A comprehensive assessment of health indicators among tribal populations in Odisha, India (Odisha Tribal Family Health Survey): a community-based, cross-sectional study

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Summary

Background Indigenous tribal communities in the state of Odisha, eastern India, face persistent health disparities driven by socio-economic marginalisation, geographical isolation, and limited healthcare access. The Odisha Tribal Family Health Survey (OTFHS) aimed to comprehensively assess the health status, socio-demographic characteristics, and healthcare utilisation patterns of Odisha's tribal populations.

Methods A community-based survey was conducted between July 2022 and July 2023, covering 9711 households across 389 clusters in 14 tribal-dominated districts in Odisha. The study included 30,292 participants from 53 notified tribal groups. The study included participants of all age groups (from neonates to the elderly, aged 0 years and above), with 56% of the sample comprising females. Individuals belonging to one of the notified tribes who were permanent residents and provided written consent were included, while bedridden individuals and those with recognisable cognitive impairments were excluded. Data collection involved the use of structured tools at the household and individual levels, anthropometric measurements, point-of-care tests (including blood pressure, random blood glucose, and haemoglobin levels, as well as haemoglobinopathy screening), and laboratory analyses of blood serum samples (for liver function, kidney function, and lipid and iron profiles).

Findings OTFHS revealed that 88.0% of children aged 12–23 months were fully vaccinated and over 40% of children younger than five years were stunted or underweight. Anaemia affected 71.3% of children aged 6–59 months, with prevalence remaining high among adolescents (76.1% of females, 56.9% of males) and adults (77.5% of women, 42.1% of men). 93.0% of women had bank accounts and 91.4% of births occurred in healthcare facilities. Gaps persisted in antenatal care (40.3% completed four or more visits) and hygienic menstrual practices (35.8% of women).

Interpretation OTFHS offers crucial disaggregated data, guiding targeted health improvements and policy reforms essential for bridging health equity gaps. The specific focus on Indigenous populations and a broader look at the social determinants alongside health indicators reflect the multi-dimensional nature of healthcare interventions needed for vulnerable groups.

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Keywords: Indigenous health; Scheduled tribes; Malnutrition; Anaemia; Odisha; Public healthcare; Women's empowerment; Chronic diseases; Odisha Tribal Family Health Survey; OTFHS

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Research in context

Evidence before this study

High-quality and reliable data on demographics, socio-economic factors, and health are essential for effectively planning and targeting interventions for vulnerable populations. While nationwide surveys in India such as the National Family Health Survey (NFHS) assess health-related population indicators, they do not focus on specific groups, resulting in limited data collection from Indigenous populations and insufficient statistical power for meaningful inferences. The Odisha Tribal Family Health Survey (OTFHS) aims to address this gap by providing comprehensive and accurate estimates of socio-demographic and health indicators among tribal communities in the state of Odisha, which has the third-largest Scheduled Tribe population in India.

Added value of this study

The study is the first state-level survey of tribal groups in India, in which all the tribes of Odisha were included and compared for the very first time. The scope of the survey is broad, as its objectives are to capture data on various aspects of family health, including reproductive health, adolescent and child health, gender issues within the family, ageing, mental health, and social problems that families face.

Implications of all the available evidence

The findings from the OTFHS will complement existing national survey data by providing a focused and detailed perspective on tribal health, thereby enabling evidence-based decision-making for policy and intervention planning. This study will help bridge the knowledge gap related to tribal health in Odisha, supporting targeted healthcare programmes, resource allocation, and long-term strategies to improve health outcomes. By integrating OTFHS data with broader health surveillance efforts, policymakers, researchers, and public health authorities can develop more inclusive and effective approaches to addressing the health inequities faced by Indigenous populations.

Introduction

Indigenous populations maintain a profound connection to their ancestral lands and possess a rich and unique socio-cultural heritage.[1] Despite their diversity, Indigenous populations experience common challenges of geographical isolation and socio-economic marginalisation, creating systemic barriers to healthcare access. These barriers have led to lower life expectancy and a higher disease burden among Indigenous populations compared to non-Indigenous populations.[2] Health disparities are further exacerbated by high levels of poverty, discrimination, and a high prevalence of people who do not have a high school diploma or equivalent (due to opportunity gaps), all of which severely limit access to primary healthcare services.[3,4] Globally, Indigenous peoples constitute over 6% of the population, with China and India together accounting for more than two-thirds of this demographic.[5]

In India, the latest Census recorded over 104 million Indigenous peoples, referred to as Scheduled Tribes (STs) or *Adivasis* (earliest inhabitants), across 705 notified ethnic groups and constituting 8.6% of the population.[6] Their health is marked by a "quadruple burden of disease"—a combination of communicable diseases, malnutrition, non-communicable diseases (NCDs), and mental health disorders, with addiction being particularly prominent.[7] STs heavily depend on public health institutions, with nearly half of outpatient visits and over two-thirds of hospitalisations occurring in government facilities.[8] Despite India's economic advancements, STs continue to experience poorer health outcomes compared to non-ST populations. In 2021, 81 out of 129 health metrics measured in national surveys showed that non-ST populations fared better than ST populations, who still suffer from higher mortality rates, widespread malnutrition, and increasing prevalence of hypertension and diabetes [2,9]. Alarmingly, over 40% of ST children younger than five years are either stunted or underweight, reflecting severe undernutrition.[9] Furthermore, migration and urbanisation add complexity to existing health problems.[4]

Odisha, a state in eastern India, exemplifies the health challenges faced by tribal communities.[10] With 62 tribal groups and 22.8% of its population identifying as tribal, Odisha has the third-largest ST population in the country.[11] The state is also home to 13 of India's 75 Particularly Vulnerable Tribal Groups (PVTGs), which are among the most marginalised communities in the nation.[4] Health outcomes for Odisha's tribal populations lag significantly behind national averages, with high malnutrition rates exacerbated by poor sanitation and inadequate maternal and child healthcare services.[12] The state's epidemiological transition—from traditional diseases of poverty to NCDs and mental health issues—highlights the need for culturally appropriate interventions.

Research on the health of STs in India remains limited, underscoring the importance of focused studies.[13] Demographic research challenges, such as inconsistencies in tribal classification and the "invisibility" of tribal populations in official data, complicate efforts to address health inequities.[8] Recognising these gaps, the Ministry of Tribal Affairs' Expert Committee on Tribal Health has recommended the collection of tribe-specific, comprehensive, disaggregated data to accurately reflect the diverse health needs of these communities.[8] As India strives to achieve the UN Sustainable Development Goals (SDGs), integrating tribal populations into the national socio-economic framework

is imperative.[14] Comprehensive surveys that provide tribe-specific insights are critical to paving the way for more inclusive and effective healthcare strategies, contributing to the long-term goal of health equity for all.[15]

In this context, the Indian Council of Medical Research (ICMR), as the apex body for biomedical research in India, has made coordinated research efforts on tribal health.[16] ICMR-Regional Medical Research Centres, one of the 27 institutes of Indian Council of Medical Research (ICMR), the apex body under for biomedical research in India under Ministry of Health and Family Welfare, Govt. of India, is in Odisha and has been working extensively in the last four decades on the regional conduct research relevant to regional health issues including tribal health. In collaboration with the state government, and the Ministry of Tribal Affairs, the undertook the Odisha Tribal Family Health Survey (OTFHS)—a comprehensive assessment of health indicators across the state's tribal populations. This survey, the first of its kind in India, provides a detailed analysis of health parameters, focusing on the entire tribal population of Odisha.

The study aims to describe and compare health status of indigenous populations. The specific objectives were to compare the key healthcare and social services access among the different tribal and economic classes, describe the socio-behavioural risk factors among them and estimate the prevalence of maternal, child health indicators and chronic diseases. In this paper, we present a summary of the key findings from OTFHS. The findings are expected to guide targeted interventions and policy development, improving the health and well-being of tribal communities in Odisha and serving as a model for similar studies across India.

Methods

Study setting, design, and participants

We conducted a community-based, cross-sectional descriptive study in the 14 tribal districts out of Odisha's 30 districts from July 2022 to July 2023 (Fig. 1). We utilised a multistage cluster sampling design. The primary sampling units were clusters, which were defined as villages, notified hamlets, or urban census blocks. We selected the clusters using probability proportional to size sampling, which was based on population size. Households, as the secondary sampling units, were selected using systematic random sampling. Within each selected household, we invited all individuals of any age or gender, who were permanent residents and belonged to one of the notified tribes to participate in the survey. The detailed methodology of the OTFHS has been previously published.[17]

The study was approved by the Institutional Human Ethics Committee of ICMR-RMRC Bhubaneswar (ICMR-RMRC/IHEC-2022/115) and state government (MS2-IV/04/2020/PI-1 Bhubaneswar). Written informed consent was obtained from all participants. In the case of adolescents, assent was obtained in addition to consent from parents. For children, parental consent was obtained. Additional written consent was obtained for blood sample collection and physical measurements. We followed ICMR's National Ethical Guidelines for Biomedical Research involving Human Participants, as required by Indian Law, particularly the chapters addressing research with vulnerable populations.[18]

Measures

We used separate tools to collect data at the cluster, household, and individual levels, where the individual tools were specific for each age and gender group. These tools were systematically pretested and provided estimates for key indicators on infectious and non-communicable diseases, nutrition, multimorbidity, maternal and child health, healthcare-seeking behaviour, self-rated health, psycho-social status, and geriatric health. Detailed descriptions of the tools, their development and operational procedures are available in the survey protocol and as a Supplementary file (Supplementary Informations S1 and S2).[17] Trained field teams, balanced in gender representation and located at the district level, collected data using electronic forms on tablets. Laboratory technicians, public health and social work graduates were recruited as field investigators and centralised training was provided as detailed in the Manual of Operating Procedures (Supplementary Information S3). Data for children younger than 10 years were obtained from their mothers. Anthropometric measurements and point-of-care tests (including blood pressure, random blood glucose, haemoglobin levels, as well as haemoglobinopathy screening) were done at the household level. Blood samples were collected by venipuncture after obtaining additional written consent. These samples were coded and transported under a cold chain to the central laboratory facility at the ICMR-RMRC in Bhubaneswar. The central laboratory adhered to stringent external quality assurance mechanisms, as outlined in the protocol.[17] Serum samples were analysed for liver function, kidney function, and lipid and iron profiles, using an automated biochemistry analyser (EM 360; Transasia Biomedical Pvt. Ltd.).

Data management and quality control

A custom-built database management system (DBMS) was built for the survey, with robust quality checks, real-time web dashboard and restricted access to data. We ensured data quality both internally and externally, using, among other methods, a hierarchical validation process. Randomly selected 5% of data entries were verified each month at multiple levels (field investigators → field supervisors→ internal investigators → external monitors). A statistician performed weekly checks for missing,

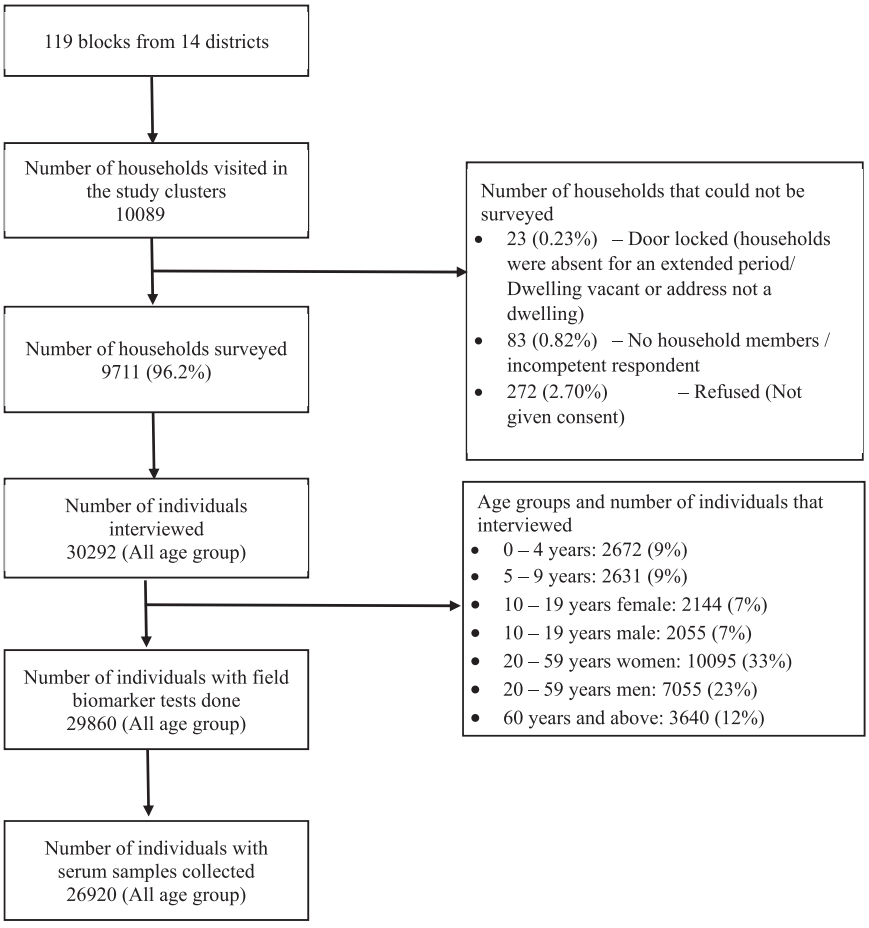

Fig. 1: Study flow diagram for participant recruitment.

faulty, or duplicate data entries, before validating it. We followed the guidance from the National Guidelines for Data Quality in Surveys.[19]

Statistical analysis

Data cleaning, transformation, categorisation, and merging were conducted systematically. Survey weights and design factors were incorporated, and a wealth index was calculated for each household.[20,21] In this paper, we present the descriptive analysis of the survey and report weighted proportions and mean (SD) using R software (version 4.1.1) and its tidyverse, gtsummary, and ggplot2 packages.

Role of the funding source

The funding agency did not have any role in study design, data collection, data analysis, interpretation, or writing of the report that as submitted to the funding agency and state government. However, in the manuscript we have coauthors belonging to the funding agency who had contributed to manuscript draft review (UKS, MN, and SK).

Results

The OTFHS engaged 30,292 participants from 9711 households across 53 distinct tribal groups, including 13 PVTGs, from 389 clusters (villages). Among the included participants, blood samples were collected and tested for 26,920 individuals (81.8%). The detailed recruitment flow is represented in Fig. 1.

Household and socio-demographic characteristics

Among the surveyed households, 91.6% reported access to electricity, 88.8% had access to improved drinking-water sources, 32.4% utilised clean fuel for cooking and 94.6% had at least one member covered under a health insurance scheme. The village and household-level access indicators are shown in Fig. 2.

Table 1 highlights disparities and similarities in access to healthcare and services among Odisha's indigenous tribes, regarding wealth status. Notably, many health metrics seem better among PVTGs as compared to STs, and the wealth-related disparities seem inconsistent.

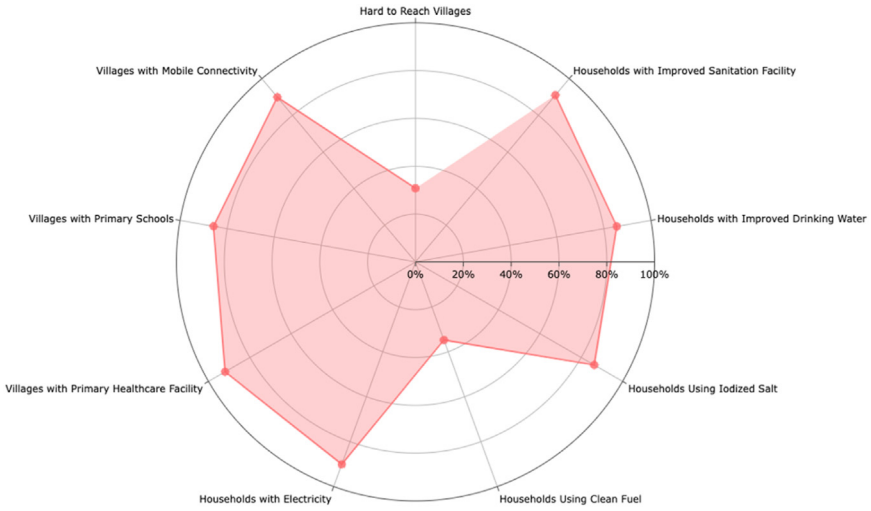

Fig. 2: Village and household-level access to health and social services among Indigenous tribes of Odisha.

Indicator	Wealth quintiles					Type of indigenous groups		Total
	Q1	Q2	Q3	Q4	Q5	ST (N = 7905 HH)	PVTG (N = 1806 HH)	
Child immunisation (age 12–24 months)								
Full immunisation	87.4	87.2	79.9	89.2	94.1	87.3	91.4	88.0
At least 1 dose of MCV	89.9	87.7	80.4	90.9	95.8	89.1	91.5	89.4
Doses at a public healthcare facility	97.6	98.7	94.1	94.6	86.3	93.0	100	94.1
Iron and folic acid supplementation								
Children (age 5–9 years)	65.9	79.9	81.4	80.2	75.5	81.1	64.4	76.6
Adolescents (age 10–19 years)	49.9	52.2	45.9	54.3	53.0	51.1	50.0	50.9
Pregnancy (age 15–49 years, last birth within 5 years)	69.6	87.9	88.3	89.4	94.2	87.8	82.7	86.6
Deworming								
Children (age 5–9 years)	65.3	86.6	89.2	87.9	82.8	85.9	72.6	82.3
Adolescents (age 10–19 years)	51.2	55.2	48.7	57.5	55.2	53.7	52.4	53.4
Mid-day meals at schools	96.9	94.2	93.8	94.1	88.8	93.5	92.9	93.4
Access to contraception (age 15-49-years)								
Any modern method	23.9	25.4	20.8	26.3	30.4	26.4	22.1	25.5
Unmet need for family planning	66.5	64.9	64.9	62.6	59.6	59.4	70.5	61.7
Hygienic menstrual practices (age 15–49 years)	21.3	30.7	30.3	36.4	53.5	38.0	27.9	35.8
Maternity care (age 15–49 years)								
ANC received in 1st trimester	86.1	85.9	86.7	85.0	79.6	84.1	86.7	84.7
4 or more ANCs	35.0	40.4	36.0	48.0	42.1	42.3	32.8	40.3
Post-natal care received within 2 days	32.5	39.6	43.9	31.3	35.7	40.0	26.9	36.7
Institutional births	91.8	91.4	94.1	88.8	90.0	93.9	84.0	91.4
Caesarean section	16.2	16.6	13.6	9.5	24.4	18.1	8.6	15.7
Health insurance (age 20–59 years)	90.9	93.0	92.5	94.8	93.4	92.2	96.2	93.1
Access to internet (age 20–59 years)	25.1	24.7	27.6	26.1	23.5	27.2	17.2	25.1
Access to mobile phones (age 20–59 years)	25.5	41.7	45.1	52.0	62.3	50.0	36.2	47.1
Have bank accounts (age 20–59 years)	87.6	92.5	91.8	94.7	96.2	93.6	90.5	93.0
Cancer screening (age 20–59 years)	0.1	0.1	0.3	0.1	0.1	0.0	0.4	0.1
Pension (60 and above years)	81.3	75.9	78.4	72.6	75.9	76.2	79.7	76.8

ST: Scheduled Tribe, PVTG: Particularly Vulnerable Tribal Group, MCV: Measles-containing vaccine, ANC: Antenatal care.

Table 1: **Proportion of indigenous tribes of Odisha in each class with access to key health and social services (%).**

Child health and nutrition

We found 88.0% of children aged 12–23 months were fully vaccinated with 94.1% receiving their doses at public healthcare facilities, 56.4% of children younger than 3 years were breastfed within 1 h of birth, 43.4% of children younger than 6 months were exclusively breastfed and 74.2% of children aged 6–8 months received appropriate complementary feeding. Among children aged 0–4 years, the prevalence of diarrhoea in the two weeks preceding the survey was 3.7%. Among the children with diarrhoea, the utilisation of oral rehydration salts (ORS) and zinc was 50% and 14.6% respectively and 56.2% of them sought care from a health provider. Similarly, the prevalence of acute respiratory infection (ARI) in the two weeks preceding the survey was 16.2%, among whom 63.9% were taken to a health facility or health provider. Among children aged 5–9 years, 82.9% were currently attending school; diarrhoea prevalence was 0.3% and ARI symptoms were reported in 13.9% of children. Malnutrition remains prevalent with 51.9% of children younger than five years categorised as stunted and 40% as underweight. The nutritional profile across age groups and gender is shown in Fig. 3, while the distribution by age groups and wealth quintile is provided in Supplementary Information S4.

Maternal health and practices

The total fertility rate among the tribal population was 2.1. Among women who gave birth in the last 5 years, 84.7% received antenatal care during the first trimester, yet only 40.3% completed the recommended four antenatal visits. A high proportion (95.3%) of mothers ensured their last birth was protected against neonatal tetanus and 86.6% of mothers used iron and folic acid supplementation for 100 days or more during pregnancy. Institutional birth rates were high at 91.6%, primarily occurring in public health facilities, marking progress in maternal health services. The majority (93.1%) of women were either mothers or pregnant at the time of the survey. Only 44.2% of currently married women reported using some form of family planning method, with 25.5% of women using any modern method. Female sterilisation was a common method (17.5%), followed by oral contraceptive pill (7.5%) and intra-uterine device (IUD), including post-partum IUD (4.4%).

Adolescent and adult health profiles

Among people aged 10–19 years, 92.6% of males and 92.5% of females had ever attended school, but only 24.9% of males and 17.2% of females have ever used the internet. Among females in this age group, 24.8% in this age group were married before the age of 18 years and among those married, 71.1% were already mothers or pregnant at the time of the survey. Among adults aged 20–59 years, 52.7% of males and 43.6% of females had attended school, 37.5% of males and 41.3% of females had received at least ten years of schooling, and 32.7% of males and 15.7% of females having accessed the internet. Tobacco and alcohol usage were prevalent, especially among adult males, with 68% using tobacco and 51.7% consuming alcohol. Access to safe toilets and drinking water was relatively high. However, knowledge about contraception and HIV/AIDS varies, indicating gaps in

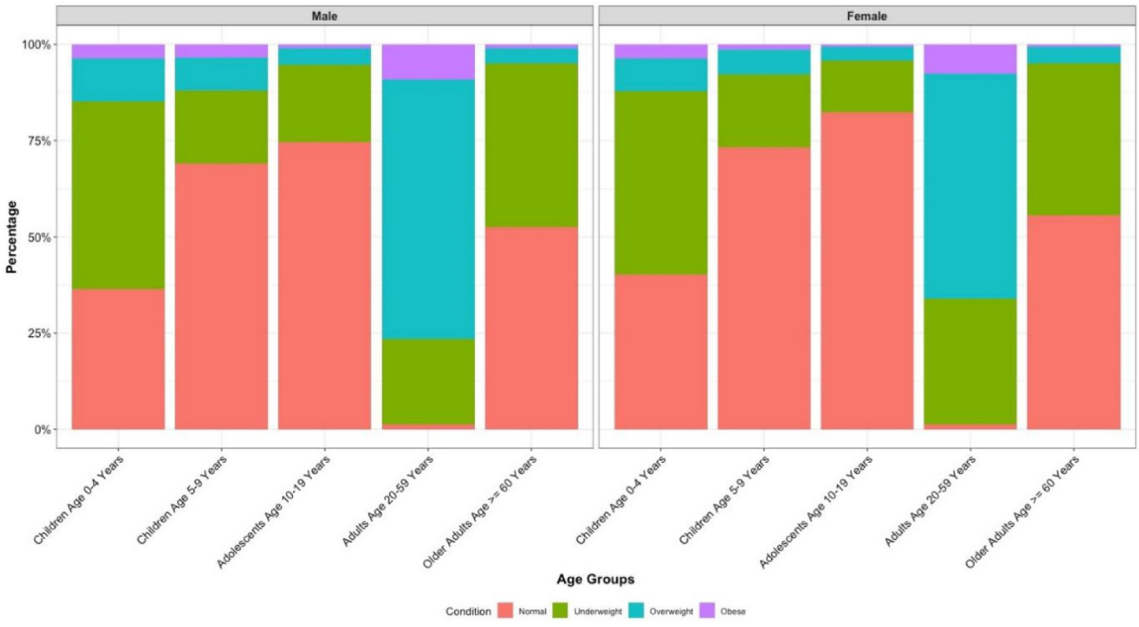

Fig. 3: Nutritional profile of the 53 Indigenous tribes in Odisha.

public health education despite high school attendance rates. Table 2 shows the other socio-behavioural risk factors among Odisha's Indigenous tribes.

The survey highlights significant health challenges among adults in Odisha's tribal communities. Hypertension is prevalent, affecting 34.5% of men, while high blood sugar levels are seen in 9.8% of males and 6.1% of females. There is notable prevalence of chronic conditions such as backache, acid peptic disease, and arthritis, underscoring the need for comprehensive healthcare interventions targeting these communities. The most common morbidities across age and gender are summarised in Table 3.

Women's empowerment

Of all women, 94.9% had their own bank or savings accounts, 45.4% had worked and received cash payments in the past year, 25.9% owned a house or land, either alone or jointly; 35.8% reported using hygienic methods during menstruation and 30.5% married before the legal age of 18.

Older adults' health

Among older adults aged 60 years or more, 54.5% were still in active employment, 76.8% received pensions, 43% had a below-normal BMI and 25.6% self-reported multimorbidity. Common chronic conditions reported are shown in Table 3. The average self-reported health (on a scale of 0–100) was lower in this age group across wealth quintiles in comparison with other age groups as shown in Fig. 4.

Anaemia and haemoglobinopathy

Among children aged 6–59 months, 71.3% were anaemic. The trend continued in adolescents, with anaemia affecting 76.1% of females and 56.9% of males. In adults, 77.5% of females and 42.1% of males were anaemic and 83.2% among older adults. Sickle cell trait was found in 4.8% of children, 6.6% of adolescents, and 5.9% of adults.

Discussion

This comprehensive health assessment of 9711 households across 53 tribes in Eastern India provides critical insights into the health challenges, disparities and progress among Odisha's indigenous populations (Fig. 1). The final sample size fell short of initial estimates due to fewer individuals per household and the difficulty in reaching rarer and migratory tribal groups. Nevertheless, the findings offer an understanding of the multifaceted health landscape of these communities.

Malnutrition and anaemia emerged as major health challenges among Odisha's tribal populations. Over 40% of children younger than five years were stunted or underweight, reflecting severe undernutrition (Fig. 3, Table 3). Despite the availability of iron and folic acid supplementation through national health programmes, uptake and adherence remain suboptimal, particularly in adolescent girls and women of reproductive age (age 15–49 years) (Table 1). This aligns with trends in national surveys like the National Family Health Survey.[9,10] These findings emphasise the urgency of scaling up and refining nutritional programs targeting maternal and child health in tribal populations, which is vital for breaking the cycle of intergenerational malnutrition.[22,23] While integrated interventions such as *Poshan Abhiyaan* and Integrated Child Development Services (ICDS) are in place, the gap between programme reach and expected outcomes points to the need for research to

Risk factor	Adolescent			Adults		
	Males (N = 2040)	Females (N = 2141)	Total (N = 4181)	Males (N = 6967)	Females (N = 9655)	Total (N = 16,622)
Tobacco use						
Current users of any form of tobacco	14.8	1.9	8.2	68.0	31.6	48.2
Median length of use (in years)	3.0	5.0	2.0	10.0	12.0	10.0
Alcohol use						
Current consumers of alcohol	8.8	1.0	4.8	51.7	15.0	32.0
Median length of use (in years)	3.0	5.0	3.0	15.0	20.0	19.0
Access to safe toilets	90.0	90.9	90.5	91.4	92.0	91.8
Access to safe drinking water	85.3	79.0	82.1	84.7	85.4	85.1
Adequate knowledge on contraception methods (any modern Methods, among those currently married)	42.8	30.2	31.7	32.6	48.4	41.1
Adequate knowledge on HIV/AIDS						
Transmission knowledge	70.2	63.8	66.6	66.4	58.5	62.5
Treatment knowledge	59.9	59.7	59.8	59.7	48.5	54.3
Prevention knowledge	66.2	61.2	63.3	64.0	53.2	58.7
Ever attended school	92.6	92.5	92.6	52.7	43.7	63.4

Weighted N: Adolescents (age 10–19 years)–Males = 303,818, Females = 318,380, and Total = 622,198. Adults (age 20–59 years)–Males = 1,339,601, Females = 1,597,611, and Total = 2,937,212.

Table 2: **Socio-behavioural risk factors among 53 Indigenous tribes of Odisha (in %).**

Health state	Children (age 5–9 years)			Adolescents (age 10–19 years)			Adults (age 20–59 years)			Older adults (age ≥ 60 years)		
	Males (N = 1370)	Females (N = 1239)	Total (N = 2609)	Males (N = 2040)	Females (N = 2141)	Total (N = 4181)	Males (N = 6967)	Females (N = 9655)	Total (N = 16,622)	Males (N = 1635)	Females (N = 1886)	Total (N = 3521)
3 most common self-reported chronic conditions												
1	Oral health problems (4.1 (2.2, 7.1))	Oral health problems (3.8 (2.3, 6.3))	Oral health problems (4.0 (2.2, 7.1))	Hypertension (1.0 (0.5, 1.9))	Hypertension (1.4 (0.8, 2.4))	Hypertension (1.2 (0.8, 1.9))	Hypertension (14.7 (13.0, 16.7))	Hypertension (13.8 (12.6, 15.0))	Hypertension (14.2 (13.2, 15.3))	Hypertension (39.0 (35.0, 43.1))	Hypertension (40.9 (36.7, 45.1))	Hypertension (40.0 (37.1, 42.9))
2	Vision impairment (0.1 (<0.01, 0.5))	Mental ill health (0.2 (<0.01, 0.3))	Vision impairment (0.1 (0.01, 0.2))	Acid peptic disease (0.9 (0.5, 1.8))	Arthritis (1.3 (0.2, 8.4))	Arthritis (0.8 (0.1, 4.1))	Chronic backache (12.1 (10.2, 14.3))	Chronic backache (13.2 (11.9, 14.6))	Chronic backache (12.7 (11.6, 13.9))	Vision impairment (27.9 (24.4, 31.7))	Vision impairment (27.4 (23.9, 31.1))	Vision impairment (27.6 (25.1, 30.3))
3	Mental ill health (0.1 (<0.01, 0.1))	Hearing loss (0.1 (0.01, 0.5))	Mental ill health (0.1 (0.03, 0.3))	Disturbed sleep (0.8 (0.2, 3.6))	Sickle cell disease (0.6 (0.2, 1.5))	Disturbed sleep 0.6 (0.2, 1.7)	Acid peptic disease (8.1 (6.4, 10.0))	Acid peptic disease (6.3 (5.8, 7.3))	Acid peptic disease (7.1 (6.2, 8.1))	Chronic backache (26.5 (22.6, 30.7))	Chronic backache (25.0 (21.3, 29.1))	Chronic backache (25.7 (23.0, 28.6))
Anaemia	80.8 (66.8, 89.8)	75.2 (70.1, 79.6)	78.7 (69.4, 85.7)	56.9 (52.3, 61.4)	76.1 (71.4, 80.2)	66.7 (63.0, 70.3)	42.1 (39.9, 44.4)	77.5 (76.0, 78.9)	61.5 (60.1, 62.9)	82.8 (79.0, 86.0)	83.6 (80.7, 86.1)	83.2 (81.0, 85.2)
High blood sugar	NA	NA	NA	0.5 (0.19, 1.06)	1.0 (0.47, 2.03)	0.7 (0.42, 1.27)	9.8 (8.5, 11.)	6.1 (5.3, 6.9)	7.7 (7.0, 8.5)	3.6 (2.08, 6.01)	3.1 (1.56, 6.26)	3.3 (2.15, 5.15)
High blood pressure	NA	NA	NA	1.0 (0.48, 1.87)	1.0 (0.50, 1.87)	1.0 (0.56, 1.66)	11.7 (10.2, 13.4)	9.1 (8.2, 10.0)	10.3 (9.4, 11.2)	27.8 (24.3, 31.7)	27.8 (25.0, 32.0)	27.8 (25.3, 30.5)
Sickle cell disease	0.2 (0.08, 0.6)	1.1 (0.3, 4.3)	0.6 (0.2, 1.7)	0.4 (0.10, 1.32)	0.2 (0.06, 0.62)	0.3 (0.11, 0.71)	0.3 (0.10, 0.92)	0.3 (0.12, 0.53)	0.3 (0.14, 0.52)	0.0 (<0.01, <0.01)	0.0 (<0.01, <0.01)	0.0 (<0.01, <0.01)
Sickle cell trait	4.8 (2.7, 8.4)	4.7 (2.9, 7.5)	4.8 (3.2, 7.1)	6.9 (4.25, 10.9)	6.3 (3.86, 10.0)	6.6 (4.55, 9.36)	5.5 (4.1, 7.4)	6.2 (4.7, 8.1)	5.9 (4.8, 7.2)	3.4 (2.1, 5.5)	4.5 (2.9, 6.8)	3.9 (2.8, 5.4)
Thalassemia	6.7 (4.4, 10.2)	7.3 (3.8, 13.8)	7.0 (4.7, 10.3)	4.6 (2.74, 7.49)	5.5 (3.25, 9.29)	5.0 (3.28, 7.70)	4.5 (3.29, 6.23)	5.5 (4.29, 6.96)	5.1 (4.20, 6.16)	6.7 (4.03, 10.8)	6.1 (2.95, 12.0)	6.4 (4.17, 9.65)
High blood cholesterol	NA	NA	NA	2.2 (1.21, 3.85)	3.7 (2.42, 5.61)	2.9 (2.10, 4.10)	10.8 (9.5, 12.1)	10.2 (9.1, 11.3)	10.4 (9.6, 11.3)	8.4 (6.5, 10.9)	11.2 (9.2, 13.6)	9.9 (8.5, 11.5)
High serum creatinine	NA	NA	NA	53.2 (49.6, 56.9)	24.1 (19.4, 29.4)	38.5 (34.2, 43.1)	72.1 (70.0, 74.1)	47.9 (46.2, 49.5)	58.9 (57.6, 60.3)	54.6 (50.7, 58.4)	51.6 (47.6, 55.7)	53.0 (50.2, 55.8)

Weighted N: Children (age 5–9 years): Male = 285,063, Female = 180,434, and Total = 465,498. Adolescents (age 10–19 years): Male = 303,818, Female = 318,380, and Total = 622,198. Adults (age 20–59 years): Male = 1,339,601, Female = 1,597,611, and Total = 2,937,212. Older adults (age ≥60 years): Male = 269,707, Female = 296,312, and Total = 566,020. NA: Not Applicable.

Table 3: **Morbidity profile of indigenous tribes of Odisha (Prevalence in % [95% CI]).**

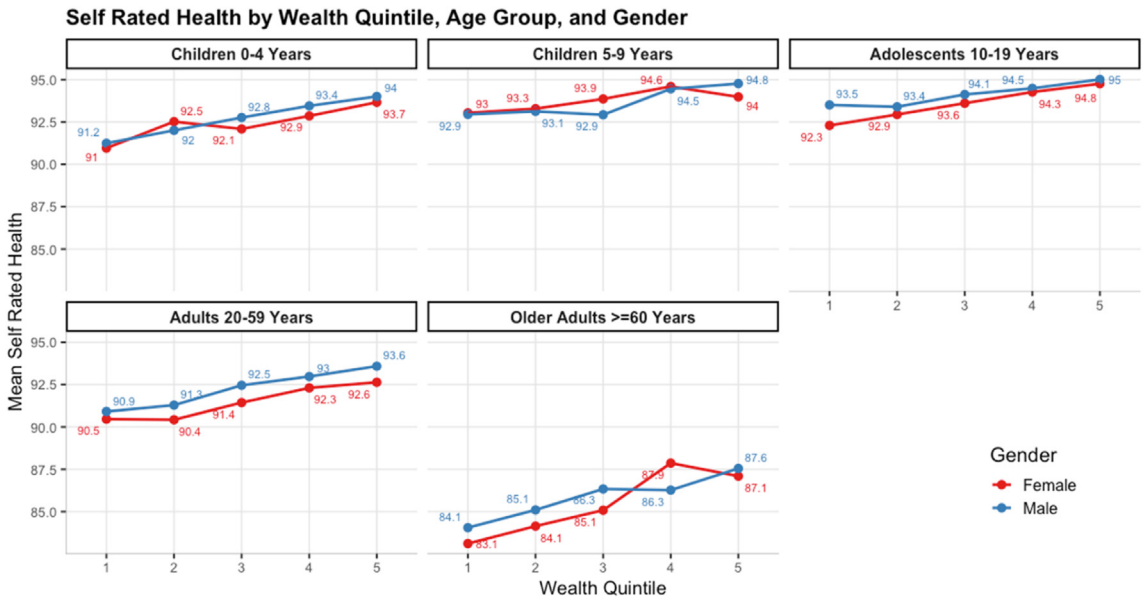

Fig. 4: Average self-rated health among 53 Indigenous tribes in Odisha.

identify cultural barriers and develop effective, context-specific strategies.[24] In addition, there is a need for behaviour change communication and community-led approaches to enhance the impact of anaemia control strategies.

The survey indicates a rising prevalence of chronic conditions such as hypertension and diabetes among adults, with a noticeable shift even in adolescents (Table 3). This epidemiological transition demands urgent public health interventions tailored to tribal populations.[2,15] High rates of tobacco (68%) and alcohol use (51.7%) among adult males, with initiation observed during adolescence, further exacerbate the risk of NCDs. Preventive measures must integrate culturally sensitive frameworks, leveraging local health systems and community engagement to effectively reduce these lifestyle risk factors (Table 2).[3]

OTFHS showed the encouraging progress in women's empowerment among Odisha's tribal communities, with 94.9% of women having bank accounts, indicating increased financial independence. Furthermore, 45.4% reported cash-based employment in the past year, and 25.9% own property either alone or jointly. Despite these advancements, areas like hygienic menstrual practices still require attention. Research consistently shows that women's empowerment positively impacts family health, as financially independent women are more likely to invest in nutrition, education, and healthcare for their families.[25,26] Building on this strength, it is crucial to develop community-specific strategies that further support women's roles in decision-making and resource management, specifically targeting health outcomes.

The reliance on public healthcare facilities for vaccinations, antenatal care, and other services across age groups underscores the dependence on government health infrastructure (Table 1). This presents a significant opportunity to strengthen healthcare delivery within these communities, as well as deliver targeted interventions where necessary. Leveraging this dependence, the government can focus on increasing resource allocation, staffing, and culturally appropriate training for healthcare providers. Additionally, such interventions align with broader goals of ensuring health equity in such groups.[27] The socio-behavioural risk factors highlight the need for public health campaigns aimed at reducing tobacco and alcohol consumption. However, these initiatives should incorporate community perspectives to ensure cultural sensitivity and effectiveness, and successful examples of similar strategies have been reported.[28]

This study provides valuable, disaggregated data specific to each tribe (Supplementary Information S5), offering a detailed overview of health disparities that can guide targeted interventions by the state. The broad scope and large sample size enhance the reliability of findings and allow for comparisons with national surveys, as the design and operational definitions of indicators are aligned with established standards.

This study has some limitations. Sampling biases may arise due to challenges in reaching remote and migratory populations, potentially affecting representativeness. The cross-sectional design restricts causal inferences, emphasising the need for longitudinal studies to better understand health transitions. Reliance on self-reported data introduces recall and social desirability

biases, while variations in laboratory testing conditions could affect measurement accuracy. Non-response bias may further impact data, particularly for sensitive health issues. Additionally, the sample size, while adequate for common conditions, may be underpowered for rare outcomes. Cultural and linguistic barriers could lead to misinterpretation of survey questions, and ethical considerations remain crucial when working with vulnerable tribal populations. Translating such multi sectoral findings into policy action requires sustained engagement with stakeholders. Future studies, if replicated, can enhance representativeness by adaptive sampling strategies, such as targeted oversampling of remote and migratory populations. To improve statistical power for rare outcomes, larger sample sizes or data pooling across similar studies should be considered.

The findings highlight progress in vaccination and institutional births (SDG 3.2) but reveal gaps in breastfeeding, complementary feeding, and malnutrition (SDG 2.2). High diarrhoea and respiratory infections stress the need for better healthcare access (SDG 3.8). Maternal health challenges, including incomplete antenatal care and low contraceptive use, indicate the need for strengthened reproductive health services (SDG 3.1, 3.7).

The survey encapsulates the journey of Odisha's tribal communities from "isolation to inclusion", as they navigate significant health challenges while moving closer to the non-tribal groups in most social and health metrics. By leveraging the robust data provided, stakeholders can implement targeted, culturally sensitive interventions that foster inclusion and improve health outcomes. Bridging the gap further from isolation to inclusion requires sustained effort and collaboration across all levels of health governance, ensuring these communities are not left behind but are integral to India's health progress.

Contributors

Conceptualisation: SP and JSK; Data Curation: JSK, KAK and TR; Formal Analysis: JSK, KAK, TR and HB; Funding acquisition: SP, JSK, DeB,UKS, MN and SK; Methodology: JSK, KAK, HB, AM and DiB; Project administration: JSK, TR, DeB, DiB, AM, HB and KAK; Writing – Original Draft: JSK, TR, KAK and HB; Writing – Review & Editing: JSK, KAK, TR, HB, DiB, AM, UKS, MN, SK, DeB, and SP; Supervision: SP, JSK and DeB.

Data sharing statement

Data will be uploaded to a central repository of ICMR and will be made available upon request through the portal.

Declaration of interests

We declare no competing interests.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lansea.2025.100611.

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