Research Article

Sociodemographic Determinants of Hypertension–Obesity–Diabetes (HOD) Complex among Adults in Central India

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Background: Hypertension, obesity, and diabetes mellitus are major non-communicable diseases that frequently coexist and substantially increase the risk of cardiovascular morbidity and mortality. The clustering of these conditions, referred to as the hypertension–obesity–diabetes (HOD) complex, reflects shared risk factors and underlying sociodemographic determinants. Understanding these determinants is essential for designing targeted and integrated public health interventions in rapidly transitioning populations such as those in Central India.

Aim and Objectives: To determine the association between sociodemographic factors and the HOD complex among adults in Central India. The study also aimed to estimate the prevalence of hypertension, obesity, diabetes, and their clustering, and to identify independent sociodemographic predictors of the HOD complex.

Methodology: A community-based cross-sectional study was conducted among 600 adults aged ≥18 years attending health camps under the Family Adoption Program in rural and urban field practice areas of R.D. Gardi Medical College, Ujjain. Data were collected using a pre-tested semi-structured questionnaire. Blood pressure, anthropometric measurements, and random capillary blood glucose were assessed using standardized procedures. Associations were evaluated using chi-square tests, and multivariable logistic regression was performed to determine independent predictors.

Results: Among the participants, 33.3% were overweight/obese, 23.7% were hypertensive, 8.5% were diabetic, and 45.0% had prehypertension. Overall, 5.3% had the HOD complex. Obesity was significantly associated with age ($p = 0.0001$) and gender ($p < 0.001$). Diabetes was significantly associated with age ($p = 0.031$) and type of family ($p = 0.003$), while hypertension showed significant associations with age ($p = 0.001$), gender ($p = 0.034$), and family type ($p = 0.016$). On multivariable analysis, increasing age (AOR =2.05; 95% CI: 1.13–3.71), female gender (AOR=6.95; 95% CI: 2.10–23.03), and nuclear family type (AOR=6.38; 95% CI: 2.16–18.88) emerged as independent determinants of the HOD complex, whereas socioeconomic status was not significant.

Conclusion: A considerable burden of cardiometabolic conditions and their clustering was observed. Increasing age, female gender, and nuclear family structure were independent determinants of the HOD complex. These findings emphasize the need for integrated community-based screening and targeted preventive strategies focusing on high-risk sociodemographic groups to reduce the growing burden of cardiometabolic diseases.

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Introduction

Non-communicable diseases (NCDs) constitute one of the most significant public health challenges of the 21st century and are responsible for a substantial proportion of global morbidity and mortality. Among these, hypertension, obesity, and diabetes mellitus are highly prevalent chronic conditions that increasingly affect adult populations across both developed and developing countries. These conditions not only reduce quality of life but also place a considerable burden on health-care systems due to their chronic nature, long-term complications, and need for sustained medical care. The growing prevalence of these diseases reflects complex interactions between biological, behavioural, environmental, and social determinants of health.[1]

Globally, diabetes continues to rise at an alarming pace. According to the 2025 International Diabetes Federation (IDF) Diabetes Atlas, approximately 589

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million adults aged 20 to 79 years about 11.1% of the global adult population were living with diabetes in 2024, equivalent to roughly 1 in 9 adults worldwide, and this number is projected to increase substantially by 2050. An estimated 43% of adults with diabetes remain undiagnosed, and low- and middle-income countries account for the vast majority of cases. Obesity, a major risk factor for both diabetes and hypertension, has similarly reached pandemic proportions, with projections suggesting that over half of the world's adult population may be overweight or obese by 2050 if current trends continue.[2,3]

In India a country experiencing rapid demographic and lifestyle transitions the burden of these metabolic conditions is similarly high and rising. Large national surveys indicate that over 11% of Indian adults are living with diabetes, while approximately 35 to 36% have hypertension. The same epidemiological evidence shows that around 28.6% of adults have generalised obesity and nearly 39.5% have abdominal (central) obesity. In absolute terms, these figures translate to over 101 million Indians with diabetes, approximately 315 million with high blood pressure, and hundreds of millions with excess body weight.[4]

Hypertension is a major risk factor for cardiovascular diseases, stroke, and renal disorders and is often asymptomatic until complications arise. Its development is influenced by a combination of genetic predisposition and modifiable factors such as diet, physical inactivity, stress, tobacco use, and alcohol consumption.[5] Obesity, defined by excessive accumulation of body fat, has emerged as a critical public health issue and is strongly associated with both hypertension and diabetes. Excess adiposity contributes to metabolic and hormonal disturbances, including insulin resistance, dyslipidemia, and systemic inflammation, which collectively increase the risk of cardiometabolic diseases. Diabetes mellitus, particularly type 2 diabetes, has shown a rapid rise in prevalence and is closely linked to overweight, obesity, sedentary lifestyles, and unhealthy dietary patterns.[6]

The coexistence of hypertension, obesity, and diabetes is common, and these conditions often act synergistically to accelerate the development of cardiovascular diseases and other complications. This clustering of metabolic risk factors highlights the need to view these conditions not in isolation but as interconnected components of a broader cardiometabolic risk profile. Early onset and prolonged duration of these conditions in adulthood further increase the likelihood of adverse health outcomes, emphasizing the importance of prevention and early identification.[7,8]

Sociodemographic factors play a crucial role in shaping the distribution and determinants of hypertension, obesity, and diabetes among adults. Variables such as age, sex, education level, occupation, income, marital status, and place of residence influence health behaviors, lifestyle choices, and access to healthcare services.[9] Ageing is associated with physiological changes that increase susceptibility to chronic diseases, while gender differences may reflect variations in body composition, hormonal factors, occupational exposures, and health-seeking behavior. Educational attainment and socioeconomic status affect health literacy, dietary habits, physical activity, and the ability to access preventive and curative health services.[10]

In countries like India, rapid urbanization, economic development, and changing social structures have significantly altered traditional lifestyles. Increased consumption of calorie-dense foods, reduced physical activity, and rising psychosocial stress have contributed to the growing burden of obesity, hypertension, and diabetes, particularly among adults. At the same time, social inequalities persist, leading to differential exposure to risk factors and unequal access to healthcare across population groups. Urban and underprivileged communities often face additional challenges such as limited awareness, financial constraints, and inadequate health infrastructure, which can further exacerbate the risk of chronic diseases.

Understanding the association of hypertension, obesity, and diabetes with sociodemographic factors is fundamental to effective public health action. Such knowledge facilitates identification of high-risk population groups and provides insight into the influence of social and demographic determinants on disease distribution and progression. This evidence is crucial for planning targeted interventions, strengthening community-based screening and prevention programs, and integrating non-communicable disease (NCD) care within primary healthcare systems. Addressing the underlying social determinants is also essential for reducing health inequities and achieving sustainable control of NCDs.[1,10]

In this context, examining the relationship between hypertension, obesity, and diabetes and sociodemographic characteristics among adults generates valuable evidence for policymakers, health planners, and clinicians. It supports the development of tailored strategies emphasizing lifestyle modification, early detection, and

health education, thereby contributing to a reduction in the growing burden of NCDs and improvement in adult health outcomes. Conducting the study in a tertiary care centre enables systematic assessment of adults from both rural and urban communities using standardized diagnostic methods and reliable laboratory facilities. As referral centres, tertiary hospitals serve socioeconomically diverse populations and capture individuals across different stages of disease, including undiagnosed cases. Inclusion of rural and urban populations from Central India is particularly important in view of rapid epidemiological transition and persistent disparities in awareness, health-seeking behavior, and access to preventive services, especially in rural settings. This approach allows identification of context-specific sociodemographic determinants and informs region-appropriate prevention and control strategies.

Aim

To determine the association between sociodemographic factors and the hypertension–obesity–diabetes (HOD) complex among adults in Central India.

Objectives

Primary Objective

To assess the association between sociodemographic factors (age, gender, residence, family type, and socioeconomic status) and the presence of the hypertension–obesity–diabetes (HOD) complex among adults.

Secondary Objectives

- To estimate the prevalence of hypertension, obesity, diabetes, and the HOD complex, and to examine their distribution across different sociodemographic groups.
- To identify independent sociodemographic predictors of the HOD complex

Methodology

Study Design and Objectives

The present community-based cross-sectional study was conducted to determine the association between sociodemographic factors and the HOD complex among adults residing in rural and urban communities of Central India. The study assessed the relationship of selected sociodemographic variables-age, gender, residence, family type, and socioeconomic status with the presence of the HOD complex. Additionally, it estimated the prevalence of hypertension, obesity, diabetes, and their clustering, examined their distribution across sociodemographic groups, and identified independent predictors of the HOD complex.

Study Setting

The study was carried out in the field practice areas attached to R.D. Gardi Medical College, Ujjain, a tertiary care teaching institution. It was implemented under the framework of the National Medical Commission (NMC) guidelines through the Family Adoption Program (FAP).[11,12] and the Community Adoption Program led by postgraduate students. Data were collected during six organized health camps-one at the Urban Health Training Centre (UHTC) and five at the Rural Health Training Centre (RHTC), Palwa ensuring representation of both urban and rural populations.

Study Population and Sampling

The study population included adults aged 18 years and above who attended the FAP health camps and were permanent residents of the respective areas for at least six months. Participants who provided written informed consent were included. Pregnant women, seriously ill individuals unable to participate, and those with incomplete data were excluded. The sample size was calculated using the formula $n = 4\ pq/L^2$, assuming a prevalence of 50% with 10% allowable error, yielding a minimum sample of 400. After adding 10% for non-response, 440 participants were required; however, 600 adults were ultimately included. Convenience sampling was used from camp attendees.

Data Collection Tools and Procedure

Data were collected using a pre-designed, pre-tested semi-structured questionnaire administered through face-to-face interviews by trained medical interns and postgraduate residents under faculty supervision. Information on age, gender, residence, type of family, and socioeconomic status (modified BG Prasad classification) was recorded, along with any known history of hypertension or diabetes.

Measurement of Variables

Blood Pressure

Blood pressure was measured using a calibrated digital sphygmomanometer following standard guidelines. Two readings were taken after five minutes of rest in the sitting position, and the average was recorded. Hypertension was defined as systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg or a self-reported history with current treatment.

Anthropometric Measurements

Weight and height were measured using standardized equipment. Body mass index (BMI) was calculated as kg/m² and categorized as underweight (<18.5), normal (18.5–24.9), and overweight/obese (≥25) as per WHO Asian cut-offs.

Blood Glucose Measurement

Random capillary blood glucose was measured using a standardized glucometer under aseptic precautions. Blood glucose was categorized as normal (≤140 mg/dL), prediabetes (141–160 mg/dL), and diabetes (>160 mg/dL). Instruments were calibrated daily to ensure accuracy.

Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee of R.D. Gardi Medical College, Ujjain. Written informed consent was secured from all participants. Confidentiality was maintained, and individuals detected with elevated blood pressure or blood glucose were counselled and referred for further evaluation and management.

Results

Sociodemographic Characteristics of Study Participants

A total of 600 participants were included in the study. The majority were aged 51–70 years (243; 40.5%), followed by 31–50 years (204; 34.0%), >70 years (80; 13.3%), and ≤30 years (73; 12.2%). Females constituted a larger proportion (344; 57.3%) compared to males (256; 42.7%). Rural residents (312; 52.0%) slightly outnumbered urban residents (288; 48.0%). Nuclear families (321; 53.5%) were more common than joint families (279; 46.5%). Most participants belonged to the middle socioeconomic class (304; 50.7%), followed by lower (169; 28.2%) and upper class (127; 21.2%).

Morbidity Profile of Participants

Normal BMI was observed in 323 participants (53.8%), while 200 (33.3%) were overweight/obese and 77 (12.8%) were underweight. Most participants had normal blood sugar levels (495; 82.5%), whereas 54 (9.0%) were prediabetic and 51 (8.5%) were diabetic. Regarding blood pressure, prehypertension was most prevalent (270; 45.0%), followed by hypertension (142; 23.7%), while 188 (31.3%) had normal blood pressure. Anaemia of any severity was observed in 271 participants (45.2%), including mild (127; 21.2%), moderate (96; 16.0%), and severe anaemia (48; 8.0%). Overall, 260 participants (43.3%) had one disease, 181 (30.2%) had two diseases, and 32 (5.3%) had all three conditions constituting the HOD complex, whereas 127 (21.2%) had no disease.

Association of Morbidities with Sociodemographic Variables

Obesity demonstrated a statistically significant association with age and gender, with the highest proportion observed in the 51–70 years age group (87; 43.5%) (p = 0.0001). Females constituted a significantly larger share of obese participants (143; 71.5%) compared to males (57; 28.5%) (p <0.001), whereas type of family (p = 0.099) and socioeconomic status (p = 0.421) were

Table 1: Distribution of sociodemographic variables among study participants (n = 600)

Sociodemographic variable	*Category*	*Frequency*	*Percentage*
Age groups	≤30 years	73	12.20
	31–50 years	204	34.00
	51–70 years	243	40.50
	>70 years	80	13.30
Gender	Male	256	42.70
	Female	344	57.30
Residence	Urban	288	48.00
	Rural	312	52.00
Type of family	Joint	279	46.50
	Nuclear	321	53.50
Socioeconomic status	Upper class	127	21.20
	Middle class	304	50.70
	Lower class	169	28.20

Table 2: Morbidity profile of study participants (n = 600)

Morbidity variable	*Category*	*Frequency*	*Percentage*
BMI category	Underweight	77	12.80
	Normal	323	53.80
	Overweight	141	23.5
	Obesity	59	9.83
Blood sugar status	Normal	495	82.50
	Prediabetic	54	9.00
	Diabetes	51	8.50
Blood pressure status	Normal	188	31.30
	Prehypertensive	270	45.00
	Hypertensive	142	23.70
Anaemia status	No anaemia	329	54.80
	Mild anaemia	127	21.20
	Moderate anaemia	96	16.00
	Severe anaemia	48	8.00
HOD complex status	No disease	127	21.20
	Only one disease	260	43.30
	Two diseases	181	30.20
	HOD complex present	32	5.30

Table 3A: Association of obesity with Sociodemographic Variables

Sociodemographic variable	*Category*	*No obesity*	*Obese*	*p-value*
Age group	≤30 yrs	64 (16.0%)	9 (4.5%)	0.01
	31–50 yrs	122 (30.5%)	82 (41.0%)	
	51–70 yrs	156 (39.0%)	87 (43.5%)	
	>70 yrs	58 (14.5%)	22 (11.0%)	
Gender	Male	199 (49.8%)	57 (28.5%)	0.01
	Female	201 (50.2%)	143 (71.5%)	
Type of family	Joint	196 (49.0%)	83 (41.5%)	0.09
	Nuclear	204 (51.0%)	117 (58.5%)	
SES	Upper	85 (21.2%)	42 (21.0%)	0.42
	Middle	196 (49.0%)	108 (54.0%)	
	Lower	119 (29.8%)	50 (25.0%)	

not significantly associated. Diabetes was significantly associated with age and family type, with the majority of cases occurring in the 51–70 years group (30; 58.8%) (p = 0.031), and a higher proportion among participants from nuclear families (38; 74.5%) compared to joint families (13; 25.5%) (p = 0.003); no significant associations were observed with gender or socioeconomic status (p >0.05). Similarly, hypertension prevalence increased significantly with advancing age, peaking in the 51–70 years group (68; 47.9%) (p = 0.001), and was more common among nuclear family participants (89; 62.7%) than joint family participants (53; 37.3%) (p = 0.016). Gender showed a modest but significant association with hypertension (p = 0.034), while socioeconomic status was not significantly related (p = 0.383). Anaemia severity differed significantly by gender (p <0.001), with females accounting for most

Table 3B: Association of diabetes with sociodemographic variables

Sociodemographic variable	*Category*	*No Diabetes*	*Diabetes*	*p-value*
Age group	≤30 yrs	69 (12.6%)	4 (7.8%)	0.03
	31–50 yrs	194 (35.3%)	10 (19.6%)	
	51–70 yrs	213 (38.8%)	30 (58.8%)	
	>70 yrs	73 (13.3%)	7 (13.7%)	
Gender	Male	240 (43.7%)	16 (31.4%)	0.12
	Female	309 (56.3%)	35 (68.6%)	
Type of family	Joint	266 (48.5%)	13 (25.5%)	0.03
	Nuclear	283 (51.5%)	38 (74.5%)	
SES	Upper	120 (21.9%)	7 (13.7%)	0.05
	Middle	270 (49.2%)	34 (66.7%)	
	Lower	159 (29.0%)	10 (19.6%)	

Table 3C: Association of hypertension with sociodemographic variables

Sociodemographic variable	*Category*	*No hypertension*	*Hypertensive*	*p-value*
Age group	≤30 yrs	69 (15.1%)	4 (2.8%)	0.01
	31–50 yrs	155 (33.8%)	49 (34.5%)	
	51–70 yrs	175 (38.2%)	68 (47.9%)	
	>70 yrs	59 (12.9%)	21 (14.8%)	
Gender	Male	184 (40.2%)	72 (50.7%)	0.03
	Female	274 (59.8%)	70 (49.3%)	
Type of family	Joint	226 (49.3%)	53 (37.3%)	0.01
	Nuclear	232 (50.7%)	89 (62.7%)	
SES	Upper	101 (22.1%)	26 (18.3%)	0.38
	Middle	225 (49.1%)	79 (55.6%)	
	Lower	132 (28.8%)	37 (26.1%)	

Table 3D: Association of anaemia status with sociodemographic variables

Socio-demographic variable	*Category*	*No anaemia*	*Mild*	*Moderate*	*Severe*	*p*
Age group (in Years)	≤30	44 (13.4%)	14 (11.0%)	11 (11.5%)	4 (8.3%)	0.83
	31-50	117 (35.6%)	45 (35.4%)	29 (30.2%)	13 (27%)	
	51–70	126 (38.3%)	53 (41.7%)	42 (43.8%)	22 (45.8%)	
	>70	42 (12.8%)	15 (11.8%)	14 (14.6%)	9 (18.8%)	
Gender	Male	156 (47.4%)	40 (31.5%)	27 (28.1%)	33 (68.8%)	0.00
	Female	173 (52.6%)	87 (68.5%)	69 (71.9%)	15 (31.2%)	
Type of family	Joint	152 (46.2%)	58 (45.7%)	50 (52.1%)	19 (39.6%)	0.53
	Nuclear	177 (53.8%)	69 (54.3%)	46 (47.9%)	29 (60.4%)	
SES	Upper	71 (21.6%)	29 (22.8%)	16 (16.7%)	11 (22.9%)	0.18
	Middle	170 (51.7%)	52 (40.9%)	56 (58.3%)	26 (54.2%)	
	Lower	88 (26.7%)	46 (36.2%)	24 (25.0%)	11 (22.9%)	

Table 4: Association of HOD Complex (Binary) with Sociodemographic Variables

Sociodemographic Variable	*Category*	*No disease*	*HOD complex*	*p-value*
Age group	≤30 yrs	26 (20.47%)	2 (6.25%)	0.07
	31–50 yrs	45 (35.43%)	9 (28.12%)	
	51–70 yrs	39 (30.71%)	17 (53.12%)	
	>70 yrs	17 (13.39%)	4 (12.50%)	
Gender	Male	60 (47.24%)	6 (18.75%)	0.00
	Female	67 (52.76%)	26 (81.25%)	
Type of family	Joint	72 (56.69%)	8 (25.00%)	0.00
	Nuclear	55 (43.31%)	24 (75.00%)	
Socioeconomic status	Upper	26 (20.47%)	9 (28.12%)	0.19
	Middle	61 (48.03%)	18 (56.25%)	
	Lower	40 (31.50%)	5 (15.62%)	

Table 5: Multivariable logistic regression analysis for determinants of HOD complex

Variable	*Adjusted OR*	*95% CI*	*p-value*
Age group (per category increase)	2.05	1.13 – 3.71	0.01
Gender	6.95	2.10 – 23.03	0.02
Type of family	6.38	2.16 – 18.88	0.01
Socioeconomic status (per category increase)	0.74	0.37 – 1.49	0.40

mild (87; 68.5%) and moderate cases (69; 71.9%), whereas severe anaemia was more prevalent among males (33; 68.8%); age, family type, and socioeconomic status did not demonstrate significant associations (p >0.05).

Association and Determinants of HOD Complex

When analyzed as a binary outcome, females constituted the majority of HOD complex cases (26; 81.3%) compared to males (6; 18.8%) (p = 0.006). Participants from nuclear families contributed a significantly higher proportion of cases (24; 75.0%) than those from joint families (8; 25.0%) (p = 0.003). Although the largest proportion of HOD complex was observed in the 51–70 years age group (17; 53.1%), the association with age was not statistically significant in bivariate analysis (p = 0.072), and socioeconomic status similarly showed no significant association (p = 0.192). However, on multivariable logistic regression analysis, increasing age category emerged as an independent predictor of HOD complex (AOR=2.05; 95% CI: 1.13–3.71; p = 0.018). Females had nearly seven times higher odds of developing the HOD complex compared to males (AOR=6.95; 95% CI: 2.10–23.03; p = 0.002), and individuals from nuclear families exhibited significantly greater odds (AOR=6.38; 95% CI: 2.16–18.88; p = 0.001). Socioeconomic status did not demonstrate an independent association with the HOD complex (AOR=0.74; 95% CI: 0.37–1.49; p = 0.402).

Discussion

In the present study (n=600), the largest proportion of participants belonged to the 51–70 years age group (243; 40.5%), followed by 31–50 years (204; 34.0%), whereas 73 (12.2%) were ≤30 years and 80 (13.3%) were >70 years. Females constituted 344 (57.3%) of the study population. Rural residents accounted for 312 (52.0%), nuclear families comprised 321 (53.5%), and the majority belonged to the middle socioeconomic class (304; 50.7%). John D *et al.* (2024) included 2245 adults aged ≥30 years and reported diabetes prevalence of 15.5% and hypertension prevalence of 17.2% in an urban underprivileged community; although age-group percentages were not specified, higher prevalence of both conditions was observed among older individuals. Compared to their cohort, the present study demonstrates a substantial representation of middle-aged and elderly participants, with 40.5% in the 51 to 70 years category and 74.5% aged >30 years overall. Similarly, Kasaudhan S *et al.* (2024)[13] studied 931 adults aged 20 to 75 years in rural Punjab and reported that diagnosed hypertension and diabetes were more common in older age groups,

though detailed age distribution percentages were not provided. Thus, the predominance of middle-aged and older adults in the present study is consistent with the age pattern observed in these comparative studies, where increasing age is associated with a higher burden of cardiometabolic conditions.

In the present study, 200 participants (33.3%) were overweight/obese, 51 (8.5%) were diabetic, and 142 (23.7%) were hypertensive, while prehypertension was observed in 270 (45.0%) participants; overall, 32 individuals (5.3%) had all three conditions constituting the HOD complex. Mendhe HG *et al.* (2023)[14] reported a markedly higher generalized obesity prevalence of 76.61% among 278 diabetic patients in an urban Central Indian cohort, compared to 33.3% in the present general adult population. John D *et al.* (2024)[15] documented a diabetes prevalence of 15.5% and a hypertension prevalence of 17.2% among 2245 adults, whereas the present study showed a lower diabetes prevalence (8.5%) but a higher hypertension prevalence (23.7%). Meshram *et al.* (2022)[16] reported age-standardized hypertension prevalence of 20.2% and overweight/obesity prevalence of 22.6% (BMI ≥23) among rural adults; both hypertension (23.7%) and overweight/obesity (33.3%) were higher in the present study. Das S *et al.* (2022)[17] reported a hypertension prevalence of 28.5%, diabetes prevalence of 9.9%, and comorbidity (hypertension and diabetes together) of 4.5% among 11,881 adults; in comparison, the present study observed slightly lower hypertension (23.7%) and diabetes (8.5%) prevalence but a marginally higher clustering prevalence (5.3%). Overall, hypertension and overweight/obesity prevalence in the present study are comparable to or slightly higher than several community-based datasets, whereas diabetes prevalence appears lower than that reported in some larger urban or nationally representative cohorts.

In the present study, obesity was significantly associated with age ($p = 0.0001$) and gender ($p < 0.001$), with the highest proportion observed in the 51–70 years age group (87; 43.5%); females constituted 143 (71.5%) of obese participants compared to 57 (28.5%) males, while type of family ($p = 0.099$) and socioeconomic status ($p = 0.421$) were not significantly associated. Mendhe HG *et al.* (2023)[14] reported a substantially higher generalized obesity prevalence of 76.61% among 278 diabetic participants in an urban cohort, compared to the 33.3% overweight/obesity prevalence in the present general population, and further noted higher obesity among individuals with family history of diabetes and tobacco chewers, though sex-wise distribution was not provided. Das S *et al.* (2022)[17] demonstrated that overweight adults had 2.47 times higher odds of hypertension (AOR 2.47; 95% CI 2.22–2.75) and obese adults had 2.65 times higher odds (AOR 2.65; 95% CI 2.16–3.26), while Meshram I *et al.* (2022)[16] reported overweight/obesity prevalence of 22.6% and 2–3 times higher odds of hypertension among overweight (CI 1.87–2.25) and obese (CI 2.65–3.27) adults; compared to their 22.6%, the present study shows a higher overweight/obesity prevalence of 33.3%. With respect to diabetes, significant associations were observed with age (p=0.031) and type of family ($p = 0.003$), with most cases in the 51–70 years group (30; 58.8%) and a greater proportion among nuclear families (38; 74.5%), whereas gender ($p = 0.120$) and socioeconomic status ($p = 0.057$) were not significant. John D *et al.* (2024)[15] reported a diabetes prevalence of 15.5% and identified significant associations with alcohol consumption (OR 2.09; 95% CI 1.1–3.9), central obesity (OR 1.83; 95% CI 1.4–2.5), and male gender; in contrast, the present study did not demonstrate a significant gender association. Das S *et al.* (2022)[17] reported diabetes prevalence of 9.9%, slightly higher than the 8.5% observed in the present study, but did not report family type associations. Regarding hypertension, significant associations were observed with age ($p = 0.001$), gender ($p = 0.034$), and type of family ($p = 0.016$), with the highest proportion in the 51–70 years group (68; 47.9%) and greater representation among nuclear families (89; 62.7%). Meshram I *et al.* (2022)[16] reported hypertension prevalence of 22% (age-standardized 20.2%), and John D *et al.* (2024)[15] reported 17.2%, both lower than the 23.7% observed in the present study; Suryananth KB *et al.* (2024)[18] reported systolic BP ≥140 mmHg in 39% of males, whereas 72 males constituted 50.7% of hypertensive participants in the present study. Finally, anaemia severity showed significant association with gender ($p < 0.001$), with females accounting for 87 (68.5%) mild and 69 (71.9%) moderate cases, while severe anaemia was more prevalent among males (33; 68.8%); no significant associations were observed with age, family type, or socioeconomic status, and comparable stratified anaemia data were not reported in the referenced studies.

In the present study, the prevalence of HOD complex was 32 (5.3%). Females constituted the majority of cases (26; 81.25%) compared to males (6; 18.75%) ($p = 0.006$), and participants from nuclear families accounted for 24 (75.0%) cases compared to 8 (25.0%) from joint families ($p = 0.003$). Although the highest proportion of HOD complex was observed in the 51 to 70 years age group

(17; 53.12%), age did not show statistical significance in bivariate analysis (p = 0.072), and socioeconomic status was also not significant (p = 0.192). Das S *et al.* (2022)[17] reported a comorbidity prevalence (hypertension and diabetes coexistence) of 4.5%, which is slightly lower than the 5.3% observed in the present study. On multivariable logistic regression analysis, increasing age category emerged as an independent predictor of HOD complex (AOR 2.05; 95% CI 1.13–3.71; p = 0.018). Females had nearly seven times higher odds of developing the HOD complex compared to males (AOR 6.95; 95% CI 2.10–23.03; p = 0.002), and individuals from nuclear families had significantly higher odds (AOR 6.38; 95% CI 2.16–18.88; p=0.001), whereas socioeconomic status was not independently associated (AOR 0.74; 95% CI 0.37–1.49; p = 0.402). In comparison, Das S *et al.* (2022)[17] reported that overweight adults had 2.21 times higher odds of comorbidity (AOR 2.21; 95% CI 1.81–2.71) and obese adults had 2.86 times higher odds (AOR 2.86; 95% CI 2.09–3.91), indicating BMI as an independent predictor of cardiometabolic clustering in their nationally representative dataset. While the present study identified age category, female gender, and nuclear family type as independent determinants, Das S *et al.* emphasized adiposity-related risk, highlighting variation in predictor profiles across populations.

Conclusion

The present study examined the distribution and determinants of the Hypertension–Obesity–Diabetes (HOD) complex among adults in a community setting. A substantial burden of individual cardiometabolic conditions and their clustering was observed, with a measurable proportion of participants affected by multiple coexisting disorders. Increasing age, female gender, and nuclear family structure emerged as significant determinants of the HOD complex, while socioeconomic status did not demonstrate an independent association. These findings underscore that cardiometabolic risk in this population is not isolated to single conditions but reflects interconnected patterns influenced by demographic and social factors. The identification of specific high-risk groups, particularly middle-aged and older adults, women, and individuals from nuclear families, has important implications for targeted screening, early detection, and integrated management strategies. Clinically, the coexistence of hypertension, obesity, and diabetes amplifies the risk of long-term cardiovascular and metabolic complications, emphasizing the need for comprehensive risk assessment rather than disease-specific approaches. From a public health perspective, these results highlight the importance of strengthening community-based screening programs, promoting early lifestyle interventions, and integrating non-communicable disease services within primary health care systems. Addressing clustering at an early stage may reduce progression to severe morbidity and help mitigate the growing burden of cardiometabolic diseases in similar populations.

Limitations and Recommendations

As a cross-sectional study, causal inferences between sociodemographic factors and the HOD complex cannot be established. The use of convenience sampling from health camp attendees may restrict generalizability and introduce selection bias. Reliance on random capillary blood glucose, rather than fasting glucose or HbA1c, may have influenced diagnostic accuracy. Moreover, important behavioral risk factors such as diet, physical activity, tobacco, and alcohol consumption were not comprehensively evaluated.

Future research should employ longitudinal designs with community-based random sampling to strengthen causal interpretation and external validity. Incorporating detailed behavioral assessments and standardized biochemical investigations (e.g., fasting glucose and HbA1c) would further improve risk estimation and diagnostic precision.

Ethical Approval

The ethical approval has been given by the Institutional Ethics Committee of R.D. Gardi Medical College, Ujjain, with reference no. 01/2025

Conflict of Interest

None.

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