



OPEN Assessing Hepatitis B virus infection, risk factors and immunization among particularly vulnerable tribal groups in Eastern India

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In a population-based survey, Hepatitis B virus (HBV) infection status, associated risk factors and vaccine coverage among the 4006 Particularly Vulnerable Tribal Groups (PVTG) participants of Odisha Tribal Family Health Survey (OTFHS) were assessed using various viral markers. All the HBsAg-positive sera were screened for viral load estimation, envelopment antigen (HBeAg) identification and liver profile parameters. The overall prevalence of HBsAg was 5.73% and the Kutia Khond tribes showed highest prevalence (17.85%; 95% CI:17.41–18.29) of HBsAg. Only 2.7% of children born following the implementation of hepatitis B vaccination were HBsAg positive. Among the children between 0 and 36 months, the vaccination coverage was 91% and mean Anti-HBs titre was 142.56 mIU/ml. Tattooing and piercing were found to be positively associated with high HBsAg positivity. Abnormal liver function (high SGOT and SGPT) occurred more often in HBeAg positive with high viral loads (> 2000 IU/ml). Given the high prevalence of HBV DNA with active viral replication, a strategy for regular monitoring and treatment of these individuals combined with risk factor management and health education in this indigenous population is urgently needed.

Keywords Hepatitis B, DNA virus, PVTG, Tribal health, Indigenous population

Hepatitis B virus (HBV) infection is a substantial global health issue, affecting an estimated 254 million people worldwide with chronic infection. The Hepadnavirus targets the liver and poses a serious threat to chronically infected individuals, potentially leading to liver cirrhosis and hepatocellular carcinoma (HCC) and accounts for of 1.3 million deaths worldwide. Approximately 1.2 million new infections are reported annually among people exposed to either HBV-infected blood or bodily fluids¹. HBV is 50–100 times more infectious than HIV. The virus is most commonly transmitted from mother to child during birth and delivery, as well as through contact with blood or other body fluids during sexual contact with an infected partner, unsafe injections or exposure to sharp objects. Children infected before the age of six are more likely to become chronic carriers².

With a prevalence of 3–4.2% of Hepatitis B surface antigen (HBsAg) and 40 million HBV carriers, India is classified as an intermediate endemic zone for the Hepatitis B virus (HBV) infection in the world³. Despite being in the low endemicity region, certain indigenous population have a greater rate of exposure to Hepatitis B infection because of inbreeding depression, inadequate knowledge regarding the spread of the disease, compromised living circumstances, intimate interpersonal contact and specific sociocultural traditions such as tattooing and piercing of various body parts^{4,5}.

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The tribal population of Odisha constitutes around 8.6% of the total population of India, with more than 90% lives in rural areas⁶. Odisha is one of the major diverse states for indigenous populations, with 62 tribal groups and 22.8% of its population belonging to Scheduled Tribes amounting to over 10 million persons⁷. In India, a particularly vulnerable tribal group (PVTG), previously known as a Primitive tribal group, is a sub-classification within the Scheduled Tribes, representing a section that is more vulnerable than regular Scheduled Tribe. The present study was part of the Odisha Tribal Family Health Survey, which is the first of its kind in the country. It aims to assess the status of HBV infections among the PVTG population, the various risk factors associated with and the hepatitis B vaccination coverage among children (aged 0–5 years).

Methods

Study design and setting

The study was part of a population-based cross-sectional survey with a multistage random sampling design carried out in the state of Odisha, India. There are 30 administrative districts in the state, among which 11 districts (119 sub-district level blocks) are PVTGs-dominated and included in the survey (Fig. 1)⁶.

Study population

The study population comprised members of the Particularly Vulnerable Tribal Group across all age group (0 to 60 years and above) and gender who belonged to one of the notified tribes, were permanent residents of the region and provided written consent were included in the survey. Participants who were ill or unable to provide required information and did not agree to give blood samples were excluded from the study. Survey was carried out for 1 year from June 2022⁶.

Sampling and sample size

The survey employed a multistage sampling design. The primary and secondary sampling units were clusters and households, respectively. The survey population was stratified based on tribes in the first sampling stage⁶. The sample size was calculated for each tribe separately to enable comparisons. The aggregated sample size calculated for the survey was 40,921, which was collected from 10,230 households spread over 341 clusters across the state. The population of the PVTGs was 4006 and all were included in the study.

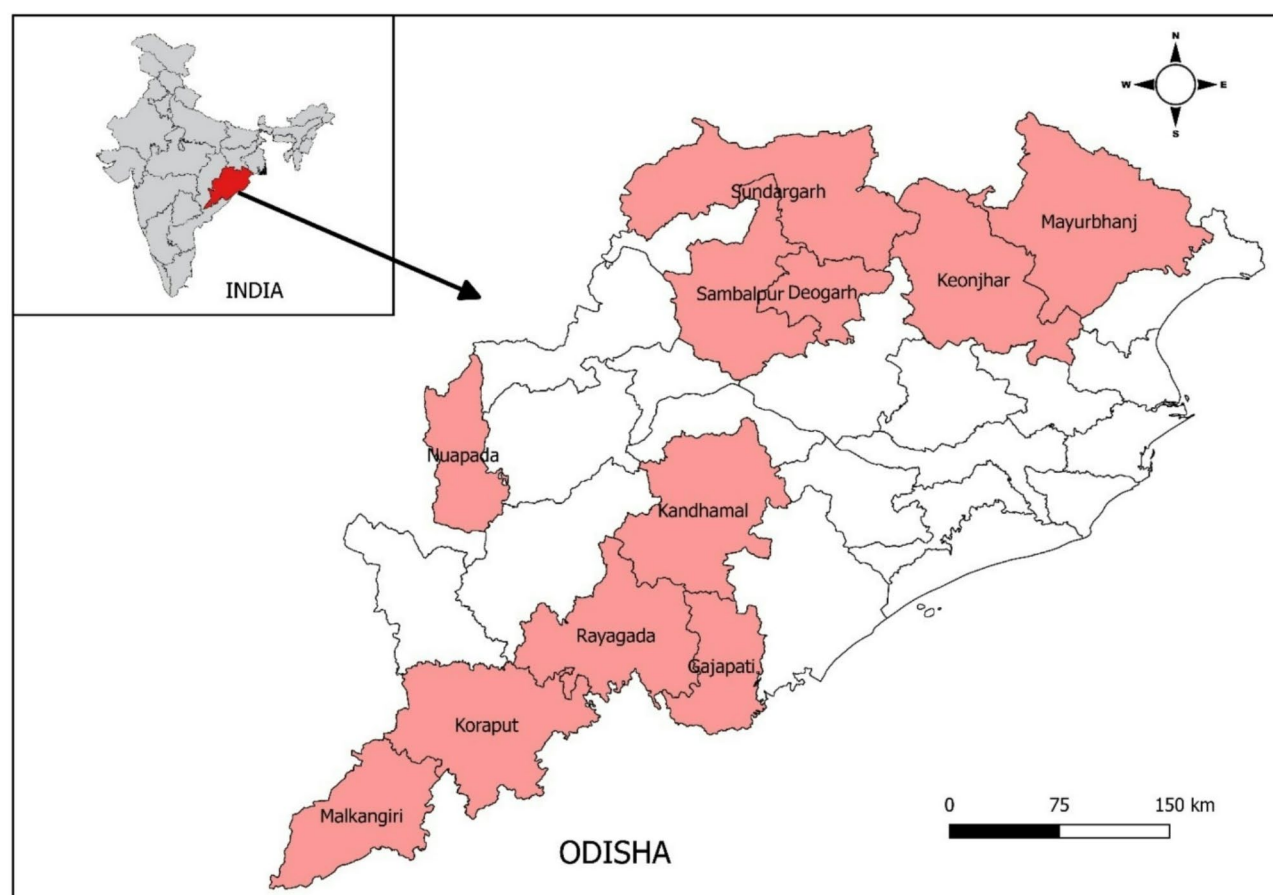


Fig. 1. PVTGs-dominated districts of Odisha included in the survey.

Data and sample collection

The participants were informed on the previous day of the actual survey and were made to understand the importance of the study. Information on various socio-demographic, household characteristics, risk factor, vaccine coverage, anthropometric profile were collected using electronic data collection tool in android tablets. The collected data was uploaded online and extracted in excel sheet format. Data was kept securely and safely for its analysis and further course of action. Following data collection, blood samples were collected from the participants for further laboratory analysis. About 5 ml and 2 ml of blood was collected respectively from adults and children by venipuncture by a trained laboratory phlebotomist. Samples were then transferred to the designated laboratory of ICMR-Regional Medical Research Centre, Bhubaneswar for laboratory diagnosis. Anonymity of both sample and data was maintained with minimal access³.

Laboratory investigation

Testing for serological marker

All 4006 serum samples were tested for detection of viral surface markers, including Hepatitis B surface antigen (HBsAg which is a marker of chronic infection) and total antibody to Hepatitis B core antigen (Anti-HBc which is a marker of HBV infection, either cleared or persistent) using commercial enzyme-linked immunosorbent assays (HBsAg: J.Mitra & Co. Ltd). Antibody to Hepatitis B surface antigen (Anti-HBs which is a marker of protective antibodies) using ARCHITECT i1000SR immunoassay analyzer. All HBsAg positive sera were further tested for the presence of Hepatitis B envelope antigen (HBeAg which is a marker of active viral infection) using commercial enzyme-linked immunosorbent assays (HBsAg: J.Mitra & Co. Ltd)³.

Molecular testing

HBV DNA (to assess active HBV viral replication) and viral load estimation were performed for all the HBsAg positive serum using Cobas[®] HBV (Roche Diagnostics India Pvt. Ltd.) with a specificity of 100%³.

Biochemical testing

The positive HBsAg sera were further tested for the different biochemical parameters like SGOT, SGPT, ALP, total bilirubin, direct bilirubin, and albumin to check the liver function test using automated biochemistry analyzer EM-360 (ERBA Diagnostics Mannheim GmbH) and reagents provided by Transasia Biochemical Ltd⁸.

Statistical analysis

Descriptive data were calculated as per the frequency and proportion of the variables. Weighted prevalence of Hepatitis B was calculated in accordance with the socio-demographic distribution and risk factors. Univariate and weighted multivariate regression analysis were adjusted for age, gender, wealth index and sample weight of the findings based on seromarker positivity. Statistical analysis was carried out in STATA v16.0.

Ethical considerations

This study was approved by the Institutional Ethics Committee of ICMR-Regional Medical Research Centre, Bhubaneswar (reference no: ICMR-RMRC/IHEC-2022/115; dated: 02/05/2022) and have followed the National Ethical Guidelines for Biomedical and Health Research Involving Human Participants by the Indian Council of Medical Research (ICMR). The study also followed the ethical principles for medical research involving human subjects of the Declaration of Helsinki adopted by World Medical Association, 1964 which were last revised in October 2013. No documented assent was obtained for children below 7 years of age. For children between 7 and 12 years, verbal/oral assent was obtained in the presence of the parents/legally acceptable authorized representative (LAR) and was recorded. For children between 12 and 18 years, written assent were obtained, which was signed by the parents/LAR.

Results

The mean age of the study participants was 32.3 years ranging between 1 year and 93 years of age. There were 1786 (44.6%) males and 2220 (55.4%) females in the study population. Majority of the participants (69.8%) belonged to the age group of >20 years followed by 10–19 years (16.5%), and <10 years (13.7%). All serum samples collected from 4006 PVTG individuals were tested for the serological markers HBsAg, Anti-HBs, and Anti-HBc. Only 11 PVTGs were included in the analysis, as we could collect only 2 samples from the Birhor and Saora tribes. HBsAg was detected in 170 of the 4006 individuals (4.24%; 95% CI: 5.67–5.79) individuals (Table 1). The weighted HBsAg positivity was highest (6.56%; 95% CI: 6.49–6.63) in >20 years age groups and among males (7.99%; 95% CI: 7.90–8.09) participants of the PVTGs of the state. Highest prevalence (17.85%; 95% CI: 17.41–18.29) of HBsAg was observed among the Kutia Khond tribe. The chronic HBV infection was detected as 2.79% (95% CI: 2.22–3.26).

The wealth index has been calculated for the study participants and has been categorized into lower, lower-middle, middle, middle-higher and higher income groups. Among the HBsAg positive participants, 77 (45.29%) belonged to lower and 44 (25.88%) belonged to lower-middle wealth income groups. Around 101 (59.41%) out of 170 HBsAg positive participants were illiterate and 75 (44.11%) were from agricultural background.

The highest HBsAg (32.39%) positivity was observed in the 10–19 age group of Kutia Khond (95% CI: 30.66–34.16). Males from the Kutia Khond (25.28%, 95% CI: 24.53–26.04) and Dongria Khond (12.36%, 95% CI: 12.14–12.58) tribes showed remarkably higher HBsAg positivity compared to females. Other tribes, such as Bondo Poraja, Juang and Paudi Bhuyan also reflected this trend, where males consistently exhibited higher rates of HBsAg positivity compared to females. The HBsAg positivity among the pregnant women was 3.01% (95% CI: 2.67–3.40) and was observed to be quite high among the pregnant women belonging to the Juang Tribe.

PVTG Tribes	Age				> 20 years				Gender		Total	
	< 10 years		10–19 years		10–19 years		Male		Female		Total	
	No. of tested	HBsAg positivity (95% C.I.)	No. of tested	HBsAg positivity (95% C.I.)	No. of tested	HBsAg positivity (95% C.I.)	No. of tested	HBsAg positivity (95% C.I.)	No. of tested	HBsAg positivity (95% C.I.)	No. tested	HBsAg positivity (95% C.I.)
Bondo Poraja	81	2.85 (2.32–3.49)	144	5.42 (4.91–5.98)	305	3.12 (2.84–3.43)	252	4.74 (4.36–5.14)	278	2.84 (2.56–3.14)	530	3.75 (3.51–3.99)
Chuktia Bhunjia	59	-	111	1.22 (0.97–1.53)	406	1.16 (1.03–1.30)	277	0.80 (0.67–0.95)	299	1.30 (1.14–1.48)	576	1.06 (0.95–1.18)
Didayi	34	-	50	-	177	1.58 (1.32–1.90)	106	2.31 (1.93–2.77)	155	-	261	1.06 (0.88–1.27)
Dongria Khond	68	-	59	14.01 (13.44–14.59)	338	9.72 (9.57–9.87)	213	12.36 (12.14–12.58)	252	5.69 (5.55–5.83)	465	8.73 (8.61–8.86)
Juang	37	-	49	-	246	6.55 (6.34–6.77)	151	6.61 (6.36–6.88)	181	3.30 (3.11–3.50)	332	4.98 (4.82–5.15)
Kharia	19	11.22 (9.58–13.09)	11	-	69	2.00 (1.69–2.38)	42	7.42 (6.61–8.32)	57	-	99	3.13 (2.78–3.52)
Kutia Khond	28	16.79 (15.69–17.95)	15	32.39 (30.66–34.16)	140	16.23 (15.75–16.72)	80	25.28 (24.53–26.04)	103	12.00 (11.51–12.51)	183	1.78 (1.74–1.83)
Lanjia Saora	74	-	96	4.42 (4.16–4.70)	426	4.36 (4.23–4.49)	253	4.69 (4.53–4.85)	343	2.95 (2.82–3.09)	596	3.83 (3.73–3.94)
Lodha	63	1.70 (1.50–1.92)	61	-	260	5.07 (4.88–5.26)	171	6.69 (6.44–6.95)	213	1.08 (0.98–1.18)	384	3.74 (3.61–3.88)
Mankidia	17	-	15	2.68 (2.27–3.16)	90	1.71 (1.54–1.90)	54	2.76 (2.52–3.03)	68	0.46 (0.35–0.60)	122	1.76 (1.61–1.92)
Paudi Bhuyan	69	2.66 (2.34–3.03)	52	-	337	5.14 (4.95–5.34)	187	7.15 (6.86–7.47)	271	2.06 (1.91–2.21)	458	4.30 (4.15–4.46)
Total	549	1.67 (1.59–1.76)	663	5.06 (4.92–5.21)	2794	6.56 (6.49–6.63)	1786	7.99 (7.90–8.09)	2220	3.66 (3.60–3.72)	4006	5.73 (5.67–5.79)

Table 1. Age and gender wise weighted prevalence of HBsAg among the PVTGs.

The overall exposure to HBV infection was 42.73% (95% CI: 41.20–44.28), indicating that 1712 individual (out of 4006) were positive for any of the three markers of HBV infection. The highest exposure rate (71.20%, 95% CI: 68.98–73.32) was observed among the adult participants (age 20 and above) who were positive for either HBsAg, or anti-HBs or anti-HBc. Anti-HBc alone positivity was found among 7.34% (95% CI: 6.56–8.20) of individual whereas protective level of Hepatitis B surface antibody (anti-HBs ≥ 10 mIU/ml) was present among 41.14% of individual (95% CI: 39.61–42.68).

All the 170 HBsAg positive individuals were also tested for Hepatitis B envelope antigen (HBeAg) and HBV DNA. HBV DNA was detected among 61 (35.9%) of 170 HBsAg positive samples of which 26 (15.3%) had viral load above 2000 IU/ml. Eleven (6.4%) were HBeAg positive indicating active replication of the virus. All the HBeAg positive participants had HBV DNA viral load above 2000 IU/ml. More than 15% (15.3%) individual were found to carry HBV DNA > 2000 IU/ml with active or inactive HBeAg and a significant number (73.1%) were in the age group of more than 20 years with mean age of 43.3 years (Table 2).

About 2.7% (21 out of 766) of the children born after the introduction of Hep B vaccine (2011–12) were positive for HBsAg. Among these none had protective level of antibody. Out of these 21 participants, 6 participants showed presence of HBV viral load of > 2000 IU/ml and three showed active replication of the virus.

Five individuals were found to be positive with concurrent presence of both HBsAg and Anti-HBs titre of > 10 mIU/ml. Of them only a 27 years female was vaccinated and had Anti-HBs titre 26 mIU/ml with presence of Anti-HBc antibody and HBV DNA.

The vaccination coverage among the children aged 0–36 months was 91% and 67.6% had a protective level of antibody. The mean Anti-HBs titre was 142.56 mIU/ml. About 37.5% of children born after the introduction (2012) of HB vaccine have protective level of Anti-HBs. The Anti-HBs titre was found to decrease with increasing age among children aged 0–60 months (Fig. 2).

Table 2 explains various risk factors and their association with Hepatitis B surface antigen (HBsAg) positivity in two age groups (10–19 years individual and individual aged 20 years and above) across both genders. Tattooing was found to be associated with increased HBsAg positivity in both age groups, although the strength of association varied. In the age group above 10–19 years, individuals with tattoos showed a positivity rate of 4.76%, with an AOR of 2.46 (Table 3). Among males, piercing was associated with a notably higher HBsAg positivity (11.38%) compared to females (2.82%) with higher risk among male (AOR of 1.25). The AOR of 1.74 and 2.44 among both males and females suggested a higher risk among alcohol consumers, particularly among those aged over 20 years. Hepatitis B vaccination was found to impact significantly HBsAg positivity rates across various age groups. Individuals who have received the vaccine show lower HBsAg positivity compared to those who have not been vaccinated (AOR- 1.23). For the age group of 10–19 years, vaccinated individuals have a positivity rate of 4.47%, compared to 3.46% in the unvaccinated group. In the age group of 10–19 years, the protective effect of vaccination is evident but moderate, with an adjusted odds ratio (AOR) of 0.89 indicating reduced risk. In the older age category (more than 20 years), the difference is more pronounced. Vaccinated individuals have a significantly lower HBsAg positivity rate of 2.55% compared to 3.88% in the unvaccinated group of more than 20 years. This disparity underscores the vaccine's effectiveness in reducing HBsAg positivity, with an AOR of 1.60 for the unvaccinated group suggesting a notable increase in risk. The practice of contraception was associated with varied HBsAg positivity rates. The adjusted odds ratios (AOR) suggest a highly increased risk for contraception non-users (AOR: 2.29) compared to users. Those who were hospitalized showed a significantly higher positivity rate (6.66% for 10–19 years and 8.46% for over 20 years) compared to non-hospitalized individuals, with AOR values of 3.09. Sharing razors also elevated the risk, with an AOR of 3.59 among those who shared razors.

Among those negative for HBsAg, Anti-HBs, and Anti-HBc ($n=3836$), the majority exhibited normal liver function, with 73.80% showing normal SGOT, 99.06% normal SGPT and 88.06% normal ALB levels. In HBeAg positive individuals with high viral loads (> 2000 IU/ml), abnormal liver function was more frequent, with elevated SGOT in 46.67% and SGPT in 13.33% of cases. Those who were HBeAg-negative with low viral loads (< 2000 IU/ml) had mostly normal liver tests, including 97.14% with normal SGPT and 100% with normal ALP and BID levels. Higher viral loads were associated with more significant liver function abnormalities, particularly in SGOT and SGPT levels, suggesting that liver health worsens as viral activity increases in individuals infected with Hepatitis B (Table 2).

Discussion

The present study is a part of Odisha Tribal Family Health Survey (OTFHS) and for the first time, reports the status of Hepatitis B infection among all the PVTGs residing in eleven districts of Odisha. The overall weighted HBsAg seropositivity in the present study was found to be 5.73% (95% CI: 5.67–5.79) and was higher than the findings of National seroprevalence of HBsAg (0.95%) observed by MOHFW in 2021 and also higher than the previously reported rates among the PVTGs of the state^{9–13}. India is ranked in the intermediate group for chronic HBV (CHB) and about 50 million people are carriers of CHB infection in India, with a mortality of 0.115 million due to CHB and its complications^{14,15}.

This study is the first of its kind to assess the HBV infection status, associated risk factors and HB vaccination coverage among the PVTGs residing in the eastern state of Odisha. The study reports for the first time the prevalence of HBsAg among the Dongria Kondh, Chuktia Bhunjia, Bondo Poraja and Didayi tribe residing in southern districts of the state. Similar to our previous report³, Kutia Khond showed the highest prevalence of HBsAg across all age group and gender by using the sample weight. The HBsAg seropositivity was higher among the 10–19 years age group.

Hepatitis B vaccine was introduced in the Universal Immunization Programme during 2011–2012 (phase-II) in seven states of India including Odisha and the coverage in India increased from 62.8% in 2015–2016 to 86% in 2020^{16–18}. Hepatitis B vaccination has been associated with substantial reductions in the incidence of acute and chronic Hepatitis B infections/carriage, which will ultimately result in significant reductions in the

Outcome	Negative for Hepatitis B infection (HBsAg, Anti HBs, Anti HBc) (N = 3836)			HBsAg (+ve)			HBsAg +ve (Active chronic carrier)			HBsAg -ve (Inactive chronic carrier)		
	Viral load (< 2000IU/ml) (N = 0)			Viral load (> 2000IU/ml) (N = 11)			Viral load (< 2000IU/ml) (N = 35)			Viral load (> 2000IU/ml) (N = 15)		
	Normal	Moderate	High	Normal	Moderate	High	Normal	Moderate	High	Normal	Moderate	High
LFT	SGOT	2831 (73.80)	864 (22.52)	141 (3.68)	-	-	3 (27.27)	7 (63.64)	1 (9.09)	20 (57.14)	12 (34.29)	3 (8.57)
	SGPT	3800 (99.06)	29 (0.76)	7 (0.18)	-	-	11 (100)	0	0	34 (97.14)	1 (2.86)	0
	ALB	3378 (88.06)	458 (11.94)	0	-	-	11 (100)	0	0	34 (97.14)	1 (2.86)	0
	ALP	3469 (90.43)	343 (8.94)	24 (0.63)	-	-	10 (90.91)	1 (9.09)	0	35 (100)	0	0
	BLD	3724 (97.08)	109 (2.84)	3 (0.08)	-	-	11 (100)	0	0	33 (94.28)	1 (2.86)	0
	BIT	3603 (93.93)	202 (5.27)	31 (0.81)	-	-	11 (100)	0	0	32 (91.43)	2 (5.71)	1

Table 2. Liver function test (LFT) outcomes for individuals based on their hepatitis B infection status and viral load.

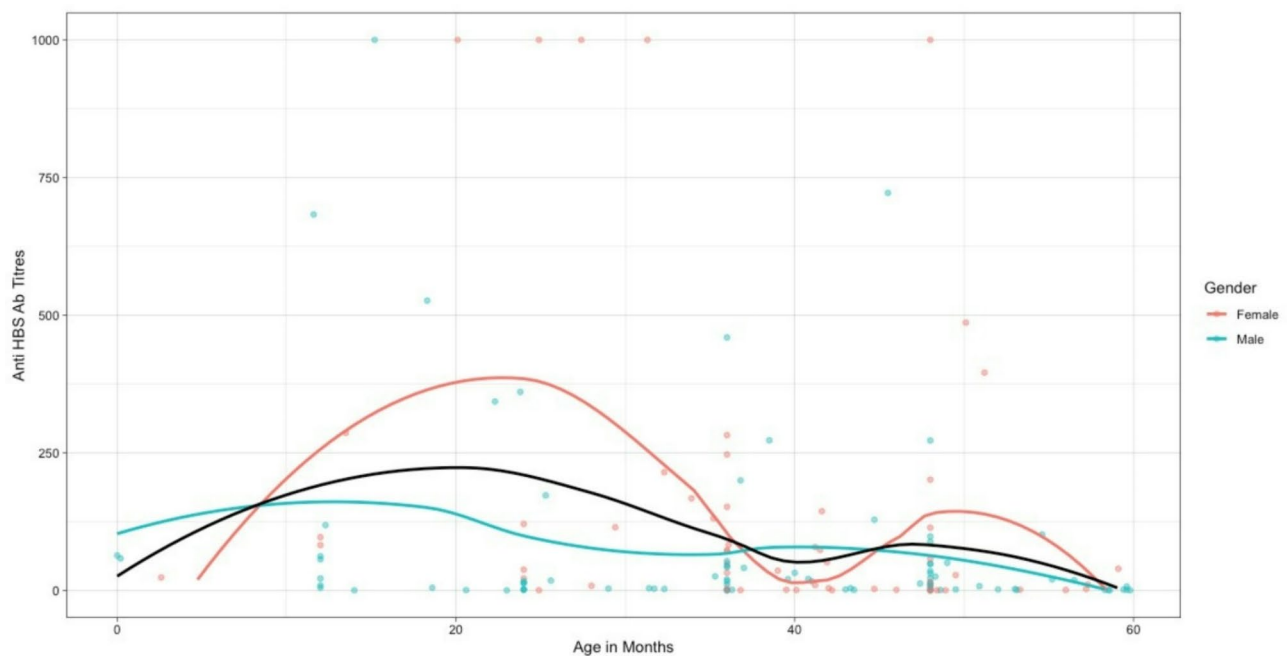


Fig. 2. Anti-HBs titres variation over age and gender.

incidence of cirrhosis and hepatocellular carcinoma¹⁹. In the present study, the vaccination coverage among the children aged 0–36 months was documented as 91% and 67.6% had a protective level of antibody. No significant breakthrough in the treatment of CHB is achieved till date, hence, preventive strategies such as vaccination are extremely important to control the infection and consequent disease burden among the people with chronic liver disease and hepatocellular carcinoma. The study documented that about 2.7% of the children born after the introduction of Hep B vaccine (2011–12) were positive for HBsAg and who did not have a protective level of antibody. About 36% of children (0–12 years) born after the introduction of HB vaccine did not have a protective level of anti-HBs, indicating the need to improve the coverage of three dose of HB vaccine in India. The WHO has established goals for elimination of viral Hepatitis as a public health threat by 2030, including elimination of MTCT of HBV, which requires an HBsAg prevalence of no more than 0.1% among children and at least 90% coverage with HepB-BD and HepB3^{20,21}. With the National Viral Hepatitis Control Programme (NVHCP) being rolled out in India with a target to increase Hepatitis B birth-dose vaccination to >90%, the present study urges for a need for more intense coverage of the vaccination and further follow up for Antibody development and persistence among these community¹⁷.

Tattooing, alcohol consumption, smoking, HB vaccination, use of contraceptive, history of hospitalization and sharing of razor were found to be significant in multivariate analysis of risk factors for HBV infection. Previously personal hygiene, history of hospitalization, use of contraception, immunization and gender have been reported to be significantly associated with HBV infection^{22–25}.

The study documented that higher viral loads were associated with more pronounced liver function abnormalities, especially in elevated SGOT and SGPT levels. Previous studies have documented a strong correlation between viral load and liver damage in patients with chronic hepatitis²⁶. It has been established that HBV viral load can remain stable over time until HBeAg sero-conversion or a hepatitis flare occurs²⁷. Therefore, it has been hypothesized that a high HBV viral load could be associated with the development of HBV-related liver disease²⁸.

Among the PVTG participants, 15.3% individual were found to carry HBV DNA viral load of >2000 IU/ml with active or inactive HBeAg and a significant number (73.1%) were in the age group of more than 20 years with mean age of 43.3 years. Recent studies conducted in large Asian cohorts indicate that HBV-DNA levels strongly predict development of HBV-related cirrhosis and HCC^{29,30}.

This study provides valuable insights into hepatitis B prevalence and risk factors among Odisha's particularly vulnerable tribal groups (PVTGs), yet it faces several limitations. One major limitation is the study's sampling constraints as data was collected from only a subset of PVTGs in the region, with notably low representation from the Birhor and Saora tribes, potentially impacting the generalizability of findings across all Odisha tribes. As the study is cross-sectional in nature, it limits the understanding of temporal progression of hepatitis B infection, vaccination efficacy over time and changes in antibody levels in individuals, especially among children born after the vaccine's introduction. Lastly, the study's findings may have been influenced by potential recall bias or self-report inaccuracies in areas like vaccination history, hospitalization, or behaviours related to personal hygiene practices.

Risk Factors	Categories	Age				Gender				Total			
		10–19 years				> 20 years				Male			
		HBsAg positivity (95% C.I.)	UOR	AOR	HBsAg positivity (95% C.I.)	UOR	AOR	HBsAg positivity (95% C.I.)	UOR	AOR	HBsAg positivity (95% C.I.)	UOR	AOR
Tattooing	No	3.70 (2.41–5.59)	Ref	Ref	5.33 (4.41–6.42)	Ref	Ref	6.81 (5.58–8.28)	Ref	Ref	4.95 (4.17–5.86)	Ref	Ref
	Yes	4.76 (1.21–16.12)	1.30 (0.29–5.71)	2.46 (2.19–2.78)	3.33 (2.21–4.95)	0.61 (0.39–0.95)	1.23 (1.19–1.27)	4.47 (1.27–13.07)	0.64 (0.19–2.07)	0.82 (0.76–0.88)	3.40 (2.30–4.98)	0.67 (0.44–1.03)	1.26 (1.22–1.30)
Piercing	No	4.65 (2.82–7.49)	Ref	Ref	6.50 (5.20–8.09)	Ref	Ref	6.29 (5.09–7.74)	Ref	Ref	6.07 (4.96–7.40)	Ref	Ref
	Yes	2.68 (1.25–5.42)	0.56 (0.24–1.32)	0.97 (0.87–1.08)	3.51 (2.68–4.56)	0.52 (0.36–0.74)	0.52 (0.50–0.54)	11.38 (6.59–18.67)	1.91 (1.05–3.47)	1.25 (1.19–1.31)	3.38 (2.63–4.32)	0.57 (0.41–0.78)	0.56 (0.54–0.58)
Alcohol Consumption	No	3.78 (2.49–5.66)	Ref	Ref	4.02 (3.21–5.01)	Ref	Ref	5.77 (4.42–7.50)	Ref	Ref	3.96 (3.26–4.80)	Ref	Ref
	Yes	3.44 (0.21–19.38)	0.90 (0.12–6.95)	0.44 (0.37–0.52)	6.62 (5.07–8.59)	1.69 (1.18–2.41)	2.11 (2.06–2.17)	8.36 (6.23–11.11)	1.49 (0.99–2.24)	1.74 (1.70–1.79)	6.52 (5.00–8.43)	1.69 (1.20–2.36)	1.96 (1.92–2.01)
Smoking	No	4.01 (2.64–6.00)	Ref	Ref	4.69 (3.64–6.01)	Ref	Ref	6.65 (4.98–8.82)	Ref	Ref	4.48 (3.62–5.53)	Ref	Ref
	Yes	1.53 (0.08–9.40)	0.37 (0.05–2.80)	0.27 (0.23–0.32)	4.88 (3.86–6.14)	1.04 (0.73–1.47)	1.11 (1.09–1.14)	6.76 (5.15–8.80)	1.01 (0.67–1.52)	1.28 (1.24–1.32)	4.74 (3.76–5.95)	1.06 (0.77–1.46)	1.05 (1.03–1.08)
Hepatitis Vaccination	Yes	4.47 (2.20–8.60)	Ref	Ref	2.55 (1.30–4.80)	Ref	Ref	4.60 (2.03–9.62)	Ref	Ref	3.33 (2.12–5.13)	Ref	Ref
	No	3.46 (2.06–5.68)	0.76 (0.33–1.76)	0.89 (0.82–0.97)	3.88 (2.97–5.05)	1.54 (0.78–3.04)	1.60 (1.50–1.71)	5.92 (3.91–8.81)	1.30 (0.55–3.09)	1.70 (1.53–1.89)	3.78 (2.99–4.76)	1.14 (0.69–1.87)	1.23 (1.18–1.30)
Hospitalization	No	3.63 (2.37–5.48)	Ref	Ref	4.43 (3.68–5.33)	Ref	Ref	5.51 (4.47–6.75)	Ref	Ref	3.95 (3.36–4.65)	Ref	Ref
	Yes	6.66 (1.16–23.50)	1.89 (0.42–8.43)	0.38 (0.33–0.43)	8.46 (5.44–12.83)	1.99 (1.22–3.23)	3.73 (3.63–3.84)	11.11 (6.79–17.45)	2.14 (1.24–3.70)	2.65 (2.56–2.74)	7.52 (4.97–11.13)	1.97 (1.26–3.08)	3.09 (3.01–3.17)
Practice of contraception	Yes	3.87 (2.57–5.75)	Ref	Ref	3.94 (2.75–5.58)	Ref	Ref	6.92 (4.27–10.90)	Ref	Ref	4.09 (3.14–5.30)	Ref	Ref
	No	0	-	-	5.48 (4.42–6.77)	1.41 (0.93–2.14)	2.35 (2.26–2.43)	6.70 (5.29–8.43)	1.03 (0.60–1.77)	2.79 (2.65–2.93)	5.20 (4.19–6.43)	1.31 (0.88–1.96)	2.29 (2.21–2.37)
Place of haircut	At home	3.25 (1.04–8.61)	Ref	Ref	6.89 (5.07–9.28)	Ref	Ref	6.28 (4.68–8.35)	Ref	Ref	6.28 (4.68–8.35)	Ref	Ref
	Saloon	6.52 (2.67–14.19)	2.07 (0.57–7.57)	2.31 (2.10–2.55)	6.72 (3.94–11.06)	0.97 (0.53–1.79)	0.81 (0.77–0.84)	6.66 (4.27–10.16)	1.06 (0.62–1.81)	0.91 (0.88–0.95)	6.66 (4.27–10.16)	1.06 (0.62–1.81)	0.91 (0.88–0.95)
	Village barber	6.06 (2.84–11.97)	1.91 (0.56–6.54)	2.35 (2.14–2.59)	8.06 (5.38–11.81)	1.18 (0.70–1.98)	0.87 (0.84–0.90)	7.46 (5.27–10.42)	1.20 (0.75–1.91)	0.97 (0.94–1.01)	7.46 (5.27–10.42)	1.20 (0.75–1.91)	0.97 (0.94–1.00)
Sharing razor	No	5.10 (3.04–8.37)	Ref	Ref	6.95 (5.47–8.77)	Ref	Ref	6.52 (5.25–8.06)	Ref	Ref	6.52 (5.25–8.06)	Ref	Ref
	Yes	5.66 (1.61–16.25)	1.11 (0.31–3.99)	3.20 (2.94–3.48)	8.53 (4.92–14.18)	1.25 (0.68–2.27)	3.57 (3.43–3.72)	7.83 (4.76–12.45)	1.21 (0.70–2.09)	3.59 (3.46–3.72)	7.83 (4.76–12.45)	1.48 (0.89–2.48)	3.59 (3.46–3.72)

Table 3. Univariate and multivariate analysis of different risk factors associated with HBV exposure.

Conclusion

In conclusion, this is the first study to examine in detail the status of hepatitis B infection, risk factors and vaccine coverage among the Particularly Vulnerable Tribal Groups residing in the state. The HBsAg prevalence among PVTGs estimated in our study was higher than the national seroprevalence of Hepatitis B. As a significant number of individuals are harboring HBV DNA with active viral replication, an intervention strategy needs to be developed for regular monitoring and treatment of the infected individuals, management of risk factors and promotion health awareness among this population of the country. The findings call for a statewide survey of Hepatitis B infection, associated risk factors, coverage and impact of the Hep B vaccination programme in Odisha after 2010–11 with special reference to these indigenous and tribal population of the state.

Data availability

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

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Author contributions

SP, DB and JSK: conceived the study; HB, DB and MP: undertook analysis, interpretation of the results and drafted manuscript; AS, AP, UKR, RP and KAK: involved in data acquisition; HB, DB and MP: critical review of manuscript.

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Declarations

Competing interests

The authors declare no competing interests.

Additional information

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