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Sedentary work and expanding waistlines: a cross-sectional study on occupational roles and abdominal obesity in India

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Abstract

Background Low- and middle-income countries are undergoing epidemiological and demographic transitions alongside economic growth, contributing to a rise in abdominal obesity. In India, the increase in sedentary occupations and insufficient physical activity are key drivers of this growing health concern. This study investigates the relationship between occupational types and abdominal obesity markers in well-characterised adults, accounting for a wide range of confounders.

Methods Using a nationally representative sample of 99,653 women and 91,990 men, occupations were categorised into sedentary work (SW), non-sedentary work (NSW), and not working (NW). Two outcomes were assessed: abdominal obesity, measured via waist-to-hip ratio (WHR) using WHO cutoffs, and a higher-risk threshold of WHR ≥ 1. Bivariate analyses and multivariable logistic regression, adjusted for socioeconomic and demographic factors, were conducted to evaluate the risk of abdominal obesity by occupation type.

Results Among women, abdominal obesity prevalence based on WHO criteria was 56% (95% CI: 55.60–56.46), highest in NW (57.3%; 95% CI: 56.80–57.83), followed by SW (57.1%; 95% CI: 55.39–58.78) and NSW (51.5%; 95% CI: 50.63–52.43). Among men, prevalence was 48.9% (95% CI: 48.31–49.46), highest in SW (57.8%; 95% CI: 56.51–59.14), followed by NSW (49.9%; 95% CI: 49.15–50.63) and NW (37.3%; 95% CI: 36.14–38.43). Adjusted odds of abdominal obesity were significantly higher for SW compared to NSW (women: aOR 1.08, 95% CI: 1.02–1.14; men: aOR 1.20, 95% CI: 1.16–1.25).

Conclusions High prevalence of abdominal obesity among both men and women implies an emerging health risk in India. The findings that contributed to associations between sedentary occupation and abdominal obesity may inform occupation-related health risks and development of interventions to limit daily sitting at work place which may reduce metabolic disease risk.

Keywords Abdominal obesity, Waist-to-hip ratio, Sedentary work, National Family Health Survey, India

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Introduction

Obesity – the excessive accumulation of fat in the body due to an imbalance in consumption and expenditure of energy – is a chronic condition that adversely affects health of individuals in both developed and developing nations [1]. The global epidemic of obesity has surged dramatically in recent decades, with prevalence tripling among adult women (6.6 to 18.5%) and quadrupling among adult men (3% to 14%) between 1975 and

2022 [2, 3]. According to the World Health Organization (WHO), one in eight people were obese in 2022, with 2.5 billion adults being overweight or obese [4]. Given its associated risk with numerous non-communicable diseases (NCDs) like cardiovascular conditions, diabetes and renal diseases, musculoskeletal diseases, and neoplasms, leading to increased morbidity, obesity, especially abdominal obesity—a form marked by excess fat around the waist, which has been identified as a strong predictor of adverse metabolic outcomes and become a significant public health concern [1, 5, 6].

Recent studies show that over the past decade, the highest increase in obesity has been observed in low- and middle-income countries like sub-Saharan Africa, Federated States of Micronesia and the regions of Polynesia [3, 7]. The global burden of obesity-related diseases is alarming, with disability-adjusted life years (DALYs) due to obesity rising from 164 million in 2020 to an estimated 230 million in 2023, accounting for 39.8% of the total DALYs and 42% of the global deaths [7]. Notably, among the WHO regions, Southeast Asia registered the highest annual increase in obesity-related DALYs and deaths, at 2.6% between 2000 and 2019, followed by the low and middle-income countries in terms of socio-demographic index across the world [6, 7]. This is alarming, considering the fragile healthcare systems and limited financial resources in low and middle-income countries primarily allocated to combat communicable diseases [8].

The prevalence of abdominal obesity is growing in low- and middle-income countries, such as India, where lifestyle shifts due to rapid urbanization, economic transitions, rise in sedentary occupations and the shift in dietary preferences are the key drivers of rising obesity prevalence [9]. As countries move towards development, the population tends to shift towards urban areas and undergoes dietary changes to energy-dense, ultra-processed foods, further exacerbating the problem [9, 10]. The transition of economies from traditional labour-intensive agricultural and manufacturing activities to service-sector jobs has led to a more sedentary lifestyle with less physical activity, especially in urban areas [9]. This shift has raised concerns about how occupational roles influence abdominal obesity. A recent study revealed that one-third of the global population was physically inactive in 2022, with the highest prevalence in high-income Asia–Pacific (48.1%) followed by South Asia (45.4%) [11]. Recognizing the strong linkage between physical inactivity and obesity and NCDs, the WHO targeted a 15% global reduction in physical inactivity among adults and adolescents by 2030 [12]. A longitudinal study of a cohort ≥ 18 years in Taiwan reported a strong association between physical activity and obesity, with increasing physical activity leading to weight loss and reduction in obesity [13].

While Body Mass Index (BMI) is traditionally the most widely used measure used to define obesity and overweight prevalence across populations, BMI does not provide insight into the distribution of fat in the human body [14] which is crucial for assessment of cardiovascular diseases (CVDs) and other NCDs. An increasing body of research has postulated abdominal obesity, measured by waist circumference (WC) or waist-to-hip ratio (WHR), is increasingly recognized as more precise measure of adverse health outcomes, as the visceral fat in the abdomen is metabolically active and strongly associated with heightened inflammatory responses and insulin resistance [15–17]. These factors collectively elevate the risk for CVDs and NCDs more significantly than BMI alone. Studies have demonstrated that individuals with increased abdominal fat, regardless of their overall body weight, are at greater risk of myocardial infarction, type 2 diabetes, and hypertension, and CVDs underlining the value of abdominal obesity as a superior predictor of adverse health outcomes [17–20].

India, home to an estimated 135 million people with obesity, reflects this global trend [21]. A recent study reveals a prevalence of 13.8% of obesity in India, with a higher percentage of abdominal obesity at 57.7% [22]. While women exhibit higher prevalence of abdominal obesity (40%) than men (12%) [19], these disparities are further influenced by rapid urbanization, shifts in dietary habits toward processed, high-fat foods, and increasingly sedentary lifestyles thereby leading to high prevalence in abdominal obesity in the country [23, 24]. While existing studies have highlighted the prevalence and distribution of abdominal obesity in the country [19, 21, 22], there is limited empirical investigation into how occupational roles, particularly sedentary and non-sedentary lifestyles, impact abdominal obesity within rapidly urbanizing low- and middle-income countries. This paper aims to investigate these gaps by examining the relationship between different occupational roles and abdominal obesity in India. The findings of the study provide insights into workplace health risks and inform policy interventions to curb the growing obesity epidemic in developing nations.

Method

Study sample

The study utilizes nationally representative cross-sectional data from the fifth round of National Family Health Survey (NFHS), India's equivalent of the Demographic Health Survey (DHS) [25]. Conducted between June-2019 to April-2021, the survey covered 707 districts across 28 states and 8 union territories. A total of 30,456 Primary Sampling Units (PSUs) were selected to ensure a uniform and representative sample at the national, state/union territory, and district levels. Interviews were successfully completed with 724,115 women, achieving a response rate of 97%, and 101,839 men, with a response rate of 92%. As our study focuses on the waist-to-hip ratio among both women and men, "refused" and "others" for both groups were excluded from the sample. Additionally, in NFHS-5, data on occupation for women were collected only in the state module, which was administered to a subsample comprising 15% of households drawn from the district sample [25]. Consequently, the sample of women with available occupation data in the NFHS-5 women's file is limited to 108,785. Furthermore, in the occupational data available for both women and men, responses categorized as 'occupation not found' and 'don't know' were removed and treated as missing values. To ensure consistency and reliability in anthropometric measurements, women who were currently pregnant were also excluded. After applying these refinements, the final analytic sample consists of 99,653 women and 91,990 men. A detailed description of the sample selection procedure is provided in Fig. 1.

Exposure variable

The NFHS-5 dataset provides information on occupations for both women aged 15–49 year and men aged 15–54 years. A total of 91 types of occupations were listed in the data. We clubbed the different occupations into three categories—non sedentary work (NSW), sedentary work (SW) and not working (NW) based on the nature of the occupations of individuals. Occupations classified as NSW included roles such as "farmer"; "agricultural worker"; "fisherman"; "poultry raising, cattle raising"; "home-based manufacturing (handicraft, food products)"; "rickshaw drivers, brick breaking, road building, construction worker, boatman, and earthwork, etc."; "domestic servant"; and "non-agricultural worker (factory worker, blue-collar service)". Occupations categorized as SW included "land owner"; professionals such as "doctors, lawyers, dentists, accountant, teachers, nurses, family welfare visitors, mid and high-level services (government/private)"; "big businessman"; "small business/trader". Individuals who were not "not working" and "retired" were classified as NW. The full list of occupation and the categorization into three categories were given in Table S-1.

Outcome variables

For the first time, NFHS-5 included information on waist and hip circumference measured through Gulick tapes for both eligible women and men. Two outcomes were measured- first is abdominal obesity, measured through waist-to-hip ratio (WHR) using WHO-recommended cutoffs. According to WHO prescribed cut-off, the ratio value of $> = 0.85$ and $> = 0.90$ for women and men respectively were treated as having abdominal obesity. Second,

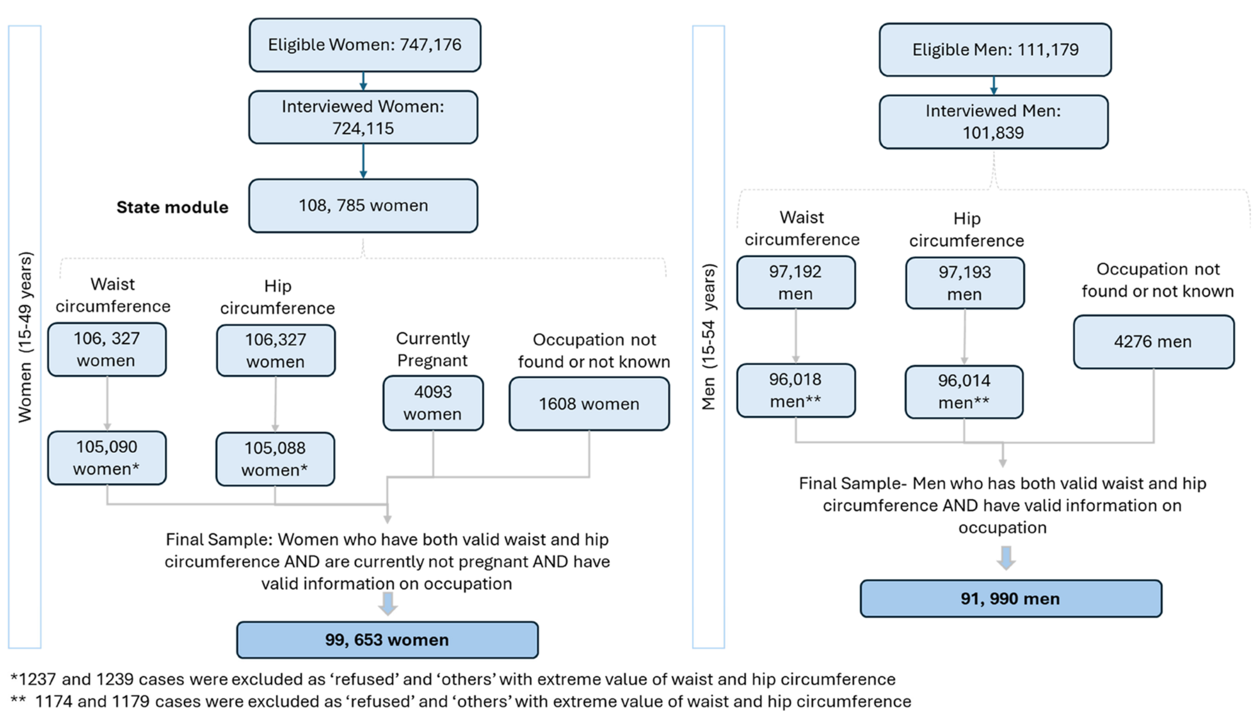

Fig. 1 Sample of women aged 15–49 years and men aged 15–54 years included in the study

we also examined the impact of a high-risk waist-to-hip ratio, defined as WHR $\geq$ 1 for both women and men, as studies suggested that a ratio exceeding 1.0 was associated with a significantly increased risk of health complications [26]. This measure was considered only at the overall level for individuals with NSW, NW and SW categories in the bivariate analysis to explore its relationship with different occupational categories. However, our primary focus remained on the standard WHO cutoff recommendations.

Confounding variables

The study accounted for potential explanatory variables that were selected based on published literature and available data. These variables included demographic, socioeconomic, behavioural, and contextual characteristics including age, marital status, woman's parity, social group, wealth status, substance use, diet type, frequency of junk food consumption, place of residence, and regions of India, that could influence the relationship between occupation and abdominal obesity. Demographic variables such as age were categorized into five-year age groups while education levels were divided into four categories: no education, primary, secondary, and higher. Marital status was grouped into never married, currently married, and widow/divorced/separated. Socioeconomic variables included wealth status, which was determined through principal component analysis of household assets during the survey, categorized into quintiles (poorest, poorer, middle, richer, richest). Health behavioural factors included substance use, such as alcohol and tobacco use, were classified as binary variables (yes or no). Dietary patterns were categorized as vegetarian or non-vegetarian, based on the frequency of consumption of eggs, fish, and meat. The junk food variable was constructed from the frequency of fried food and aerated drink intake. Place of residence- rural and urban, and regions were grouped into north, central, east, northeast, west, and south.

Statistical analysis

The male-to-female ratio in NFHS-5 was 1:8, which differs from the actual male-to-female ratio in India. To address this discrepancy and ensure analytical robustness, gender-stratified analyses were conducted instead of deriving population-level estimates. The analysis began with descriptive statistics to summarise key variables, followed by bivariate analyses. Survey weights provided in the NFHS-5 dataset were applied using the 'svy' command to account for the complex survey design and ensure representative estimates. We then performed multivariable logistic regression to assess the association between abdominal obesity and occupation type. Separate models were examined for women and men to estimate both adjusted and unadjusted odds ratios (OR), with results presented alongside 95% confidence intervals (CIs). All statistical analyses were conducted using Stata version 16.0 [27], adhering to standard practices for survey-based data analysis.

Results

A total of 99,653 women and 91,990 men were included in the analysis. Among women, the proportion of NSW, SW, and NW was 24.4% (n = 24277), 7.4% (n = 7372), and 68.2% (n = 68004), respectively, while among men the proportion was 59.7% (n = 54967), 20.7% (n = 19070) and 19.5% (n = 17953) respectively (Tables 1 and 2). The sample reported a missing value of 1523 and 4020 for men and women respectively for categories "don't know" and "occupation not found". The highest proportion of NSW was observed in the 35–39 age group for both women (18.7%, CI: 17.94–19.43) and men (15.3%, 95% CI: 14.77–15.87). Wealth quintiles found to be an inverse relationship between wealth and NSW. Women in the poorest quintile had the highest proportion of NSW (26.8%, 95% CI: 26.06–27.57), compared to only 6.5% (95% CI: 6.03–7.01) in the richest quintile women. For men, the poorer quintile showed the highest proportion of NSW (23.7%, 95% CI: 23.14–24.34), while the lowest was recorded in the richest quintile men (11.6%, 95% CI; 10.99–12.14). Birth parity revealed women having two children had the highest proportion of NSW (31.7%, 95% CI: 30.84–32.59), while women having one child reported the lowest proportion at 9.6% (95% CI: 9.01–10.15). Regional classification showed women in the southern region had the highest proportion of (27.3%, 95% CI: 26.44–28.12) NSW while the eastern region reported the highest proportion for men (26.7%, 95% CI: 26.01–27.44).

We estimated the gender-wise prevalence of abdominal obesity under two scenarios. The first scenario used the WHR values exceeding the WHO-recommended cutoff for abdominal obesity, indicating an increased risk of metabolic complications and NCDs. The second scenario considered WHR values greater than one to assess the proportion of women and men at a heightened risk. Prevalence estimates for both scenarios were presented according to the occupational categories of the respondents (Fig. 2).

Our analysis reveals that as per the WHO standard, abdominal obesity was found to be more prevalent among women. Results showed that the overall prevalence of abdominal obesity was 56% (95% CI: 55.60–56.46) among women as per the WHO criteria with the highest prevalence among NW women (57.3%; 95%CI: 56.80–57.83) followed by women engaged in SW (57.1%; 95% CI:55.39–58.78) and NSW (51.5%; 95%CI:

Table 1 Distribution of the study sample based on occupation, India (women aged 15–49 years)

	Women (15–49 years)									
	Overall Sample	NSW (24,277)		SW (7,372)		NW (68,004)		Missing (1,523)		
	N = 101176	%	95%CI	%	95%CI	%	95%CI	%	95%CI	*p*-value
WHR (as per WHO)										< 0.001
No	43,160	48.5	47.57–49.37	42.9	41.22–44.61	42.7	42.2–43.24	40.9	37.47–44.49	
Yes	58,016	51.5	50.63–52.43	57.1	55.39–58.78	57.3	56.76–57.8	59.1	55.51–62.53	
WHR ≥ 1										< 0.001
No	99,146	98.5	98.26–98.67	97.7	97.08–98.16	97.8	97.6–97.95	97.5	96.17–98.37	
Yes	2,030	1.5	1.33–1.74	2.3	1.84–2.92	2.2	2.05–2.4	2.5	1.63–3.83	
Age Group										< 0.001
15–19	17,063	8.4	7.96–8.88	7.2	6.37–8.2	21.0	20.54–21.39	10.3	8.17–12.88	
20–24	15,708	9.1	8.61–9.57	15.4	14.31–16.66	17.6	17.2–18	12.6	10.41–15.11	
25–29	15,949	12.9	12.32–13.52	18.0	16.76–19.42	16.1	15.71–16.47	14.8	12.55–17.39	
30–34	14,371	16.5	15.86–17.22	18.2	16.93–19.51	13.1	12.73–13.47	15.6	13.25–18.34	
35–39	14,104	18.7	17.94–19.43	17.7	16.4–19.03	11.8	11.5–12.18	18.3	15.75–21.18	
40–44	11,687	16.6	15.94–17.27	12.7	11.5–13.92	9.7	9.38–10	15.2	12.54–18.41	
45–49	12,294	17.8	17.13–18.49	10.8	9.73–11.87	10.7	10.41–11.06	13.2	10.93–15.75	
50–54	na	na	na	na	na	na	na	na	na	
Children Ever Born										< 0.001
No Children	31,262	17.6	16.96–18.26	31.4	29.79–32.99	33.4	32.91–33.89	25.0	21.99–28.17	
One Children	13,259	9.6	9.01–10.15	17.0	15.66–18.37	14.8	14.43–15.23	11.8	9.46–14.64	
Two Children	26,082	31.7	30.84–32.59	31.5	29.88–33.08	25.7	25.2–26.14	29.9	26.73–33.33	
Three Children	15,986	21.2	20.44–21.89	12.3	11.3–13.4	13.9	13.52–14.21	15.4	12.99–18.12	
Four & above Children	14,587	20.0	19.32–20.64	7.9	7.09–8.76	12.2	11.93–12.58	17.9	15.35–20.85	
Marital Status										< 0.001
Never Married	25,937	12.9	12.31–13.41	24.8	23.39–26.35	27.6	27.16–28.08	20.2	17.49–23.27	
Married	70,716	77.9	77.11–78.64	68.5	66.94–70.1	69.6	69.14–70.09	71.5	68.15–74.64	
Widowed/Separated	4,523	9.3	8.67–9.89	6.6	5.84–7.49	2.8	2.59–2.95	8.3	6.5–10.46	
Social Groups										< 0.001
SCs	19,339	26.0	25.18–26.81	20.7	19.35–22.21	22.1	21.66–22.59	27.6	24.39–31.1	
STs	19,301	17.5	16.92–18.11	5.5	4.78–6.22	7.7	7.51–7.99	12.6	10.69–14.8	
OBC	38,904	44.0	43.11–44.91	47.3	45.55–49.03	46.3	45.78–46.85	40.6	37–44.35	
Others	18,876	12.5	11.85–13.18	26.5	24.95–28.13	23.8	23.35–24.3	19.2	16.12–22.6	
Wealth Quintile										< 0.001
Poorest	20,659	26.8	26.06–27.57	6.5	5.79–7.3	17.2	16.87–17.62	20.2	17.51–23.15	
Poorer	22,790	26.6	25.8–27.35	12.1	11.17–13.19	19.8	19.35–20.16	23.6	20.72–26.66	

Table 1 (continued)

	Women (15–49 years)									
	Overall Sample	NSW (24,277)		SW (7,372)		NW (68,004)		Missing (1,523)		
	N = 101176	%	95%CI	%	95%CI	%	95%CI	%	95%CI	*p*-value
Middle	21,486	24.0	23.22–24.77	18.6	17.39–19.85	20.1	19.67–20.51	23.0	19.93–26.34	
Richer	19,601	16.1	15.42–16.87	26.3	24.85–27.72	21.6	21.12–22	19.6	16.79–22.8	
Richest	16,640	6.5	6.03–7.01	36.5	34.76–38.28	21.4	20.91–21.82	13.7	11.47–16.18	
Consumption of Alcohol										< 0.001
No	99,063	97.9	97.7–98.07	99.1	98.67–99.35	99.5	99.42–99.53	98.4	96.88–99.24	
Yes	2,113	2.1	1.93–2.3	0.9	0.65–1.33	0.5	0.47–0.58	1.6	0.76–3.12	
Consumption of Any Tobacco										< 0.001
No	94,225	91.1	90.67–91.59	97.5	96.97–97.98	96.8	96.66–96.99	90.9	88.79–92.69	
Yes	6,951	8.9	8.41–9.33	2.5	2.02–3.03	3.2	3.01–3.34	9.1	7.31–11.21	
Type of Diet										< 0.001
Vegetarian	37,444	36.3	35.44–37.11	37.6	35.96–39.19	38.5	37.95–38.95	32.6	29.44–36.02	
Non-Vegetarian	63,732	63.7	62.89–64.56	62.4	60.81–64.04	61.5	61.05–62.05	67.4	63.98–70.56	
Frequency of Junck Food										< 0.001
Never	15,635	18.7	17.99–19.43	16.3	15.04–17.72	14.6	14.27–14.99	18.2	15.61–21.19	
Occasionally	74,275	74.1	73.33–74.91	74.3	72.73–75.83	75.7	75.28–76.16	68.1	64.65–71.45	
Daily	11,266	7.2	6.75–7.62	9.4	8.39–10.42	9.7	9.35–9.96	13.6	11.23–16.41	
Place of Residence										< 0.001
Urban	24,815	18.5	17.63–19.34	52.1	50.43–53.81	33.2	32.7–33.77	33.8	30.33–37.55	
Rural	76,361	81.5	80.66–82.37	47.9	46.19–49.57	66.8	66.23–67.3	66.2	62.45–69.67	
Regions										< 0.001
North	20,507	11.8	11.3–12.23	14.6	13.67–15.49	15.2	14.9–15.5	11.0	9.36–12.84	
Central	23,017	22.3	21.64–22.96	17.6	16.52–18.75	25.4	24.96–25.79	18.9	16.53–21.61	
East	16,717	16.3	15.63–17	16.5	15.21–17.82	26.4	25.87–26.85	25.8	22.52–29.43	
Northeast	14,966	3.1	2.9–3.24	3.0	2.78–3.34	4.1	3.94–4.19	8.2	7.12–9.52	
West	10,238	19.3	18.51–20.14	15.8	14.24–17.57	12.1	11.65–12.49	14.3	11.6–17.47	
South	15,731	27.3	26.44–28.12	32.5	30.89–34.1	16.9	16.51–17.38	21.7	18.76–25.03	

Occupation category of "Missing" consist of responses: "Occupation not found" and "don't know"; na: not applicable

Table 2 Distribution of the study sample based on occupation, India (men aged 15–54 years)

	Men (15–54 years)									
	Overall Sample	NSW (54,967)		SW (19,070)		NW (17,953)		Missing (4,020)		
	N = 96010	%	95%CI	%	95%CI	%	95%CI	%	95%CI	*p*-value
WHR (as per WHO)										< 0.001
No	50,211	50.1	49.37–50.85	42.2	40.86–43.49	66.0	64.81–67.26	50.0	47.23–52.8	
Yes	45,799	49.9	49.15–50.63	57.8	56.51–59.14	34.0	32.74–35.19	50.0	47.2–52.77	
WHR ≥ 1										< 0.001
No	90,445	93.1	92.72–93.53	91.7	90.97–92.36	97.2	96.79–97.6	93.5	92.15–94.63	
Yes	5,565	6.9	6.47–7.28	8.3	7.64–9.03	2.8	2.4–3.21	6.5	5.37–7.85	
Age Group										< 0.001
15–19	15,580	6.8	6.48–7.23	4.4	3.87–4.9	60.6	59.34–61.92	10.5	8.85–12.48	
20–24	13,469	11.6	11.15–12.08	12.6	11.64–13.54	23.0	21.93–24.13	12.3	10.46–14.38	
25–29	13,451	14.5	14.02–15.09	17.3	16.36–18.37	7.0	6.38–7.69	14.7	12.99–16.55	
30–34	12,458	14.4	13.84–14.89	17.0	15.99–17.98	2.2	1.79–2.7	15.0	13.24–16.96	
35–39	12,241	15.3	14.77–15.87	15.8	14.85–16.78	1.6	1.25–1.97	14.4	12.61–16.37	
40–44	10,291	12.7	12.22–13.14	12.7	11.83–13.58	1.8	1.48–2.31	11.8	10.18–13.72	
45–49	10,326	13.9	13.35–14.39	11.4	10.62–12.3	1.7	1.38–2.05	12.4	10.67–14.48	
50–54	8,194	10.8	10.37–11.25	8.9	8.14–9.67	2.0	1.69–2.46	8.8	7.15–10.85	
Marital Status										< 0.001
Never Married	34,381	22.0	21.41–22.64	26.1	24.91–27.34	89.9	89–90.69	30.5	27.99–33.21	
Married	60,138	76.1	75.49–76.76	72.7	71.45–73.91	9.7	8.86–10.53	67.6	64.93–70.23	
Widowed/Separated	1,491	1.8	1.67–2.05	1.2	0.92–1.56	0.5	0.33–0.65	1.8	1.19–2.8	
Social Groups										< 0.001
SCs	18,030	24.3	23.65–25.01	17.6	16.54–18.73	20.3	19.22–21.37	22.2	19.97–24.57	
STs	18,710	12.5	12.13–12.98	5.1	4.6–5.61	8.2	7.59–8.95	8.9	7.8–10.18	
OBC	36,950	44.3	43.52–45	46.4	45–47.75	47.6	46.22–48.92	40.0	37.25–42.8	
Others	18,029	18.9	18.25–19.49	30.9	29.62–32.28	23.9	22.76–25.11	28.9	25.97–32.01	
Wealth Quintile										< 0.001
Poorest	18,875	23.0	22.43–23.6	6.1	5.53–6.69	12.7	11.94–13.51	15.9	13.95–18.01	
Poorer	21,522	23.7	23.14–24.34	12.5	11.68–13.31	18.5	17.54–19.42	19.1	17.16–21.27	
Middle	20,549	22.7	22.08–23.3	19.1	18.16–20.08	21.1	20.16–22.17	21.9	19.74–24.18	
Richer	18,961	19.0	18.43–19.62	28.5	27.32–29.75	23.6	22.44–24.69	23.4	21.21–25.71	
Richest	16,103	11.6	10.99–12.14	33.8	32.52–35.16	24.1	22.89–25.43	19.7	17.29–22.42	
Consumption of Alcohol										< 0.001
No	70,815	71.9	71.2–72.55	76.2	74.99–77.33	93.3	92.64–93.93	78.5	76.18–80.71	
Yes	25,195	28.1	27.45–28.8	23.8	22.67–25.01	6.7	6.07–7.36	21.5	19.29–23.82	
Consumption of Any Tobacco										< 0.001
No	59,990	57.8	57.07–58.52	65.9	64.6–67.14	87.9	87.02–88.68	65.0	62.43–67.51	
Yes	36,020	42.2	41.48–42.93	34.1	32.86–35.4	12.1	11.32–12.98	35.0	32.49–37.57	
Type of Diet										< 0.001
Vegetarian	27,378	23.4	22.87–24.03	25.2	24.1–26.34	27.7	26.62–28.88	24.1	21.8–26.61	
Non-Vegetarian	68,632	76.6	75.97–77.13	74.8	73.66–75.9	72.3	71.12–73.38	75.9	73.39–78.2	
Frequency of Junck Food										< 0.001
Never	16,103	17.6	17.07–18.2	15.0	14.07–15.92	14.2	13.22–15.15	17.7	15.71–19.94	
Occasionally	67,157	71.1	70.42–71.76	72.2	70.97–73.3	72.8	71.55–73.94	70.4	67.88–72.75	
Daily	12,750	11.3	10.83–11.75	12.9	12.04–13.76	13.1	12.21–14	11.9	10.46–13.51	

Table 2 (continued)

	Men (15–54 years)									
	Overall Sample	NSW (54,967)		SW (19,070)		NW (17,953)		Missing (4,020)		
	N = 96010	%	95%CI	%	95%CI	%	95%CI	%	95%CI	*p*-value
Place of Residence										< 0.001
Urban	24,358	23.8	23.09–24.62	54.5	53.21–55.79	36.3	34.93–37.71	41.8	38.94–44.66	
Rural	71,652	76.2	75.38–76.91	45.5	44.21–46.79	63.7	62.29–65.07	58.2	55.34–61.06	
Regions										< 0.001
North	19,658	7.4	7.24–7.63	9.7	9.3–10.1	11.1	10.69–11.59	5.8	5.26–6.48	
Central	21,662	12.2	11.94–12.5	8.6	8.17–8.97	12.2	11.74–12.78	5.6	5.02–6.33	
East	14,368	26.7	26.01–27.44	23.8	22.68–25.01	25.5	24.32–26.76	29.2	26.5–31.97	
Northeast	14,482	5.7	5.52–5.93	5.5	5.22–5.88	5.4	5.08–5.77	7.3	6.53–8.08	
West	11,052	23.9	23.17–24.59	26.0	24.62–27.5	20.6	19.38–21.88	26.6	23.86–29.52	
South	14,788	24.0	23.39–24.69	26.3	25.22–27.48	25.1	23.88–26.33	25.5	23.35–27.77	

Occupation category of "Missing" consist of responses: "Occupation not found" and "don't know"

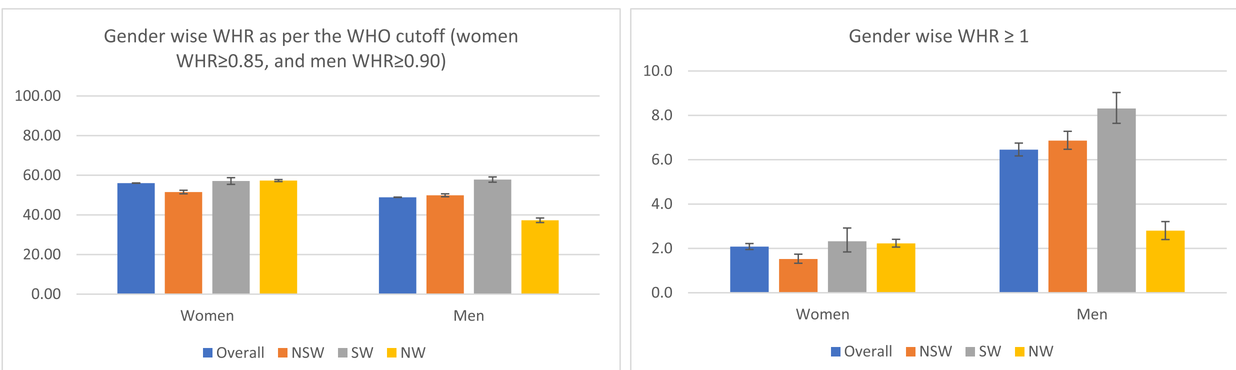

Fig. 2 Prevalence of waist to hip ratio by type of occupation

50.63–52.43). The overall prevalence of abdominal obesity for WHR with a cutoff value of greater than one was observed to be 2.1% (95% CI: 1.95–2.22) among women.

Among men, abdominal obesity prevalence based on the WHO cut-off was 48.9% (95% CI: 48.31–49.46). Prevalence was highest among those in SW (57.8%; 95% CI: 56.51–59.14), followed by NSW (49.9%; 95% CI: 49.15–50.63), and NW (34%; 95% CI: 32.74–35.19). Using the stricter WHR threshold of greater than one, the prevalence among men was 6.5% (95% CI: 6.17–6.75) overall. By occupational category, the prevalence was highest among men in SW (8.3%; 95% CI: 7.64–9.03), followed by NSW (6.9%; 95% CI: 6.47–7.28) and NW (2.8%; 95% CI: 2.40–3.21).

Overall, the prevalence of abdominal obesity (risky WHR) increases consistently with age for both women and men across all occupational categories, with the highest prevalence observed among older age groups (Table 3). For instance, among women aged 45–49 in the SW category, the prevalence of abdominal obesity is 74.1% (95% CI: 69.52–78.27), significantly higher than the 43.5% (95% CI: 37.32–49.89) observed among SW women aged 15–19. A similar age-related trend is observed among men, with the highest abdominal obesity prevalence of 73.8% (95% CI: 70.08–77.12) in SW men aged 50–54, compared to 32.8% (95% CI: 27.64–38.5) for men aged 15–19. The wealth quintile depicts that there was a higher prevalence of abdominal obesity amongst the wealthier sections of women and men in India irrespective of their nature of occupation. Birth parity exhibited the highest prevalence of abdominal obesity among women who have four or more children (61.7%, 95% CI: 60.67–62.77) across all the occupational categories (NSW 56.3%, 95% CI: 54.51–58.04; SW 63.5%, 95% CI: 58.06–68.68; NW 64.5%, 95% CI: 63.18–65.88). Among women who consume alcohol, those in SW roles exhibit

Table 3 Prevalence of abdominal obesity (risky WHR) by type of occupation and background characteristics

	Prevalence of Risky WHR (as per WHO) among Women (15–49 years)								Prevalence of Risky WHR (as per WHO) among Men (15–54 years)							
	Overall		NSW		SW		NW		Overall		NSW		SW		NW	
Background Characteristics	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI
Age Group																
15–19	45.3	44.28–46.34	41.7	38.96–44.43	43.5	37.32–49.89	45.8	44.71–46.96	28.1	26.9–29.28	27.2	24.9–29.57	32.8	27.64–38.5	27.8	26.37–29.27
20–24	51.0	49.88–52.07	46.3	43.55–48.98	47.2	43.14–51.32	52.1	50.81–53.32	37.0	35.56–38.53	35.8	33.76–37.87	39.9	36.11–43.87	37.5	34.98–40.17
25–29	54.8	53.69–55.88	47.2	44.68–49.65	53.4	49.28–57.44	56.9	55.66–58.21	47.7	46.17–49.32	44.9	42.88–46.92	54.5	51.31–57.6	44.6	39.88–49.49
30–34	57.7	56.57–58.91	50.1	47.8–52.31	57.6	53.76–61.4	60.8	59.33–62.27	55.2	53.59–56.78	52.7	50.77–54.7	60.4	57.25–63.45	58.1	47.89–67.57
35–39	59.0	57.82–60.18	50.7	48.44–52.94	59.4	55.36–63.41	63.0	61.55–64.45	55.4	53.75–56.99	53.8	51.88–55.78	58.8	55.49–62.05	50.2	39.00–61.46
40–44	62.7	61.46–63.94	55.3	53.15–57.44	63.7	58.48–68.58	66.6	64.94–68.14	58.6	56.97–60.31	57.0	55.09–58.91	63.5	59.84–67.05	51.8	40.56–62.77
45–49	67.2	66.04–68.3	60.8	58.75–62.82	74.1	69.52–78.27	69.7	68.28–71.14	60.1	58.44–61.83	57.4	55.39–59.38	68.3	64.62–71.73	60.4	50.27–69.64
50–54									62.5	60.68–64.24	58.8	56.74–60.91	73.8	70.08–77.12	63.5	54.04–71.98
Children Ever Born																
No Children	48.5	47.68–49.24	47.1	45.12–49.14	48.2	45.13–51.31	48.6	47.71–49.47								
One Children	60.6	59.39–61.85	54.7	51.53–57.81	63.3	59.16–67.26	61.4	59.94–62.78								
Two Children	58.1	57.23–58.96	50.5	48.73–52.19	59.7	56.61–62.64	60.9	59.84–61.96								
Three Children	57.8	56.71–58.8	50.9	48.98–52.8	60.5	55.92–64.81	60.7	59.43–62.03								
Four & above Children	61.7	60.67–62.77	56.3	54.51–58.04	63.5	58.06–68.68	64.5	63.18–65.88								
Marital Status																
Never Married	46.9	46.05–47.76	45.0	42.77–47.24	47.5	44.07–50.87	47.0	46.04–47.97	35.5	34.63–36.47	35.9	34.36–37.43	45.1	42.4–47.83	31.7	30.41–32.91
Married	58.9	58.38–59.4	52.1	51.06–53.08	60.1	58.07–62.12	61.2	60.54–61.78	56.4	55.65–57.06	54.1	53.25–54.93	62.3	60.8–63.75	55.0	50.34–59.51
Widowed/Separated	59.5	57.28–61.67	56.1	52.51–59.57	62.0	55.7–67.93	62.3	59.14–65.44	48.6	43.97–53.29	44.1	39.01–49.28	65.0	52.33–75.82	42.8	27.85–59.17
Social Groups																
SCs	55.5	54.52–56.45	53.0	51.08–54.82	56.9	53.09–60.7	56.2	55.05–57.43	48.8	47.55–50.15	50.3	48.63–51.9	58.5	55.06–61.92	33.4	30.76–36.24
STs	52.5	51.37–53.7	50.8	48.96–52.54	54.4	47.41–61.17	53.6	51.98–55.16	40.6	39.08–42.09	40.2	38.49–41.96	55.0	50.16–59.73	31.5	27.84–35.46
OBC	54.0	53.32–54.6	50.1	48.75–51.48	54.5	52–56.99	55.1	54.31–55.84	48.5	47.69–49.38	50.3	49.21–51.39	56.2	54.27–58.11	32.8	31.01–34.68
Others	59.2	58.21–60.23	52.6	49.73–55.44	60.2	56.79–63.58	60.1	58.96–61.25	52.3	50.95–53.61	53.7	51.84–55.52	61.4	58.76–63.93	34.7	32.13–37.28
Wealth Quintile																
Poorest	54.4	53.5–55.34	51.4	49.78–52.96	60.5	54.66–66.13	55.6	54.39–56.71	44.3	43.08–45.55	44.2	42.75–45.57	51.4	46.5–56.27	38.6	35.35–41.91
Poorer	53.9	53.04–54.84	49.9	48.21–51.56	57.1	52.81–61.2	55.4	54.25–56.47	45.4	44.24–46.57	47.0	45.62–48.47	53.7	50.23–57.18	31.3	28.89–33.75
Middle	54.6	53.63–55.52	48.7	46.89–50.61	54.6	51.07–58.13	56.7	55.53–57.84	47.3	46.14–48.46	50.9	49.42–52.46	51.5	48.83–54.24	30.7	28.36–33.11
Richer	56.6	55.65–57.61	54.7	52.18–57.14	54.4	51.35–57.51	57.3	56.18–58.47	51.4	50.17–52.66	53.1	51.39–54.87	60.5	58.04–62.98	33.2	30.76–35.78
Richest	60.8	59.69–61.86	61.5	57.55–65.23	59.7	56.39–62.83	61.0	59.76–62.17	55.4	53.87–56.96	59.8	57.17–62.38	61.8	59.32–64.16	37.2	34.24–40.17

Table 3 (continued)

Background Characteristics	Prevalence of Risky WHR (as per WHO) among Women (15–49 years)								Prevalence of Risky WHR (as per WHO) among Men (15–54 years)							
	Overall		NSW		SW		NW		Overall		NSW		SW		NW	
	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI
Consumption of Alcohol																
No	56.0	55.56–56.43	51.4	50.49–52.32	57.0	55.33–58.75	57.2	56.73–57.77	47.3	46.69–47.99	48.8	47.98–49.72	56.9	55.44–58.43	33.1	31.88–34.39
Yes	60.1	56.68–63.49	57.5	53.09–61.75	61.8	44.41–76.65	63.8	58.35–68.86	54.1	52.85–55.27	52.6	51.15–53.98	60.7	57.88–63.41	45.6	40.63–50.62
Consumption of Any Tobacco																
No	56.0	55.57–56.46	51.4	50.44–52.35	56.9	55.16–58.61	57.3	56.73–57.79	47.8	47.08–48.52	50.2	49.23–51.22	57.8	56.22–59.47	32.6	31.32–33.91
Yes	56.5	54.65–58.25	53.0	50.26–55.63	65.0	55.38–73.5	58.1	55.51–60.67	50.9	49.99–51.89	49.4	48.33–50.54	57.8	55.53–60.03	43.8	40.22–47.41
Type of Diet																
Vegetarian	51.7	51.04–52.35	47.5	46.12–48.86	52.0	49.39–54.6	52.9	52.1–53.66	47.2	46.13–48.26	48.8	47.48–50.19	57.2	54.75–59.69	30.4	28.54–32.35
Non-Vegetarian	58.7	58.1–59.24	53.8	52.66–55.01	60.2	57.94–62.34	60.0	59.35–60.71	49.4	48.76–50.12	50.2	49.35–51.09	58.0	56.47–59.58	35.3	33.81–36.85
Frequency of Junck Food																
Never	55.8	54.77–56.93	51.2	49.06–53.34	58.8	54.26–63.11	57.3	56–58.61	52.3	50.91–53.72	52.2	50.5–54	62.0	58.84–65.12	38.0	34.61–41.53
Occasionally	55.5	55.03–56.04	51.2	50.11–52.19	56.2	54.26–58.14	56.8	56.16–57.37	48.0	47.27–48.64	49.1	48.18–49.95	56.9	55.29–58.47	33.0	31.58–34.4
Daily	60.4	59.05–61.76	56.4	53.22–59.45	61.2	55.5–66.64	61.3	59.75–62.89	49.8	48.15–51.36	51.4	49.3–53.59	58.2	54.79–61.56	35.0	31.65–38.54
Place of Residence																
Urban	59.8	58.88–60.69	57.8	55.09–60.41	58.6	55.87–61.22	60.4	59.31–61.39	51.7	50.47–52.9	54.2	52.21–56.09	58.2	56.14–60.23	34.4	32.01–36.9
Rural	54.3	53.83–54.78	50.1	49.2–51.04	55.5	53.46–57.49	55.8	55.17–56.33	47.5	46.85–48.06	48.6	47.81–49.32	57.4	55.83–58.93	33.7	32.38–35.03
Regions																
North	64.6	63.81–65.46	64.1	62.07–65.98	62.2	59.12–65.19	65.0	64.04–65.95	54.2	53.38–55.06	55.6	54.42–56.78	61.2	59.52–62.92	42.5	40.73–44.22
Central	50.6	49.85–51.37	47.4	45.82–48.99	53.2	49.89–56.48	51.2	50.32–52.12	49.0	48.22–49.87	50.3	49.23–51.28	60.5	58.44–62.54	34.5	32.76–36.32
East	65.9	64.98–66.77	63.1	60.9–65.27	71.1	67.08–74.72	66.0	65.02–67.06	53.6	52.35–54.82	53.4	51.78–55.05	65.1	62.45–67.72	39.6	36.8–42.49
Northeast	66.1	64.97–67.24	66.0	63.42–68.52	66.1	61.85–70.04	65.9	64.58–67.29	43.6	42.33–44.87	42.7	41.03–44.41	51.2	48.39–53.97	35.8	32.82–38.81
West	44.3	42.8–45.72	41.5	39.07–43.94	47.3	41.37–53.37	45.1	43.18–46.96	42.0	40.52–43.42	42.9	41.15–44.71	50.0	46.47–53.46	25.7	22.95–28.66
South	51.3	50.23–52.35	48.1	46.23–49.94	53.7	50.74–56.73	52.4	51.01–53.86	50.0	48.79–51.13	52.7	51.1–54.22	58.3	55.87–60.65	30.5	27.92–33.29
India (as per WHO)	56.0	55.6–56.46	51.5	50.63–52.43	57.1	55.39–58.78	57.3	56.80–57.83	48.9	48.31–49.46	49.9	49.15–50.63	57.8	56.51–59.14	34.0	32.74–35.19

a prevalence of 61.8% (95% CI: 44.41–76.65), compared to 57.0% (95% CI: 55.33–58.75) among non-drinkers in the same category. Similarly, among tobacco users, SW women report a prevalence of 65.0% (95% CI: 55.38–73.5) compared to their counterparts (56.9%;95% CI: 55.16–58.61). For men, a similar pattern was observed, with alcohol and tobacco use linked to increased abdominal obesity, particularly in SW roles.

Women who consumed a non-vegetarian diet had a higher prevalence of abdominal obesity (58.7%; 95% CI: 58.1–59.24) compared to vegetarian women (51.7%; 95% CI: 51.04–52.35). In SW, non-vegetarian women exhibit the highest prevalence of abdominal obesity at 60.2% (95% CI: 57.94–62.34). Among men, non-vegetarians in SW roles also show the highest prevalence at 58.0% (95% CI: 56.47–59.58). The prevalence is even higher among those who consume junk food daily, particularly for women in the NW category (61.3%; 95% CI: 59.69–62.8). Among women, those in the NW and reside in urban areas show the highest prevalence of abdominal obesity at 60.4% (95% CI: 59.31–61.39), surpassing other categories. Similarly, among men, urban residents exhibit higher prevalence of abdominal obesity, with those in SW roles showing the highest prevalence at 58.2% (95% CI: 56.14–60.23). Regional differences were evident as well, with the Northeast (66.1%, 95% CI: 64.97–67.24) and North (54.2%, 95% CI: 53.38–55.06) regions exhibiting the highest abdominal obesity prevalence for women and men respectively.

We employed multivariate logistic regression with the outcome of WHR based on WHO prescribed cut-off. The result showed that compared to NSW, both the unadjusted and adjusted odds of SW were significantly higher for both men and women, and significantly higher for NW only for women. The results indicated that the adjusted odds of women (aOR: 1.08; 95% CI: 1.02–1.14) and men (aOR: 1.20; 95% CI: 1.16–1.25) engaged in SW were significantly higher compared to NSW. Similarly, the odds of NW among women were also higher (aOR: 1.15; 95% CI: 1.12–1.19) compared to NSW. The results of descriptive statistics and adjusted odds ratios are concurrent for socioeconomic and demographic characteristics. Our analysis revealed a significant association between WHR and age, with older adults having a higher likelihood of high WHR compared to adolescents for both women and men. As the households become wealthy, both women and men exhibited higher odds of acquiring abdominal obesity. In terms of birth parity, while unadjusted odd ratios showed higher likelihood of abdominal obesity with an increase in parity among women, adjusted odd ratios reveal a lower likelihood with the increase in parity compared to women having no children. Consumption of alcohol revealed higher likelihood for abdominal obesity for both men and women, compared to non-consumption. Unexpectedly, individuals consuming tobacco were less likely to have risky WHR. Individuals consuming non-vegetarian food and daily consumption of junk food have higher odds of being abdominally obese. Regional classification shows a lower likelihood of abdominal obesity for both men and women in all regions compared to the North, except for men in the East (Table 4).

Discussions

Globally, India has the third highest number of obese people in absolute numbers, after the US and China [3]. The last few decades have witnessed substantial economic growth in the country, concomitant with rapid urbanization, lifestyle and dietary changes leading to an increased prevalence of obesity [28]. In 2021, the NCDs accounted for 56% of all deaths in India. The high burden of obesity coupled with increasing NCDs poses a grave threat to the health scenario in the country. While several studies have been carried out to understand the prevalence of obesity and its factors, to the best of our knowledge the present study is the first to show the effects of sedentary work on abdominal obesity in India.

The country's economic growth, post the 1990s reform period has been driven predominantly by growth in the country's service sector [29]. As more workers transitioned from labour-intensive agriculture and industries to the service sector, the percentage of people employed in sedentary occupations rose in recent years. According to WHO estimates, India recorded the highest prevalence of people with insufficient physical activity at 34% among the Southeast Asian countries in 2016 with prevalence among women being almost double that of men [30]. In this paper, we establish an association between abdominal obesity and sedentary occupation.

Our analysis revealed that women exhibited a higher prevalence of risky WHR based on the WHO-recommended cutoff. However, when we applied a more stringent threshold (WHR $\geq$ 1.0), the trend reversed, with men showing a prevalence three times higher than women. This additional analysis was conducted to explore the implications of adopting a higher WHR threshold, as Sruthi et al. [26] suggests that a WHR greater than 1.0 in either sex is associated with a significantly elevated risk of health complications. Nevertheless, we do not advocate for a WHR cutoff exceeding the WHO-defined threshold for either sex, as the global standard remains the widely accepted reference. Multivariate analysis

Table 4 Factors associated with risky WHR as per the prescribed cut off by WHO (Outcome variable: women WHR ≥ 0.85, and Men WHR ≥ 0.90)

	Women (15–49 years)						Men (15–54 years)					
Explanatory Variables	**uOR**	**95%CI**	***p*-value**	**aOR**	**95%CI**	***p*-value**	**uOR**	**95%CI**	***p*-value**	**aOR**	**95%CI**	***p*-value**
Type of Work												
Non-Sedentary (Ref.)												
Sedentary	1.22	1.16–1.28	< 0.001	1.08	1.02–1.14	0.008	1.41	1.36–1.45	< 0.001	1.20	1.16–1.25	< 0.001
Not Working	1.19	1.15–1.22	< 0.001	1.15	1.12–1.19	< 0.001	0.59	0.57–0.61	< 0.001	0.99	0.94–1.03	0.585
Age Group												
15–19 (Ref.)												
20–24	1.24	1.19–1.29	< 0.001	1.15	1.09–1.21	< 0.001	1.40	1.33–1.47	< 0.001	1.30	1.23–1.37	< 0.001
25–29	1.51	1.44–1.57	< 0.001	1.40	1.32–1.49	< 0.001	1.97	1.88–2.07	< 0.001	1.73	1.63–1.84	< 0.001
30–34	1.70	1.63–1.78	< 0.001	1.66	1.56–1.78	< 0.001	2.54	2.42–2.67	< 0.001	2.15	2.01–2.31	< 0.001
35–39	1.83	1.75–1.92	< 0.001	1.83	1.71–1.96	< 0.001	2.81	2.67–2.95	< 0.001	2.39	2.22–2.56	< 0.001
40–44	2.04	1.94–2.14	< 0.001	2.08	1.94–2.24	< 0.001	3.21	3.05–3.38	< 0.001	2.72	2.53–2.93	< 0.001
45–49	2.30	2.2–2.42	< 0.001	2.41	2.24–2.59	< 0.001	3.26	3.1–3.44	< 0.001	2.81	2.62–3.03	< 0.001
50–54							3.41	3.22–3.6	< 0.001	2.91	2.7–3.15	< 0.001
Children Ever Born												
No Children (Ref.)												
One Children	1.55	1.49–1.62	< 0.001	1.08	1.01–1.16	0.022						
Two Children	1.47	1.42–1.52	< 0.001	0.94	0.88–1	0.060						
Three Children	1.47	1.42–1.53	< 0.001	0.88	0.82–0.95	< 0.001						
Four & above Children	1.63	1.57–1.7	< 0.001	0.91	0.84–0.97	0.008						
Marital Status												
Never Married (Ref.)												
Married	1.56	1.51–1.6	< 0.001	1.15	1.08–1.23	< 0.001	2.10	2.05–2.16	< 0.001	1.19	1.14–1.25	< 0.001
Widowed/Separated	1.57	1.47–1.67	< 0.001	1.07	0.98–1.17	0.153	1.58	1.42–1.75	< 0.001	0.92	0.82–1.03	0.133
Social Groups												
SCs (Ref.)												
STs	1.05	1.01–1.09	0.018	1.02	0.97–1.06	0.495	0.65	0.62–0.67	< 0.001	0.75	0.72–0.79	< 0.001
OBC	0.91	0.88–0.94	< 0.001	0.98	0.95–1.02	0.279	0.97	0.94–1	0.083	0.96	0.93–1	0.046
Others	1.23	1.18–1.29	< 0.001	1.06	1.02–1.11	0.005	1.20	1.15–1.25	< 0.001	1.06	1.01–1.11	0.013
Wealth Quintile												
Poorest (Ref.)												
Poorer	1.01	0.97–1.05	0.573	1.05	1.01–1.09	0.026	1.16	1.12–1.21	< 0.001	1.19	1.14–1.24	< 0.001
Middle	1.05	1.01–1.09	0.010	1.13	1.08–1.18	< 0.001	1.32	1.27–1.37	< 0.001	1.33	1.27–1.39	< 0.001
Richer	1.16	1.11–1.2	< 0.001	1.22	1.16–1.28	< 0.001	1.56	1.5–1.62	< 0.001	1.52	1.45–1.6	< 0.001
Richest	1.36	1.3–1.41	< 0.001	1.30	1.23–1.37	< 0.001	1.91	1.83–1.99	< 0.001	1.72	1.63–1.82	< 0.001
Consumption of Alcohol												
No (Ref.)												
Yes	1.28	1.17–1.39	< 0.001	1.12	1.02–1.23	0.017	1.17	1.14–1.21	< 0.001	1.05	1.01–1.08	0.010
Consumption of Any Tobacco												
No (Ref.)												
Yes	1.08	1.02–1.13	0.004	0.88	0.83–0.93	< 0.001	1.03	1.01–1.06	0.014	0.93	0.91–0.96	< 0.001
Type of Diet												
Vegetarian (Ref.)												
Non-Vegetarian	1.27	1.24–1.3	< 0.001	1.35	1.3–1.39	< 0.001	0.94	0.91–0.96	< 0.001	1.09	1.06–1.13	< 0.001
Frequency of Junck Food												
Never (Ref.)												
Occasionally	0.98	0.95–1.02	0.337	0.95	0.92–0.99	0.012	0.89	0.86–0.92	< 0.001	0.94	0.91–0.98	0.002
Daily	1.13	1.08–1.19	< 0.001	0.93	0.88–0.98	0.012	0.87	0.83–0.91	< 0.001	0.92	0.88–0.97	0.003

Table 4 (continued)

	Women (15–49 years)						Men (15–54 years)					
Explanatory Variables	**uOR**	**95%CI**	***p*-value**	**aOR**	**95%CI**	***p*-value**	**uOR**	**95%CI**	***p*-value**	**aOR**	**95%CI**	***p*-value**
Place of Residence												
Urban (Ref.)												
Rural	0.82	0.8–0.85	< 0.001	0.89	0.86–0.93	< 0.001	0.80	0.78–0.83	< 0.001	0.99	0.96–1.03	0.773
Regions												
North (Ref.)												
Central	0.50	0.48–0.52	< 0.001	0.55	0.53–0.57	< 0.001	0.75	0.72–0.78	< 0.001	0.89	0.85–0.93	< 0.001
East	0.82	0.79–0.86	< 0.001	0.81	0.77–0.86	< 0.001	0.88	0.85–0.92	< 0.001	1.07	1.02–1.13	0.006
Northeast	0.86	0.83–0.9	< 0.001	0.80	0.75–0.84	< 0.001	0.56	0.54–0.58	< 0.001	0.69	0.65–0.73	< 0.001
West	0.36	0.35–0.38	< 0.001	0.36	0.34–0.38	< 0.001	0.56	0.53–0.59	< 0.001	0.57	0.54–0.6	< 0.001
South	0.50	0.48–0.52	< 0.001	0.43	0.41–0.46	< 0.001	0.78	0.75–0.81	< 0.001	0.73	0.69–0.76	< 0.001

uOR Unadjusted Odds Ratio, *aOR* Adjusted Odds Ratio

revealed that while women had a higher prevalence and odds of abdominal obesity compared to their counterparts, the prevalence was found to be greater for NW and SW compared to NSW for both men and women after controlling other confounding factors. These findings are consistent with previous studies conducted in Bangladesh [31] and Japan [32], wherein women engaged in sedentary work had higher WHR than other occupations. Studies conducted in the U.S [33]. and Australia [34] also observed a link between obesity and sedentary behaviour at the workplace, with workers having longer sitting hours registering a higher prevalence of obesity.

A study based on the interaction of sedentary behaviour and energy intake observed that increased sedentary behaviour is significantly linked to reduced energy expenditure, the onset of insulin resistance, diminished insulin sensitivity, and accumulation of abdominal fat [35]. Although genetic predisposition cannot be ruled out in the dynamics of reduced energy expenditure and subsequently accumulation of abdominal fat in the body, studies suggest at least two major mechanisms proposed to explain how sedentary behaviour contributes to body fat accumulation [36]. First, prolonged sedentary activity, such as sitting, involves minimal muscular movement, often leading to a positive energy balance as it is not typically offset by a reduction in energy intake. Occupations that require long hours of sitting involve very low physical exertion, with the body's metabolic rate during these periods closely mirroring the resting metabolic rate. This lack of physical activity may not apply uniformly across all sedentary behaviors. However, research suggests that the absence of non-exercise activity thermogenesis (NEAT)-low-energy activities like standing, stretching, or fidgeting-contributes to body fat accumulation, especially under conditions of extended sedentary behavior [37]. Secondly, sedentary time tends to replace physical exercise and other active pursuits, thereby decreasing overall energy expenditure [38]. This shift from active to sedentary time can contribute to weight gain and fat accumulation over time, as fewer calories are burned, and the opportunity for metabolic stimulation through movement is reduced. These mechanisms underscore how sedentary lifestyles, whether due to occupational demands or personal habits, can escalate weight gain and increase health risks associated with abdominal fat storage.

The study also explores a diverse array of confounders that could influence the association between sedentary occupation and abdominal obesity. Aging and abdominal obesity were found to have an inherent association. Our study observed that with an increase in age, the prevalence and odds of abdominal obesity increase, regardless of the occupational category. This can be explained by the change in metabolism and distribution of adipose tissue in the body with the advancement of age which makes the elderly more prone to abdominal obesity [39, 40]. Economic condition was also found to be significantly associated with abdominal obesity. Globally, rapidly growing and transitional economies exhibited a higher prevalence of obesity and abdominal obesity driven by changes in dietary patterns, a rise in fast food markets, and increased consumption of energy-dense junk foods [10, 24]. As per the Household Consumption Expenditure Survey 2022–23, conducted by the National Statistical Survey Organization, the share of processed foods and beverages in average MPCE increased from 7.4% in 2009–10 to 9.6% in 2022–23 in the rural areas and 8% in 2009–10 to 10.6% in 2022–23 in the urban areas in India respectively, with simultaneous significant reduction in the consumption of cereals during the same period [41]. The present study found that both men and women in the richest quintile as well as those who consumed non-vegetarian food exhibited higher prevalence and odds of abdominal obesity, concurrent with the findings of the studies conducted in Bangladesh [42] and China [43]. The growing shift from traditional dietary cereals to calorie-dense processed foods and oils is recognized as a key contributing factor [44, 45]. Females who consumed junk food daily were also found to have higher odds and prevalence of abdominal obesity while no such association was found for their counterparts. The findings are concurrent with previous studies [46, 47]. Hormonal changes, physiological differences, and different metabolism of females may be cited as some of the reasons. Our analysis also reported lower likelihood of abdominal obesity with increase in birth parity among women, which is contradictory to the existing studies [48, 49].

Alcohol is recognized as one of the key risk factors affecting the rising burden of NCDs like CVDs, diabetes and cancers. Studies have shown that the consumption of alcohol is significantly associated with an increase in abdominal obesity, and thereby increased blood pressure, cholesterol and insulin levels [50, 51]. Our study also reported higher odds and prevalence of abdominal obesity among those who consumed alcohol for both males and females. While several studies have reported a higher prevalence of obesity in rural areas [52, 53], our study revealed lower prevalence and odds of abdominal obesity in rural areas compared to their counterpart across all occupations. Villages in India are still predominantly dependent on labour-intensive agriculture, coupled with a less sedentary lifestyle which may be cited as the important reasons for the same.

Our study highlights the link between sedentary occupations and abdominal obesity in India. Amidst rapid economic growth and the escalating burden of NCDs, abdominal obesity remains a significant risk factor, highlighting the need for targeted policy interventions. This include health promotion campaigns, integrating sedentary behavior policies with existing NCD prevention programs, integration of dietary practices in the existing health programmes, regulating sale of processed foods as well as encouraging physical activity during leisure hours [44, 54]. Further, workplace interventions like sit-stand desks, movement breaks and behaviour change campaigns may also reduce the sedentary behaviour of the individuals [55]. A systematic review of studies on workplace interventions and sedentary behaviour by Malik et. al found that behavioural support, health promotion and exercise intervention resulted in statistically significant increase in physical activities of the individuals in almost half of the studies [56]. Comprehensive policy interventions are essential to mitigate the growing burden of abdominal obesity in India. These should include the promotion of active work environments, stringent regulation of processed foods, and the integration of behaviour change strategies targeting sedentary lifestyles within existing NCD programmes.

The key strengths of this study include its national representativeness, large sample size segregated by gender, its structured questionnaire, and the reliable biomarker information on waist-to-hip ratio which was collected using standard measuring instruments by trained staff across the country. The study findings are significant for comprehending the underlying mechanisms and causes of obesity, promoting scientific decision-making for the prevention of obesity and improving the general health of the population. Our study is also not free from limitations. First, due to the absence of information on physical activities, the study solely focuses on the nature of work as a proxy for physical activities. Secondly, the study considers the adults only and does not account for children and the elderly. With childhood obesity being a major risk factor for impaired cognitive development and an increasingly aging population, study of these two groups is intrinsic for informed policy decisions. Third, social desirability bias may lead to underestimate the sedentary behavior of respondents. Fourth, our study is based on a cross-sectional design, which precludes a causal inference of our findings.

Conclusions

A sedentary lifestyle has direct impact on the Sustainable Development Goals (SDGs), especially SDG 3 – Good Health and Wellbeing. India's vision of achieving "highest possible level of health and wellbeing at all ages" is hindered by the dual burden of increasing NCDs and a persistently significant, though declining, burden of communicable diseases nationwide. The growing prevalence of abdominal obesity, a major risk factor for CVDs and diabetes, exacerbates the overall health burden. Prolonged inactivity due to sedentary occupations increases the risk of chronic diseases hindering overall health and productivity [57, 58]. This study significantly enhances our understanding of the growing public health challenge posed by abdominal obesity in the country. Prevalence was found to be higher for women across all occupational categories compared to their counterparts, with NW and SW showing higher prevalence. A significant association was observed between sedentary work and abdominal obesity, with both men and women engaged in SW showing a higher likelihood for acquiring abdominal obesity after controlling other confounding factors. Additionally, factors such as age, wealth status, dietary habits, and alcohol consumption were all positively associated with abdominal obesity. There is a pressing need for policies that raise awareness about the risks of sedentary occupation and promote physical activity, both during leisure time and at work in India. Strategies to limit daily sitting may reduce metabolic disease risk. Such initiatives could reduce abdominal obesity and help curb the rise of NCDs, improving public health and easing the long-term burden on both, individuals and healthcare systems.

Supplementary Information

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Supplementary Material 1.

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Authors' contributions
NKS and RS conceptualized and designed the study; NKS, SKS and RB contributed to data extraction, statistical analysis, and interpretation. RS and NS search the literature and contributed to the first draft of the manuscript. RS, SKS and NS revised the manuscript. All authors approved the final manuscript. RS and NKS contributed equally and are co-first authors.

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Data availability
Data utilized in this study is publicly available from DHS upon request and filing the registration. DHS data are available on https://dhsprogram.com/data/available-datasets.cfm.

Declarations

Ethics approval and consent to participate
Ethical approval for this study was not needed. The study used only anonymised data from secondary sources. All methods were carried out following relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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