uploaded this questionnaire into the Open Data Kit, and electronic devices were employed for data collection. Our field staff received comprehensive training on using tablets for data collection. The collected data were periodically downloaded, and data cleaning and monitoring were carried out by a dedicated data handler. Data was collected twice in the district, first during the pre-intervention stage known as the baseline survey and another post-intervention stage known as the endline survey.

2.6. One Health intervention

A One Health intervention package was developed with the help of various stakeholders from the department of public health, veterinary and forest in Koraput district of Odisha. Active surveillance of animal and human anthrax cases was carried out throughout the entire district with multi-level, multi-departmental coordination under the monitoring and supervision of the Integrated Surveillance Team (IST). A dedicated human anthrax diagnostic facility was set up under the health department to streamline the early identification and reporting of anthrax cases, adhering to established case definitions. Comprehensive standard operating procedures and outbreak response protocols were initiated across all relevant government departments, following a consultative approach. Sensitization and capacity-building training and/or

workshops were conducted for stakeholders from the Health, Veterinary, and Forest departments operating to enhance their abilities in prompt detection and the implementation of appropriate measures at various levels, including district, sub-district, block, and village levels. Behavioral Change Communication (BCC) and Information Education Communication (IEC) activities at the community level were conducted through the distribution of brochures, placement of banners in common community areas, and posting of information on walls at the Community Health Center/Primary Health Center and Gram Panchayat level. The state departments carried out coordinated IEC/BCC activities, which included both targeted and general outreach efforts, throughout the entire year. Free livestock vaccination drive was conducted throughout the district to vaccinate 100% of livestock against anthrax within a period of six months with the help of district veterinary department and coordination or support from the other stakeholders for smooth execution of the vaccination drive.

2.7. Data analysis

We performed data analysis using Statistical Package for Social Sciences (SPSS) version 21. We computed frequency distributions and percentages for the variables in the dataset. Bivariate and multivariate logistic regression analyses were conducted to assess the impact of variables like age, gender, educational level, occupation, livestock ownership, and meat consumption on the level of knowledge about anthrax, with a significance threshold set at 0.05.

2.8. Ethics approval and consent to participate

Ethical clearance was obtained from the Institutional Human Ethics Committee of ICMR-Regional Medical Research Centre (RMRC), Bhubaneswar [ECH/911/Inst/OR/2017]. Participants were informed about the aims and objectives of the study and a participant information sheet was provided for reference. Written informed consent was taken from each literate participant and the same was obtained from legally authorized representatives/tribe's head for illiterate participant before participation in the study. There was no child participant in this study. The study was conducted following the relevant ethical guidelines of Indian Council of Medical Research, New Delhi.

3. Results

The study team surveyed a total of 2670 baseline and 2511 endline households from 112 villages across 14 blocks of the district respectively. There were minimal differences in household characteristics between baseline and endline groups (Table 1). >70% of the study participants were male in both baseline and endline groups with the 18–29 age group being maximum in the baseline group 714 (26.75%), whereas the 30–39 age group being most in the endline group 617 (24.57%). During baseline, a total of 1432 (53.63%) study participants were illiterate and in endline, this number was 1198 (47.71%). Most of the respondents belonged to the Schedule Tribe in both the surveys. In India, Schedule Tribe represents the communities suffering from extreme social, educational and economic backwardness on account of the primitive agricultural practices, lack of infrastructure facilities and geographical isolation. Most of the study participants in both baseline (2094; 78.43%) and endline (2097; 83.51%) reported their annual income below INR 50,000. The main occupation of participants was agriculture in both the baseline and endline group.

Table 2 provides details on the information about livestock. Among the surveyed households, 71.42% owned livestock in the baseline survey and 56.71% in the endline survey. Majority of these households primarily had cattle or buffalos, followed by goats and sheep. The primary reason for keeping livestock was for agricultural purposes, with 82.12% and 72.82% of households indicated this as their main motive during baseline and endline survey. Dairy farming and meat selling were also common reasons for livestock ownership. Forest areas were the most preferred grazing grounds for animals in both the surveys.

Knowledge of anthrax pertains to individuals who can identify the

Table 1
Socio-demographic characteristics of baseline and endline survey.

Characteristics	Baseline n (%)	Endline n (%)
Gender		
Male	2036 (76.25)	1810 (72.08)
Female	634 (23.75)	701 (27.92)
Age-groups		
18–29	714 (26.75)	569 (22.66)
30–39	633 (23.7)	617 (24.57)
40–49	542 (20.3)	586 (23.34)
50–59	397 (14.87)	419 (16.69)
60 and above	384 (14.38)	320 (12.74)
Ethnicity		
General	259 (9.7)	285 (11.35)
Other backward caste	330 (12.36)	342 (13.62)
Schedule caste	414 (15.51)	480 (19.12)
Schedule tribe	1667 (62.43)	1404 (55.91)
Education		
Illiterate	1432 (53.63)	1198 (47.71)
Literate	1238 (46.37)	1313 (52.29)
Annual income (in Rs)		
<10,000	496 (18.58)	400 (15.93)
10,000–50,000	1598 (59.85)	1697 (67.58)
>50,000	576 (21.57)	414 (16.49)
Household size		
1–3	533 (19.96)	430 (17.12)
4–6	1546 (57.91)	1552 (61.81)
7 and more	591 (22.13)	529 (21.07)
Occupation		
Unemployed	128 (4.79)	81 (3.23)
Government service	61 (2.28)	31(1.23)
Private service	87 (3.27)	85 (3.38)
Home maker	148 (5.54)	195 (7.77)
Agriculture	1447 (54.19)	1370 (54.56)
Business	173 (6.48)	226 (9.00)
Daily labour	626 (23.45)	523 (20.83)

Table 2
Information on livestock animals of baseline and endline survey.

Characteristics	Baseline n (%)	Endline n (%)
Respondents having livestock		
Yes	1907 (71.42)	1424 (56.71)
No	763 (28.58)	1087(43.29)
Person's dealing with the livestock		
Respondent	1269 (66.54)	677 (47.54)
Wife/Husband	218 (11.43)	383 (26.90)
Parents	222 (11.65)	181 (12.72)
Son	104 (5.45)	122 (8.56)
Other relatives	94 (4.93)	61 (4.28)
Respondents having which livestock[#]		
Cattle/Buffalo	1832 (96.06)	1347 (94.59)
Goat	467 (24.49)	416 (29.21)
Pig	30 (1.57)	19 (1.33)
Sheep	354 (18.56)	250 (17.55)
Purpose of keeping livestock animals		
Leather Industry	2 (0.1)	2 (0.14)
Skinning	6 (0.31)	3 (0.21)
Dairy	469 (24.59)	86 (6.04)
Farming	1566 (82.12)	1037 (72.82)
Selling meat	342 (17.93)	296 (20.79)
Respondent's preferred place for grazing		
Forest	1182 (61.98)	761 (53.44)
Agricultural land	343 (17.99)	233 (16.36)
Grass field	353 (18.51)	400 (28.09)
Buy commercial fodder	29 (1.52)	30 (2.11)
Respondent's having how many years of experience in handling livestock animals		
<1 year	140 (7.34)	33 (2.32)
1–5 years	200 (10.49)	129 (9.06)
5–10 years	284 (14.89)	225 (15.80)
>10 years	1283 (67.28)	1037 (72.82)

signs, symptoms, and transmission methods of anthrax in both humans and animals. Table 3 displays how the study population was categorized based on their knowledge, attitudes, and practices related to anthrax in both baseline and endline survey. Approximately 20.26% of the participants were aware of anthrax affecting both animals and humans in baseline survey whereas the number increased to 53.64% in the endline survey after intervention.

Around 25.9% of individuals involved in livestock management were aware of anthrax vaccination for animals during baseline survey but after intervention the awareness increased to 90.66% during the endline survey which is an essential step in controlling anthrax among livestock. Furthermore, over 70% of livestock owners reported suspected anthrax cases to relevant authorities in both the surveys.

Regarding risky practices and behaviors related to anthrax, there was a decrease of 3.94% of dead meat consumption and a 19.12% reduction of animal blood in the diet of the study population when compared between baseline and endline survey. Approximately there was 1.65% reduction in the habit of livestock owners who consumed meat from deceased animals. Notably, >80% of livestock owners followed a practice of burying dead animals in both the surveys by digging a hole up to 5 ft deep and conducting the burial in the presence of a livestock inspector or veterinary doctor. The p-value calculated between the baseline and endline survey of KAP showed that there was a significant change in the knowledge, attitude and practices of survey respondents towards anthrax.

In Table 4, we utilized both adjusted odds ratios of baseline and endline survey, along with their respective 95% confidence intervals (CIs), to evaluate the associations. Individuals aged 30–39 years were found to have higher likelihood of possessing knowledge about anthrax compared to those in the reference age group in both the surveys. Moreover, males exhibited a greater propensity to possess knowledge about anthrax than females, potentially due to their predominant involvement in livestock handling activities. In comparison to participants with no formal education, those who had received a formal education had a twofold higher likelihood of possessing knowledge about anthrax which was observed in both the surveys. Additionally, participants who had livestock showed a 1.4 times higher probability of possessing knowledge about anthrax compared to those who didn't have livestock in the endline survey which is almost 0.2 times higher than the baseline survey.

4. Discussion

The results indicate a noteworthy enhancement in the knowledge, attitude and practices about anthrax disease among the study population from the baseline to endline survey. In the baseline survey, the analyses revealed a substantial harmful practice in the community, such as consuming livestock blood, eating the meat of dead animals, distribution or selling of carcasses to local tribal communities, and careless disposal of carcasses in open fields. However, these concerning practices were limited after the implementation of intervention packages using One Health approach as found during endline survey. The outcome of this study emphasizes on the adoption of One Health approach to address the zoonotic diseases in endemic regions in India and other low and middle income countries [17].

In the baseline survey, it was observed that only 21.2% of livestock owners had administered anthrax vaccinations to their animals, indicating a lack of awareness and practice in the tribal communities regarding anthrax vaccination. However, such implemented interventions helped to gain the vaccination awareness among the livestock owners which was revealed in endline data. Coordination with veterinary department played a pivotal role in implementing anthrax disease control programs, particularly in ensuring annual anthrax vaccination for animals, which significantly reduced the risk of anthrax transmission.

Authorities tend to direct their attention to anthrax only when

Table 3
: Knowledge, Attitude and Practices comparison of anthrax between baseline and endline survey.

Model	Characteristics	Baseline n (%)	Endline n (%)	p-value
KNOWLEDGE	Have heard about anthrax in animals or humans			
	Yes	541 (20.26)	1347 (53.64)	<0.001
	No	2129 (79.74)	1164 (46.36)	
	Knowledge about symptoms of animal anthrax			
	Yes	227 (8.50)	855 (34.05)	<0.001
	No	2443 (91.50)	1656 (65.95)	
	Knowledge about transmission of anthrax in animals			
	Yes	271 (10.15)	1017 (40.50)	<0.001
	No	2399 (89.85)	1494 (59.50)	
	Knowledge about symptoms of human anthrax			
	Yes	296 (11.08)	1190 (47.39)	<0.001
	No	2374 (88.92)	1321 (52.61)	
	Knowledge on mode of transmission of anthrax from animal to human			
	Yes	207 (7.75)	1018 (40.54)	<0.001
	No	2463 (92.25)	1493	
	Knowledge about preventive method of anthrax—vaccination of livestock			
	Yes	495 (25.96)	1291 (90.66)	<0.001
	No	1412 (74.04)	133 (9.34)	
ATTITUDES	Place of anthrax vaccination			
	Home	377 (76.16)	943 (99.78)	<0.001
	Veterinary hospital	82 (16.56)	1 (0.11)	
	Animal health check-up camps	36 (7.28)	1 (0.11)	
	Misconceptions and challenges regarding anthrax vaccination			
	Productivity of animals will be hampered	90 (18.19)	63 (13.15)	<0.001
	Vaccination is costly	86 (17.38)	56 (11.69)	
	Livestock inspector is not coming home	61 (12.32)	35 (7.31)	
	Animals become weak after vaccination	108 (21.81)	145 (30.27)	
	None	150 (30.30)	180 (37.58)	
	Respondents' reaction to suspected anthrax cases in animals			
	Inform relevant authority	398 (73.57)	1065 (79.07)	0.02
	Traditional methods	18 (3.33)	27 (2.00)	
	Do not report anyone	125 (23.10)	255 (18.93)	
PRACTICES	Vaccinated their livestock animals against anthrax			
	Yes	406 (21.29)	945 (66.50)	<0.001
	No	1501 (78.71)	479 (33.50)	
	Period of conduction of anthrax vaccination of animals			
	<6 months	245 (60.35)	424 (44.87)	<0.001
	6 months–1 year	117 (28.81)	316 (33.44)	
	1–2 years	23 (5.67)	118 (12.48)	
	>2 years	21 (5.17)	87 (9.21)	
	Was the anthrax vaccination free of cost			
	Yes	162 (39.90)	779 (82.43)	<0.001

(continued on next page)

Table 3 (*continued*)

Model	Characteristics	Baseline n (%)	Endline n (%)	p-value
	No	244 (60.10)	166 (17.57)	
	Respondent's meat consuming habit			
	Yes	2393 (89.63)	2081 (82.88)	<0.001
	No	277 (10.37)	430 (17.12)	
	Type of meat the respondents consume[#]			
	Beef	353 (14.75)	225 (10.81)	<0.001
	Pig	135 (5.64)	65 (3.12)	
	Sheep	2204 (92.10)	1662 (79.86)	
	Goat	1810 (75.64)	1941 (93.27)	
	Respondent's consuming animal blood in their diet			
	Yes	599 (25.03)	123 (5.91)	<0.001
	No	1794 (74.97)	1958 (94.09)	
	Respondents managing dead bodies of livestock animals			
	Burial	1591 (83.43)	1203 (84.48)	<0.001
	Throw them away	129 (6.77)	139 (9.76)	
	Distribute among villagers	55 (2.88)	36 (2.52)	
	Selling the carcass	51 (2.67)	9 (0.64)	
	Consume the meat	81 (4.25)	37 (2.60)	

outbreaks occur in the community, resulting in illnesses or deaths following the consumption of infected or uninspected meat [18]. An important finding was that >55% of the study population owned livestock, mostly cattle or buffalo (>90%) in both baseline and endline surveys. This high dependence on cattle for livelihood could be a significant factor contributing to frequent outbreaks of anthrax in cattle compared to other livestock [19]. Many of these livestock animals also graze in the forest, which could increase their risk of ingesting anthrax spores, thereby serving as a potential factor for anthrax disease outbreaks among animals [20,21].

Zoonotic diseases are increasingly concerning, constituting roughly 60% of known human pathogens, with over 75% of them originating from animals [22]. Often, these diseases emerge in animals before spreading to humans [23]. Veterinarians are uniquely positioned to offer reliable guidance to cattle owners, possessing a deeper understanding of the risks associated with zoonotic diseases and effective mitigation strategies. They are also equipped with specialized training in zoonoses, represent a valuable source of information on the subject. A study has suggested that individuals would be open to seeking advice from veterinarians if diagnosed with a zoonotic disease by their physician [24]. This is partly because their physicians may lack confidence in the diagnosis of zoonotic diseases. Earlier studies also indicate that veterinarians play a crucial role not only in controlling zoonotic diseases in animals but also in educating patients and physicians about the same [24,25]. However, there appears to be a lack of communication between veterinarians and physicians [25]. It's crucial to raise awareness of this gap and foster collaboration and communication. Therefore, the collaboration between medical and veterinary communities is essential across clinical, public health and research domains, given the potential transmission of zoonotic diseases to both animals and humans [26]. Both veterinarians and physicians have their respective roles to play in public health education and efforts should be made to ensure effective cooperation between the two. An interdisciplinary One Health approach, involving professionals from animal, human and environmental sectors, is imperative to address the escalating threat of emerging zoonotic diseases [27].

It is important to note that due to the observational nature of this study, we cannot isolate the effects of the intervention from external and confounding factors that may have influenced the knowledge, such as socio-economic status, education or unequal access to media. However, there were no significant demographic differences between the baseline and endline survey populations, possibly due to the strict adherence to the multistage random sampling method. Despite these limitations, it's evident that the knowledge of anthrax among the participants increased from baseline to endline during this study. Although we can't establish a causal association for this result on the magnitude of the observed changes, however, the consistency of the results suggests that the One Health interventions contributed to these positive outcomes.

5. Conclusion

This study highlights a significant increase in both knowledge and practices related to anthrax within the community, signaling a clear improvement in these areas. On the other hand, One Health interventions can address various health challenges related to zoonotic diseases, governments should continue to steward and ensure that One Health programs align with health policy objectives. To facilitate the early detection, prevention, and control of outbreaks, it is imperative to establish a surveillance system for prompt case identification and to provide comprehensive education to the community about anthrax. Additionally, addressing these gaps may require active coordination between various departments, adopting the One Health approach, especially in regions where anthrax is endemic.

Table 4
Multivariate logistic regression analysis output of factors associated with knowledge of anthrax between baseline and endline survey.

Characteristics	Comparison	Baseline		Endline	
		Adjusted Odds Ratio (95%CI)	p-value	Adjusted Odds Ratio (95%CI)	p-value
Age	18–29	Ref		Ref	
	30–39	1.48 (1.08–2.03)	0.02	0.78 (0.61–0.99)	0.04
	40–49	0.96 (0.69–1.42)	0.96	0.74 (0.58–0.95)	0.01
	50–59	1.07 (0.72–1.57)	0.73	0.61 (0.46–0.80)	<0.01
	>60	0.98 (0.65–1.49)	0.95	0.52 (0.38–0.69)	<0.01
Gender	Female	Ref		Ref	
	Male	2.20 (1.50–3.22)	<0.01	1.17 (0.96–1.42)	0.10
Education	Illiterate	Ref		Ref	
	Literate	2.17 (1.68–2.79)	<0.01	1.94 (1.62–2.31)	<0.01
Occupation	Non-Agriculture	Ref		Ref	
	Agriculture	1.09 (0.85–1.39)	0.47	0.77 (0.65–0.92)	<0.01
Livestock	Absent	Ref		Ref	
	Present	1.17 (0.93–1.47)	0.18	1.48 (1.25–1.75)	<0.01
Meat Consumption	No	Ref		Ref	
	Yes	1.79 (1.13–2.82)	<0.01	1.17 (0.95–1.46)	0.13

Consent for publication

All the authors have scrutinized the script and give their consent for publication.

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CRediT authorship contribution statement

Matrujyoti Pattnaik: Data curation, Formal analysis, Investigation, Methodology, Software, Writing – original draft. **Hari Ram Choudhary:** Data curation, Investigation, Methodology, Project administration, Validation, Writing – review & editing. **Debaprasad Parai:** Data curation, Investigation, Methodology, Project administration, Validation, Writing – review & editing. **Jyoti Shandilya:** Investigation, Methodology. **Arun Kumar Padhi:** Investigation, Methodology, Project administration. **Niranjana Sahoo:** Methodology, Validation. **Shishirendu Ghosal:** Data curation, Investigation, Methodology. **Sarangdhar Sathpathy:** Methodology, Validation. **Santosh Kumar Panigrahi:** Methodology, Validation. **Susanta Kumar Sahu:** Methodology, Validation. **Aurobindo Samantaray:** Methodology, Validation. **Sanghamitra Pati:** Conceptualization, Funding acquisition, Project administration, Supervision. **Debdutta Bhattacharya:** Conceptualization, Funding acquisition, Investigation, Project administration, Supervision.

Declaration of competing interest

The authors have no competing interests in any form.

Availability of data and materials

Raw data will be available on request to the corresponding author.

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