ORIGINAL RESEARCH ARTICLE

Profile of Risk Factors for Noncommunicable Diseases Among the Migrants of Santal Tribe Residing in Bhubaneswar City, Odisha, India

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ABSTRACT

Background: Risk factors of Noncommunicable diseases (NCDs) are increasing among Indian tribes. However, this issue remains unexplored in migrants of Odisha's Santal tribe, in Bhubaneswar city. **Objective:** To assess the prevalence of behavioural and selected metabolic risk factors of NCDs among Santal migrants aged 18 to 69 years in Bhubaneswar.

Methodology: A cross-sectional study involving 516 Santal migrants was conducted from September to December 2022 using the WHO STEPS survey questionnaire. Descriptive statistics and logistic regression analyses were performed using R statistical software.

Results: Prevalence of tobacco and alcohol use were 80% (95% CI: 76.3–83.3) and 81.8% (95% CI: 78.1–85.0), respectively with higher rates among males. Low physical activity was reported by 30.6% (95% CI: 26.7–34.8), commonly among females. 98.8% participants had inadequate fruit and vegetable intake. Hypertension was found in 40.3% (95% CI: 36.1–44.7), abdominal obesity in 33.5% and obesity in 28.5%.

Conclusions: High prevalence of NCD risk factors was observed among Santal migrants with inadequate intake of fruits and vegetables, followed by alcohol and tobacco use being most prevalent. Male gender was independently linked to tobacco and alcohol use; age 45-69 years with alcohol use and low education with tobacco use. Culturally appropriate, community-based health promotion programs could be beneficial.

Key-words: NCD risk factors, tribal, migrants, prevalence, WHO STEPs, Odisha

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Introduction

Noncommunicable diseases (NCDs) represent an escalating public health challenge and primary cause of premature mortality globally, responsible for 74% of all deaths, including 41 million annually, with over 75% occurring in low- and middle-income nations.[1,2] NCDs, such as heart disease, stroke, cancer, diabetes, and chronic lung disease, result in 8.5 million fatalities each year in the South-East Asia region.[1,3] The WHO's NCD Progress Monitor 2022, indicates noncommunicable diseases account for 66% of all deaths in India.[4] Key modifiable risk factors encompass tobacco use, poor dietary habits, physical inactivity, and harmful alcohol consumption, all of which contribute to metabolic risk factors that elevate the likelihood of developing NCDs.[2,5]

Growing evidence indicates that marginalized communities are at a greater risk of developing NCDs due to limited access to healthcare and higher exposure to harmful habits such as tobacco use and unhealthy diets.[6] India, with over 104 million tribal people comprising 8.6% of the population,[7] faces a triple burden of diseases. While malnutrition and communicable diseases such as malaria and tuberculosis remain widespread, the prevalence of NCDs like cancer, hypertension, and diabetes has increased due to rapid urbanization, environmental distress, and changing lifestyles.[8] A study on Kerala's Kani tribe revealed a high prevalence of hypertension (48.3%), tobacco use (81.5%), and alcohol consumption (36.2%) among this tribe.[9]

Odisha, an eastern Indian state, has a sizeable tribal population, comprising 22.8% of its total population.[7] With 62 distinct tribal groups.[10] The Santal, the second-largest tribal group in Odisha and one of its more advanced tribal communities, have a literacy rate of 55.6%, above the state's tribal average of 52.5%.[11,12] Santals predominantly engage in settled agriculture and supplement their income through seasonal forest collection. Over the past four decades, the majority, originally from Odisha's Mayurbhanj district, have migrated to Bhubaneswar for employment and better living conditions,[13] settling in slums across the city.

Migration introduces significant lifestyle changes. While tribal customs and values shape their traditional health behaviours, their urban migration often leads to adopting or intensifying unhealthy practices, including tobacco use, alcohol consumption, poor dietary habits, and decreased physical activity. These behaviors are known risk factors for noncommunicable diseases, compounding health vulnerabilities. Lifestyle changes driven by urbanization are strongly linked to elevated NCD risk factors.[14]

Reducing the NCD burden and its primary risk factors among tribal communities necessitates a thorough understanding of the current situation. While a few studies have examined specific NCD risk factors, including tobacco use, alcohol consumption, and hypertension among certain tribal communities in Odisha, no studies have explored the prevalence of significant risk factors of NCDs within Santal migrants residing in Bhubaneswar. Considering Odisha's large tribal population and increasing rural-to-urban migration of tribes, it is crucial to investigate NCD risk factors among the Santal migrants in Bhubaneswar. This evidence could serve as a guide in shaping targeted interventions and enhancing NCD prevention and control initiatives for tribal migrants.

The objective of this study was to examine the prevalence of behavioural risk factors, which include tobacco use, alcohol consumption, unhealthy dietary habits, and physical inactivity, as well as metabolic risk factors such as elevated blood pressure and overweight/obesity of NCDs among migrant individuals of the Santal tribe residing in Bhubaneswar. The assessment was conducted using the WHO STEP-wise approach for noncommunicable disease risk factor surveillance (STEPS).

Methodology

Study setting and Study population: This cross-sectional study was conducted among migrants of the Santal tribe, aged 18–69 years, who had relocated from Odisha's Mayurbhanj district and had been residing in the slums of Bhubaneswar city for at least five years. The survey, which focused on NCD risk factors, was carried out following the WHO STEPS guidelines,[15] between September and December 2022.

Sample size and Sampling Methods: The sample size calculation was based on the prevalence of hypertension (15.6%) among tribal males in Odisha, as reported in NFHS-4.[16] A 5% precision level and a design effect of 2 were considered, resulting in a required sample size of 404. To account for gender-stratified analysis and a 7% non-response rate, the final sample size was rounded to 516. A multistage sampling technique was employed. In the first stage, four slums were randomly selected from seven in Bhubaneswar where Santal migrants resided. In the second stage, Santal Households in each selected slum were identified. In the 3rd stage, 129 participants were selected from identified households in each slum. All eligible individuals from these households who consented to participate were included in the study. The initial household was selected randomly, and subsequent households were surveyed consecutively until the target of 129 participants per slum was reached.

Data collection Instrument and Procedure: The WHO-STEPS (version 3.2) survey questionnaire on surveillance of non-communicable disease risk factors was adapted to the local context, translated into Odia, and piloted before commencing data collection. The assessment of risk factors was carried out in two steps. In the first step, behavioural risk factors, including tobacco use, alcohol consumption, physical

inactivity, and insufficient intake of fruits and vegetables, were assessed. In the second step, physical measurements for calculation of body mass index (BMI) and abdominal obesity, as well as blood pressure (BP) measurement to determine hypertension were conducted. Data were collected from eligible individuals in the households by trained investigators, including the first author, through face-to-face interview using KoBo Toolbox. WHO STEPS standard operating procedures were strictly followed. Height was recorded with a portable stadiometer (accuracy: 0.1 cm), while weight was measured using an electronic flat weighing scale with an accuracy of 100 g. Waiste circumference (WC) was measured using SECA constant tension tape. BP was measured with an OMRON digital sphygmomanometer (HEM 7120), with three readings taken at three-minute intervals and the last two readings were averaged to establish BP. To ensure reliability and validity of data, all field investigators were uniformly trained using standardized protocols prior to data collection. Additionally, regular field supervision and consistency checks were made during data collection to ensure inter-observer reliability and data accuracy.

Operational definition used: Behavioural risk factors were defined based on the thresholds outlined in the STEPS guidelines.[15] Tobacco use, encompassing both smoking and smokeless forms, was classified as current use if consumed within the last 30 days. Similarly, alcohol consumption was considered current use if it had occurred within the past 12 months. Eating less than five servings of fruits and vegetables per day was termed as inadequate intake of fruits and vegetables. Physical activity was assessed by recording different types of activities (work, travel, and recreational) and intensity levels (low, moderate, and vigorous). This was factored with activity duration, for computing metabolic equivalent time ('MET-minutes per week'). Based on 'MET-minutes/week', physical activity was categorized as high (≥3000 'MET-minutes/week'), moderate (600–2999 'MET-minutes/week'), or low (<600 'MET-minutes/week').[9] Overweight and obesity were classified based on Asian-specific BMI cut-offs. A BMI between 23 to 24.99 kg/m^2 was categorised as overweight, whereas BMI ≥25 kg/m^2 was classified as obese. Abdominal obesity was assessed based on waist circumference criteria, set at 90 cm or more (≥90 cm) for men and 80 cm or more (≥80 cm) for women.[17] Hypertension was identified based on a systolic blood pressure of ≥140 mm Hg, or a diastolic blood pressure of ≥90 mm Hg, or the current use of hypertension-lowering medication.[18]

Ethical Consideration: The study received technical approval from the doctoral committee of SRM Institute of Science and Technology, Kattankulathur, Tamil Nadu. Ethical clearance was granted by the Institutional Ethics Committee of Kalinga Institute of Medical Sciences (KIMS), Bhubaneswar (Ref. No.: KIIT/KIMS/IEC/773/2021, dated 09/12/2021). Approval from the Research and Ethics Committee of the Department of Health and Family Welfare, Government of Odisha was also obtained. Prior to the data collection, informed consent was obtained from all participants, ensuring voluntary participation and the right to withdraw at any stage.

Statistical Analysis: Data compilation and cleaning were carried out using Microsoft Excel 2011. R statistical software (version R.4.4.1) was used for performing further analysis. Descriptive statistics were utilized to summarize the socio-demographic characteristics of the study population, and chi-square tests were employed to study the variations among groups. The prevalence of NCD risk factors was estimated with 95% confidence intervals (CI) to assess variability across subgroups. Additionally, bivariate and multiple logistic regression analyses were performed to explore associations between NCD risk factors and various social determinants, presenting un-

Table 1: Socio-demographic profile of Santal Tribal migrants in Bhubaneswar (N=516)

Variables	Female (N=216) (%)	Male (N=300) (%)	Total (N=516) (%)	p value
Age (in years)				
18-44	146 (67.6%)	193 (64.3%)	339 (65.7%)	0.442
45-69	70 (32.4%)	107 (35.7%)	177 (34.3%)	
Educational Status				
No formal schooling	97 (44.9%)	100 (33.3%)	197 (38.2%)	0.011
Primary school	41 (19.0%)	60 (20.0%)	101 (19.6%)	
Secondary school and above	76 (35.2%)	140 (46.7%)	216 (41.9%)	
Refused	2 (0.9%)	0 (0.0%)	2 (0.4%)	
Marital status				
Currently not married	56 (25.9%)	66 (22.1%)	122 (23.7%)	0.153
Currently married	160 (74.1%)	228 (76.5%)	388 (75.5%)	
Refused	0 (0.0%)	4 (1.3%)	4 (0.8%)	
Work status				
Working	120 (55.6%)	254 (84.7%)	374 (72.5%)	
Not working	89 (41.2%)	43 (14.3%)	132 (25.6%)	< 0.001
Refused	7 (3.2%)	3 (1.0%)	10 (1.9%)	
Annual income				
Less than Rs. 1 lakh	75 (34.7%)	85 (28.3%)	160 (31.0%)	0.122
Rs. 1 Lakhs and above	141 (65.3%)	215 (71.7%)	356 (69.0%)	

adjusted and adjusted odds ratios (ORs) respectively to quantify these relationships. Variables with *p*-value < 0.25 in the bivariate analysis were included in the multiple logistic model.

RESULTS

The socio-demographic profile of the study population is reflected in the Table 1. The study participants comprised 516 Santal tribal migrants residing in Bhubaneswar, consisting of 300 males and 216 females. The mean age of the respondents was 38.91 years (SD=12.39 years). The majority of the respondents (65.7%) were aged 18 - 44 years. 38.2% of the respondents had no formal schooling while 41.9% had completed secondary education and higher. Educational attainment also differs across gender with more females (44.9%) than males 33.3% lacking formal education (p=0.011). 72.5% of the respondents were employed primarily with informal sectors, with males showing a significantly higher employment rate (84.7%) than females (55.6 %), p<0.001. Nevertheless, no significant difference was observed in income levels, with 69% of the respondents earning Rs. 1 lakh or more yearly (p=0.122). The prevalence of various risk factors of NCDs is shown in table 2. The prevalence of current tobacco and alcohol use among the respondents was 80% (95% CI: 76.3 - 83.3) and 81.8% (95% CI:78.1-85.0), respectively. Tobacco and alcohol consumption were significantly more prevalent among individuals aged 45-69 years, with rates of 88.1% (95% CI: 82.2-92.3) and 88.7% (95% CI: 82.9-92.8), respectively, compared to those in the 18-44 years age group. Additionally, the consumption of tobacco and alcohol was notably higher among males than females. Low physical activity was observed among 30.6% (95% CI: 26.7-34.8) respondents, and it was more common in females, 39.4% (95% CI: 32.9 - 46.2) and non-working individuals, 68.9% (95% CI: 60.2 - 76.5). Nearly all the respondents, i.e., 98.8% (95% CI: 97.4 - 99.5), reported inadequate fruits and vegetables intake (<5 servings per day). No significant difference was observed across age and gender sub-groups. 40.3% (95% CI: 36.1 - 44.7) of the respondents had elevated blood pressure (hypertension), which was significantly higher among the 45-69 age group 51.4 % (95% CI: 43.8- 58.9) compared to the 18-44 age group 34.5 % (95% CI: 29.5-39.9). Prevalence was a little higher in males 41.0 % (95% CI: 35.4 - 46.8) than in females 39.4% (95% CI: 32.9-46.2). Abdominal obesity was observed among 33.5% (95% CI: 29.5-37.8) of the participants. Females showing significantly higher prevalence of abdominal obesity 54.6% (95% CI: 47.7-61.4), which is 3 times than that of the males 18.3% (95% CI: 14.2-23.3). Overweight and obesity were identified in 23.1% (95% CI: 19.5 -27.0) and 28.5% (95% CI:24.7-32.6) of respondents respectively. Obesity prevalence was significantly higher in the age group of 45 - 69 years, 35.0% (95% CI: 28.1- 42.6) compared to 18-44 years age group, 25.1% (95% CI: 20.6 - 30.1).

Association between Socio-demographic determinants and NCD risk factors are shown in table 3 and 4. Tobacco use was significantly higher among males (AOR: 3.13, 95% CI: 1.87-5.30) and married individuals (AOR: 2.88, 95% CI: 1.70-4.89). Education plays a significant role, with individuals having no formal schooling have higher odds of tobacco use (AOR: 3.65, 95% CI: 1.90-7.29) compared to those having secondary and higher education. Alcohol consumption was more prevalent in men (AOR: 2.75, 95% CI: 1.62-4.71), married individuals (AOR: 2.19, 95% CI: 1.26-3.77), and persons aged 45-69 years (AOR: 1.98, 95% CI: 1.06-3.86), though it was not significantly associated with education.

Table2a: Prevalence of NCD Risk factors among Santal Tribal Migrants in Bhubaneswar (N=516)

Variables	Current Tobacco Use % (95% CI)	Current Alcohol Use % (95% CI)	Low Physical Activity % (95% CI)	Inadequate intake of fruits & Vegetables % (95% CI)
Age (in years)				
18-44	75.8*(70.8 - 80.2)	78.2*(73.3- 82.4)	33.0 (28.1- 38.4)	99.1 (97.2 - 99.8)
45-69	88.1 (82.2 - 92.3)	88.7 (82.9 - 92.8)	26.0 (19.8 - 33.2)	98.3 (94.7 - 99.6)
Sex				
Female	71.8*(65.2 - 77.6)	74.1*(67.6 - 79.7)	39.4*(32.9 - 46.2)	98.1 (95.0 - 99.4)
Male	86.0 (81.4 - 89.6)	87.3 (82.9 - 90.8)	24.3 (19.7 - 29.7)	99.3 (97.3 - 99.9)
Educational Status				
No formal schooling	89.3* (84.0 - 93.1)	85.3 (79.4 - 89.8)	28.9* (22.8 - 35.9)	99.0 (96.0 - 99.8)
Primary school	81.2 (71.9 - 88.0)	83.2 (74.1 - 89.6)	17.8 (11.2 - 27.0)	98.0 (92.3 - 99.7)
Secondary school and above	71.3 (64.7 - 77.1)	78.2 (72.0 - 83.4)	38.4 (32.0 - 45.3)	99.1 (96.3 - 99.8)
Marital Status				
Currently married	84.8* (80.7 - 88.1)	85.8* (81.9 - 89.1)	27.1* (22.8 - 31.8)	98.7 (96.8 - 99.5)
Currently not married	65.6 (56.4 - 73.8)	71.3 (62.3 - 79.0)	41.0 (32.3 - 50.3)	99.2 (94.8 - 100.0)
Work Status				
Working	83.4* (79.2 - 87.0)	84.5 (80.3 - 87.9)	15.2* (11.8 - 19.4)	98.9 (97.1 - 99.7)
Not working	74.2 (65.8 - 81.3)	79.5 (71.5 - 85.9)	68.9 (60.2 - 76.5)	99.2 (95.2 - 100.0)
Annual Income				
Less than Rs. 1 lakh	75.0 (67.4 - 81.3)	74.4* (66.8 - 80.8)	41.9* (34.2 - 49.9)	100.0 (97.1 - 100.0)
Rs. 1 Lakhs and above	82.3 (77.8 - 86.0)	85.1 (80.9 - 88.6)	25.6 (21.2 - 30.5)	98.3 (96.2 - 99.3)
Overall	80.0 (76.3 - 83.3)	81.8 (78.1 - 85.0)	30.6 (26.7 - 34.8)	98.8 (97.4 - 99.5)

Table2b: Prevalence of NCD Risk factors among Santal Tribal Migrants in Bhubaneswar (N=516)

Variables	Elevated Blood Pressure % (95% CI)	Abdominal Obesity % (95% CI)	Overweight % (95% CI)	Obesity % (95% CI)
Age (in years)				
18-44	34.5 *(29.5 - 39.9)	31.3 (26.4 - 36.5)	22.7 (18.4 - 27.6)	25.1*(20.6 - 30.1)
45-69	51.4 (43.8 - 58.9)	37.9 (30.8 - 45.5)	23.7 (17.8 - 30.8)	35.0 (28.1 - 42.6)
Sex				
Female	39.4 (32.9 -`46.2)	54.6*(47.7-`61.4)	19.9 (14.9 - 26.0)	29.2 (23.3 - 35.8)
Male	41.0 (35.4 - 46.8)	18.3 (14.2 - 23.3)	25.3 (20.6 - 30.7)	28.0 (23.1 - 33.5)
Education				
No formal schooling	47.7* (40.6-54.9)	36.5 (29.9 - 43.7)	22.8 (17.3 - 29.5)	31.0 (24.7 - 38.0)
Primary school	42.6(32.9-52.8)	33.7 (24.8 - 43.8)	21.8 (14.4 - 31.3)	27.7 (19.5 - 37.7)
Secondary school and above	32.4(26.3-39.1)	31.0 (25.0 - 37.7)	24.1 (18.6 - 30.4)	26.4 (20.7 - 32.9)
Marital Status				
Currently married	43.6*(38.6-48.7)	35.1 (30.3 - 40.1)	23.5 (19.4 - 28.1)	28.9 (24.5 - 33.7)
Currently not married	30.3(22.5-39.4)	29.5 (21.8 - 38.6)	23.0 (16.0 - 31.6)	27.0 (19.6 - 36.0)
Work Status				
Working	44.4(39.3-49.6)	30.5* (25.9 - 35.5)	25.1 (20.9 - 29.9)	28.3 (23.9 - 33.3)
Not working	31.1(23.5-39.8)	43.9 (35.4 - 52.8)	17.4 (11.6 - 25.2)	29.5 (22.1 - 38.2)
Annual Income				
Less than Rs. 1 lakh	36.3 (28.9- 44.3)	35.0 (27.7 - 43.0)	20.6 (14.8 - 27.9)	27.5 (20.9 - 35.2)
Rs. 1 Lakhs and above	42.1(37.0-47.5)	32.9 (28.1 - 38.0)	24.2 (19.9 - 29.0)	28.9 (24.3 - 34.0)
Overall	40.3 (36.1 - 44.7)	33.5 (29.5 - 37.8)	23.1 (19.5 - 27.0)	28.5 (24.7 - 32.6)

*Indicates that there is a statistically significant (p<0.05) difference between the sub-groups. CI: Confidence Interval

Low physical activity was significantly linked with employment status, with non-working people 12.7 times more likely to report low physical activity (AOR: 12.7, 95% CI: 7.60-21.7). Elevated blood pressure was more common among individuals aged 45-69 years (AOR: 1.63, 95% CI: 1.08-2.47), while non-working individuals showed lower odds (AOR: 0.64, 95% CI: 0.41-0.99). Abdominal obesity was significantly higher among individuals aged 45-69 years (AOR: 1.72, 95% CI: 1.07-2.75) and females, whereas males are less likely to experience it (AOR: 0.16, 95% CI: 0.11-0.25).

For two outcome variables such as inadequate intake of fruits and vegetables and obesity, only one independent variable each met the inclusion criteria of p <0.25 in bivariate analysis. Therefore, multiple logistic regression was not conducted for these outcome variables.

Discussion

The study highlights the prevalence of NCD risk factors and their association with socio-demographic characteristics among Santal migrants in Bhubaneswar. Most participants were young adults (18-44 years), with a notable gender gap in education levels, as a higher proportion of women lacked formal schooling compared to men. Insufficient fruit and vegetable intake (98.8%) was the most identified risk factor followed by alcohol (81.8%) and tobacco (80.0%) use, particularly in males. Nearly one-third of the participants reported low physical activity, with a higher prevalence observed among females and those that were unemployed. Older adults were more likely to have elevated blood pressure, while abdominal obesity and obesity were commonly witnessed in females. Among working individuals, low physical activity was the least prevalent risk factor. Using multiple logistic regression analysis, male gender, age 45–69 years, lack of formal education, unemployment, and low income were identified as independent risk factors for NCDs. Men had decreased odds of abdominal obesity, but higher odds of tobacco and alcohol consumption. Older age was associated with a higher probability of alcohol consumption, hypertension, and abdominal obesity, while unemployment (not working) and income were linked to low physical activity.

Tobacco use among Santal migrants was significantly higher than the general population of Odisha (45.6%, Global Adult Tobacco Survey - GATS-2),[19] and urban tribal adults of Madhya Pradesh (48.1%),[20] but lower than the Nicobarese tribe (88.25%),[21] and Assam's Mishing tribe (84.3%).[22] Older adult (45-69 years) group had higher rates of tobacco consumption, aligning with the national data of Longitudinal Ageing Study in India - LASI (2017-19),[23] and a nationwide study using GATS and the Global Youth Tobacco Survey (GYTS)[24] data. The gender disparity in tobacco use reflects findings from tribal populations of Wayanad, Kerala, where men had substantially higher usage rates.[25] Tobacco use was also more frequent among married individuals, a trend observed in a previous tribal study in Madhya Pradesh.[26] A relationship between tobacco use and educational attainment was observed, with those lacking formal schooling consuming more, consistent with findings from Madhya Pradesh,[26] underscoring education's protective role.

High alcohol consumption was noted among Santal migrants which was more than that found among several Indian tribes, such as Kani (Kerala),[9] Mishing (Assam),[22] Kinnaur (Himachal Pradesh),[27] rural tribes (Nagaland),[28] tribal groups in Siliguri (West Bengal),[29] and Tripura,[30] with prevalence ranging from 15.9% to 67%.

Table 3: Determinants of NCD risk factors among Santal migrants in Bhubaneswar: Results from bivariate logistic regression analysis (Unadjusted ORs) (N=516)

Variables	Current tobacco use OR (95% CI)	Current alcohol use OR (95% CI)	Low physical activity OR (95% CI)	Inadequate intake$ OR (95% CI)	Elevated Blood Pressure OR (95% CI)	Abdominal Obesity OR (95% CI)	Overweight OR (95% CI)	Obesity OR (95% CI)
Age 45-69 years	2.37(1.43-4.07)**	2.19(1.31-3.82)	0.71(0.47-1.06)	0.52(0.09-2.82)	2.01(1.39-2.91)**	1.34(0.91-1.96)	1.06(0.69-1.62)	1.61(1.08-2.39)*
Male Gender	2.42(1.56-3.77)**	2.41(1.53-3.83)**	0.5(0.34-0.72)**	2.81(0.54-20.4)	1.07(0.75-1.53)	0.19(0.12-0.28)**	1.37(0.90-2.10)	0.94(0.64-1.39)
Educational Status								
No formal schooling	3.37(2.00-5.90)**	1.61(0.97-2.71)	0.65(0.43-0.98)*	0.91(0.11-7.65)	1.9(1.28-2.84)**	1.28(0.85-1.93)	0.93(0.59-1.47)	1.25(0.82-1.92)
Primary school	1.74(0.99-3.17)	1.37(0.76-2.60)	0.35(0.19-0.61)**	0.46(0.05-3.90)	1.55(0.95-2.52)	1.13(0.68-1.86)	0.88(0.49-1.53)	1.07(0.62-1.81)
Currently married	2.93(1.83-4.66)**	2.44(1.49-3.95)**	0.53(0.35-0.82)**	0.63(0.03-3.98)	1.77(1.15-2.76)**	1.29(0.83-2.02)	1.03(0.64-1.69)	1.09(0.70-1.74)
Not working	1.75(1.08-2.80)*	1.4(0.83-2.31)	0.08(0.05-0.13)**	0.71(0.04-4.83)	1.77(1.17-2.72)**	0.56(0.37-0.84)**	1.59(0.97-2.69)	0.94(0.61-1.47)
Annual income ≥Rs. 1 Lakhs	1.55(0.98-2.42)	1.97(1.24-3.12)**	0.48(0.32-0.71)**	NA	1.28(0.87-1.89)	0.91(0.62-1.35)	1.23(0.78-1.95)	1.07(0.71-1.64)

*p <0.05; **p<0.01; $ Inadequate intake of fruits and vegetables

Reference group (for age '18-44 yr', for Gender 'female', for Educational status 'secondary school and above', for Marital status 'Currently not married', for work status 'Working', for Annual income 'Less than Rs. 1 lakh')

OR: Unadjusted Odds Ratio, CI: Confidence Interval, NA: Logistic regression was not performed due insufficient variability in the outcome variable for meaningful statistical analysis.

Table 4: Determinants of NCD risk factors among Santal migrants in Bhubaneswar: Results from multiple logistic regression analysis (Adjusted ORs) (N=516)

Variables	Current tobacco use AOR (95% CI)	Current alcohol use AOR (95% CI)	Low physical activity AOR (95% CI)	Elevated Blood Pressure AOR (95% CI)	Abdominal obesity AOR (95% CI)	Overweight AOR (95% CI)
Age 45-69 years	1.46(0.79-2.77)	1.98*(1.06-3.86)	0.98(0.56-1.68)	1.63*(1.08-2.47)	1.72*(1.07-2.75)	1.06(0.69-1.64)
Male Gender	3.13*(1.87-5.30)	2.75*(1.62-4.71)	1.01(0.61-1.69)	a	0.16*(0.11-0.25)	1.27(0.81-2.01)
Educational Status						
No formal schooling	3.65*(1.90-7.29)	1.33(0.71-2.53)	0.53*(0.30-0.94)	1.54(0.98-2.42)	0.79(0.48-1.30)	a
Primary school	1.33(0.71-2.57)	1.06(0.54-2.15)	0.4*(0.19-0.80)	1.26(0.75-2.09)	0.95(0.54-1.66)	a
Currently married	2.88*(1.70-4.89)	2.19*(1.26-3.77)	1.06(0.62-1.86)	1.38(0.87-2.20)	a	a
Not working	1.02(0.59-1.78)	1.2(0.68-2.16)	12.7*(7.60-21.7)	0.64*(0.41-0.99)	1.05(0.66-1.67)	0.69(0.40-1.15)
Annual income ≥Rs. 1 Lakhs	1.42(0.84-2.39)	1.54(0.90-2.60)	0.56*(0.34-0.93)	1.2(0.79-1.81)	a	a

Reference group (for age '18-44 yr', for Gender 'female', for Educational status 'secondary school and above', for Marital status 'Currently not married', for work status 'Working', for Annual income 'Less than Rs. 1 lakh')

AOR: Adjusted Odds Ratio, CI: Confidence Interval, * Indicates a statistically significant at p< 0.05, a: Variables whose *p*-value was >0.25 in unadjusted model, excluded in adjusted model.

However, it remained lower than the Munda tribe in Odisha, where consumption was almost universal at 100%.[31] Among male Santal migrants, alcohol use (87.3%) surpassed levels in Assam's Mishing tribe,[22] Kerala's Kani tribe,[9] and tribal groups in Siliguri,[30] (46.3% to 81.6%). They also exceeded the consumption rates in the general male population in Odisha and India, as per the National Family Health Survey - 5 (NFHS-5).[33] Female alcohol consumption was strikingly elevated compared to the Mishing tribe,[22] and Santal and Mahato tribes in West Bengal.[32] Contrary to a study on Kinnaur tribe of Himachal Pradesh,[27] our study found no significant association between alcohol consumption and education levels, unlike the one observed with tobacco intake.

Around one-third of the respondents reported low level of physical activity with more prevalent among women and non-working individuals. Low physical activity was observed in one-third of the participants, with higher prevalence among women and non-working individuals. However, overall prevalence among Santal migrants was lower than Bhubaneswar's urban population (71.9%),[34] but higher than rural tribal groups like the Rang Bhotia (Uttarakhand, 17.7%),[35] and Kani (Kerala, 9.7%)[9]. These differences highlight variations in lifestyle patterns across tribal and urban settings. These differences depict variations in lifestyle patterns between tribal and urban settings. Reduced physical activity among women and non-working individuals may stem from traditional gender roles and occupational patterns. Devising community-based fitness programs and awareness campaigns, promoting active lifestyles could be a useful approach to tackle this issue.

Inadequate fruit and vegetable intake was nearly universal, mirroring trends among the Kani tribe in Kerala,[9] and industrial workers in Assam,[36] where none met dietary recommendations. This prevalence was higher than the rural tribal population in Mokokchung (Nagaland),[28] urban slum dwellers in Burdwan Municipality (West Bengal),[37] and Assam's Mishing tribe.[22] This inadequacy could be probably attributed to affordability issues and gradual transitions from their traditional dietary habits in the context of urban living.

Prevalence of hypertension among Santal migrants (40.3%) was higher than other tribal populations, such as the Mishing tribe (Assam),[22] the Sabar and Munda tribes (Odisha),[38] and the tribal population in Kinnaur's tribal population,[27] (16.7%-25.5%). It was however similar to levels seen in the Gujjar and Bakarwal tribes (Jammu and Kashmir),[39] and lower than the Langia Saora tribe (Odisha),[40] Thrissur's tribal population (Kerala),[41] the Bhotia tribe (Uttarakhand),[35] and the Gujjar and Bakarwal tribes (Jammu and Kashmir),[39] where prevalence ranged from 41.4% to 68%.

About one third of the respondents had abdominal obesity with disproportionately high among women. Nevertheless, the overall prevalence of abdominal obesity was higher than the findings from Missing tribe (Assam),[22] Kani tribe (Kerala),[9] and tribe of Himachal Pradesh,[27] with a prevalence ranged from 8.8% to 22.1%. Yet, the prevalence was lower than that reported among tribal communities in Vellore, Tamil Nadu,[42] Tripura,[30] Paschim Midnapore, West Bengal,[43] and Nagaland,[28] ranging between 35% to 49.6%. However, overall prevalence was lower than that observed in Kerala's slum population,[44] and the rural population in Khurda district, Odisha,[45] and the urban population of Odisha as per NFHS-5.[33]

Obesity among Santal migrants was higher than in Assam's Rengma tribe,[46] and the tribal population of Birbhum, West Bengal.[47] However the prevalence was lower than that reported among urban population of Odisha as per NFHS-5.[33]

Limitations

Since the study was conducted through interviews, certain behavioral risk factors may have been underestimated due to socially desirable responses. Additionally, dependence on participants' self-reported health habits could have introduced recall bias. However, these biases were minimized by conducting interviews with trained investigators and using the standardized STEPS questionnaire

Conclusion

High prevalence of different behavioural and metabolic risk factors of NCDs has been reported among Santal tribal migrants in Bhubaneswar in the current study. The most prevalent risk factors were inadequate intake of fruits and vegetables, followed by alcohol consumption and tobacco use. Male gender was independently associated with tobacco and alcohol use; age 45-69 with alcohol use and low education was associated with tobacco use. The findings emphasize the need for comprehensive, and targeted public health measures. Culturally appropriate strategies that promote behaviour change, coupled with community-based health promotion programs, could play a pivotal role in preventing and controlling the risk of NCDs among this vulnerable population.

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sion of the manuscript, and overall oversight of the study, including supervision. Both authors have reviewed and approved the final manuscript.

Availability of Data: The Data that support the findings of this study are available upon reasonable request from the corresponding author due to privacy/ethical restrictions

No use of generative AI tools: This article was prepared without the use of generative AI tools for content creation, analysis, or data generation. All findings and interpretations are based solely on the authors' independent work and expertise

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