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Original Research Article

# Clustering of Modifiable Cardiovascular Risk Factors Among Urban Adults in Northern India: Insights from WHO/ISH Risk Prediction

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**Abstract:**

**Background:** Cardiovascular diseases (CVDs) are often driven by a combination of modifiable risk factors that frequently occur together. Exploring how these factors cluster can help design focused preventive strategies. This study aimed to examine the co-occurrence of modifiable CVD risk factors and their association with the anticipated 10-year CVD risk in an urban population using WHO/ISH risk prediction tables in northern India.

**Methods:** A cross-sectional study involving 350 persons in the Dehradun area between the ages of 40 and 70 was conducted. Information was gathered on tobacco use, BMI, waist circumference, hypertension, alcohol consumption, and diabetes. WHO/ISH SEAR-D risk charts were applied to estimate 10-year CVD risk. Participants were classified according to the number of co-existing risk factors.

**Results:** Of the 350 participants, 79.4% were obese (BMI ≥25 kg/m²), 24.9% reported tobacco use, 16.6% consumed alcohol, 12.6% had diabetes, and 25.4% had hypertension. More than half (54.6%) had two or more modifiable risk factors. The likelihood of having an elevated 10-year CVD risk (≥10%) rose significantly with an increasing number of clustered risk factors ($p<0.001$).

**Conclusion:** The clustering of modifiable CVD risk factors is highly prevalent and strongly linked to higher 10-year CVD risk. Community-based strategies that integrate screening and interventions addressing multiple risk factors simultaneously are essential for effective CVD prevention.



## Introduction

Cardiovascular risk has emerged as the foremost contributor to mortality and disability worldwide, with their impact particularly pronounced in LMIC's such as India [1,2]. Over the past three decades, India has reported a steady rise in deaths and disability-adjusted life years (DALYs) attributable to CVD, reflecting a major shift in the country's health priorities [3]. In states like Uttarakhand, where urbanization is rapid but healthcare resources remain constrained, addressing this growing epidemic poses unique challenges [4].

CVD typically develops through the combined effect of several risk variables that can be changed as opposed to a single cause. Common contributors include tobacco use, alcohol consumption, obesity, hypertension, and diabetes [5,6]. While these risk factors are often studied and managed individually, they frequently coexist in the same person, creating a compounding effect that significantly elevates cardiovascular risk. Understanding such clustering is therefore essential for designing interventions that are both comprehensive and effective.

A simple and economical method is offered by resources like the WHO/International Society of Hypertension (ISH) risk charts for estimating an individual's 10-year likelihood of experiencing a major cardiovascular event, especially in settings with limited resources [7]. These charts incorporate parameters like age, sex, smoking, blood pressure, and diabetes. However, they may not fully account for the heightened risk posed when several modifiable factors occur together, leaving an important gap in risk assessment.

Although numerous studies in India have explored individual cardiovascular risk factors [8–13], relatively few have examined how these risks cluster within communities and how such patterns influence predicted CVD outcomes [14–18]. This study seeks to address that gap by investigating the co-occurrence of modifiable risk factors among adults

aged 40–70 years in an urban area of Dehradun, Uttarakhand. It further evaluates the relationship between the number of co-existing risk factors and estimated 10-year CVD risk using WHO/ISH SEAR-D charts, with the aim of informing integrated preventive approaches under national programs such as the National Programme for Prevention and Control of Non-Communicable Diseases (NP-NCD).

## Materials and Methods

**Study Design and Setting:** Adults living in the urban field practice area of the Himalayan Institute of Medical Sciences (HIMS), Uttarakhand, Dehradun district, participated in a community-based cross-sectional study. Data collection was conducted over six months in 2021, following approval from the Institutional Ethics Committee (Approval No. SRHU/Reg/Int/2021-33510).

**Study Population and Sampling:** Eligible participants were adults aged 40–70 years who were permanent residents of selected urban wards under Nagar Palika Doiwala. Individuals with a prior history of cardiovascular events (e.g., MI, stroke), those unwilling to participate, or those too ill to be interviewed were excluded. The minimum required sample size was estimated as 334 using the formula $n = 4pq/d^2$, with hypertension prevalence assumed at 32.4% [8], 5% absolute precision, and 95% confidence. Allowing for non-response, 350 participants were ultimately included, selected through multistage systematic random sampling.

**Data Collection:** Face-to-face interviews were used to administer a structured, pre-tested questionnaire to collect information on demographics, socioeconomic background (classified using the 2019 Kuppuswamy scale [9]), and behavioural habits such as alcohol consumption, tobacco use, and physical activity.

Anthropometric assessments included:

- Height (cm) measured with a stadiometer
- Weight (kg) recorded using a calibrated digital scale
- Waist circumference measured with a constant-tension tape

BMI was computed and categorized as per WHO standards, while waist circumference thresholds for high risk were defined as ≥80 cm for women and ≥94 cm for men [10].

A digital sphygmomanometer that has been verified was used to collect two readings of blood pressure, separated by ten minutes. Systolic and diastolic BP readings of 140 mmHg and 90 mmHg, respectively, or the use of antihypertensive drugs were considered indicators of hypertension [11]. Random blood glucose was assessed via glucometer; diabetes was defined as prior diagnosis, current treatment with hypoglycaemic agents, or RBS ≥200 mg/dL [12].

### Cardiovascular Risk Assessment

The 10-year likelihood of a cardiovascular event (MI or stroke) that is either fatal or non-fatal was estimated using the non-cholesterol version of the WHO/ISH risk prediction tables for South-East Asia Region D (SEAR-D) [7]. Participants were categorized into:

- **Elevated risk:** ≥10%.
- **Low risk:** <10%.

### Definition of Risk Factor Clustering

The following modifiable risk factors were considered:

1. Current or past alcohol use
2. Current or past tobacco use
3. Obesity (BMI ≥25 kg/m²)
4. High-risk waist circumference
5. Diabetes mellitus
6. Hypertension

Each individual was scored from 0 to 6 based on the number of risk factors present. For analysis, participants were grouped as:

- ≥3 risk factors
- 2 risk factors
- 0–1 risk factor

**Statistical Analysis:** SPSS version 20.0 was used for data entry and analysis. Descriptive statistics were presented as frequencies and percentages. Associations between risk factor clustering and elevated CVD risk were examined using the Chi-square test. A p-value <0.05 was considered statistically significant.

## Results

The study included 350 adults aged 40–70 years, with a mean age of 53.6 ± 8.4 years. Males comprised a slightly higher proportion of participants (57.7%). In terms of education, the largest group had studied up to middle school (26.6%). Nearly 39.7% of the sample belonged to the upper-middle socioeconomic class. More than half (56%) lived in nuclear families, while 44% were from joint families (Table 1).

Table 2 presents the prevalence of individual modifiable cardiovascular risk factors. Obesity (BMI ≥25 kg/m²) was the most widespread, observed in 79.4% of participants. High-risk waist circumference was present in 53.1%. Tobacco use (current or past) was reported by 34.6%, and 22.6% consumed alcohol. Diabetes and hypertension were documented in 12.6% and 25.4% of individuals, respectively.

Clustering analysis showed that 41.1% of participants had three or more modifiable risk factors, 35.1% had two risk factors, and only 23.7% reported one or none (Table 3).

A significant association emerged between the number of risk factors and predicted cardiovascular risk (Table 4). Among those with three or more risk factors, 72.2% were classified as having a ≥10% 10-year CVD risk, compared with only 20.5% in the group with 0–1 risk factor ($p < 0.001$).

This pattern is further illustrated in Figure 1, where the bar chart demonstrates a sharp rise in elevated CVD risk with an increasing number of risk factors. Participants with three or more risk factors were over three times more likely to fall into the elevated risk category compared to those with fewer than two.

**Table 1: Socio-demographic Profile of Study Participants (n=350)**

| S.No | Variable | Category | Frequency (%) |
|---|---|---|---|
| | Age group (years) | 40–50 | 192 (54.9%) |
| | | 51–60 | 67 (19.1%) |
| | | 61–70 | 91 (26.0%) |
| | Gender | Male | 202 (57.7%) |
| | | Female | 148 (42.3%) |
| | Education | Illiterate | 40 (11.4%) |
| | | Primary (1st–5th) | 38 (10.9%) |
| | | Middle school (6th–8th) | 93 (26.6%) |
| | | High school (9th–10th) | 67 (19.1%) |
| | | Intermediate (11th–12th) | 57 (16.3%) |
| | | Graduate and above | 55 (15.7%) |
| | Occupation | Skilled/Semi-skilled | 168 (48.0%) |
| | | Unemployed | 135 (38.6%) |
| | | Others (professional, clerical, unskilled) | 47 (13.4%) |
| | Socio-economic class | Upper/Upper middle | 139 (39.7%) |
| | | Lower middle | 133 (38.0%) |
| | | Upper lower/Lower | 78 (22.3%) |
| | Family type | Nuclear | 196 (56.0%) |
| | | Joint | 154 (44.0%) |

**Table 2: Prevalence of Individual Modifiable CVD Risk Factors Among Study Participants (n=350)**

| S. No | Risk Factor | Frequency (%) |
|---|---|---|
| | Tobacco use (current or past) | 121 (34.6%) |
| | Alcohol use (current or past) | 79 (22.6%) |
| | Obesity (BMI ≥25 kg/m²) | 278 (79.4%) |
| | High-risk waist circumference | 186 (53.1%) |
| | Diabetes mellitus (known cases) | 44 (12.6%) |
| | Hypertension (known cases) | 89 (25.4%) |

**Table 3: Distribution of Participants by Number of Modifiable Risk Factors (n=350)**

| S. No | Number of Risk Factors Present | Frequency (%) |
|---|---|---|
| | 0–1 | 83 (23.7%) |
| | 2 | 123 (35.1%) |
| | ≥3 | 144 (41.1%) |

**Table 4: Association Between Number of Modifiable Risk Factors and Estimated 10-Year CVD Risk (n=350)**

| S. No | Number of Risk Factors | CVD Risk <10% (n=185) | CVD Risk ≥10% (n=165) | Total (n=350) | p-value |
|---|---|---|---|---|---|
| | 0–1 | 66 (35.7%) | 17 (10.3%) | 83 (23.7%) | **<0.001*** |
| | 2 | 79 (42.7%) | 44 (26.7%) | 123 (35.1%) | |
| | ≥3 | 40 (21.6%) | 104 (63.0%) | 144 (41.1%) | |

* Significant

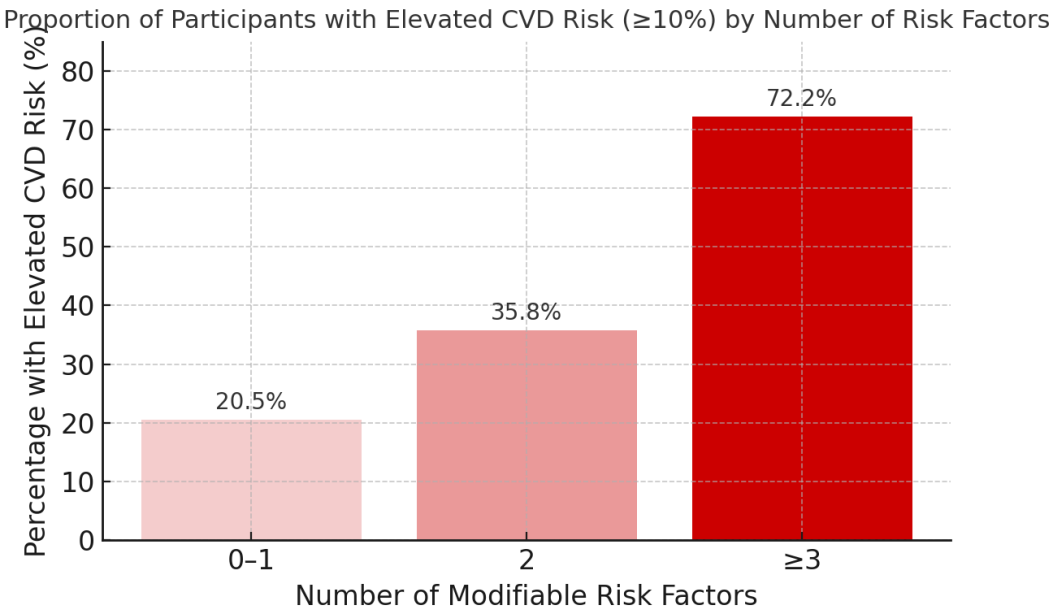


**Figure 1: Percentage of participants with WHO/ISH-estimated elevated 10-year cardiovascular disease (CVD) risk (≥10%) across categories of modifiable risk factor clustering.**

## Discussion

This study underscores an important observation in cardiovascular health: individuals rarely present with a single risk factor. Instead, several modifiable risks—including obesity, central adiposity, hypertension, and tobacco use—often occur together, amplifying overall susceptibility. Our findings revealed that more than 40% of participants carried three or more of these risk factors, and such clustering was strongly linked to elevated 10-year CVD risk, as determined through WHO/ISH prediction charts [7].

These results are in line with both global and national evidence highlighted by Reddy et al., who emphasized that non-communicable diseases like CVD usually emerge from overlapping behavioural and metabolic risks rather than isolated exposures [5,6]. The presence of multiple risk factors not only heightens individual vulnerability but also complicates both patient management and the design of effective public health interventions.

Among the risk factors, obesity emerged as the most widespread, affecting nearly 80% of participants. This mirrors observations from other community-based Indian studies by Dakshinamurthy et al. and Unnas et al., which link rising obesity levels to sedentary routines and changing dietary patterns in urban areas [8,19]. HTN and diabetes were present in 25.4% and 12.6% of individuals, respectively, aligning with prior Indian estimates [16,19,20]. What distinguishes this study, however, is the focus on how these risks combine: almost three-fourths of participants with three or more co-existing factors were categorized as having a ≥10% 10-year CVD risk, reinforcing evidence from earlier Indian and LMIC-based research that cardiovascular risk multiplies rather than adds up when risk factors cluster [14,17,18].

These insights highlight the need to transition from single-risk-focused prevention strategies to integrated, multi-risk models. Although the NP-NCD advocates opportunistic screening at the primary care level, in practice, screening is often vertical—targeting hypertension or diabetes alone—and may overlook individuals with silent, overlapping risks. A clustering-based approach could help identify high-risk individuals earlier, enabling more timely preventive measures.

The WHO/ISH charts employed in this study remain a practical and cost-effective tool for estimating cardiovascular risk in low-resource contexts. However, their design primarily incorporates age, sex, smoking, diabetes, and blood pressure, while omitting obesity and waist circumference—two highly prevalent risks in our cohort. As noted by Rajanandh et al., modifying these charts or developing region-specific models tailored to Asian populations may improve accuracy in capturing the full spectrum of risk [21].

From a public health standpoint, the implications are clear: clustering of modifiable risk factors is both common and consequential. Strategies focused on lifestyle change, community awareness, and longitudinal monitoring should be framed around combined risk profiles rather than individual diseases. Even within a relatively small urban sample, the high burden of clustering observed here underscores the urgency of adopting such integrated preventive approaches.

## Conclusion

The present study highlights that the clustering of modifiable cardiovascular risk factors is widespread among urban adults and is closely linked with a higher chance of getting CVD in ten years. Obesity, hypertension, and tobacco use were the most frequent and overlapping risks, and the probability of being categorized as high-risk on WHO/ISH charts rose with the accumulation of multiple factors.

These results underscore the need to move beyond single-factor approaches toward integrated models of screening and prevention. At the primary care and community level, national initiatives such as the NP-NCD should focus on early detection and management of individuals with multiple risk factors, even before clinical symptoms appear.

For improved accuracy in risk assessment within the Indian setting, future prediction models could incorporate additional parameters such as abdominal obesity and lifestyle behaviors. Moreover, prospective studies are warranted to examine how clustering of risk factors translates into actual cardiovascular outcomes over time.

## References


1. World Health Organization. Definition of cardiovascular diseases. [Last accessed on June 04, 2022].
2. Menard A, Liu LA. Cardiac disease in the young [Internet]. Acls.net. [cited 2022 June 7].
3. India State-Level Disease Burden Initiative CVD Collaborators. The changing patterns of cardiovascular diseases and their risk factors in the states of India: the Global Burden of Disease Study 1990–2016. Lancet Glob Health. 2018;6(12):e1339–51.
4. Kumar R, Sharma SK. Trends of communicable and non-communicable morbidities in Uttarakhand state: A systemic review. Indian J Community Health. 2013;25(2):178–87.
5. WHO. Scaling up prevention and control of chronic noncommunicable diseases in SEAR. India: World Health Organization; 2007.
6. Reddy KS, Shah B, Varghese C, Ramadoss A. Responding to the threat of chronic diseases in India. Lancet. 2005;366(9498):1744–9.
7. World Health Organization. Prevention of cardiovascular disease pocket guidelines for assessment and management of cardiovascular risk WHO/ISH cardiovascular risk prediction charts. 2008. [Accessed on 2022 June 7].
8. Dakshinamurthy S, Saxena V, Kumari R, Mirza A, Dhar M. Association of obesity and metabolic syndrome among urban dwellers of Rishikesh, Uttarakhand. Indian J Community Med. 2020;45(4):516–21.
9. Wani RT. Socioeconomic status scales: modified Kuppuswamy and Udai Pareekh's scale updated for 2019. J Family Med Prim Care. 2019;8(6):1846–9.
10. World Health Organization. Waist circumference and waist–hip ratio: report of a WHO expert consultation, Geneva, 8–11 December 2008.
11. National Institute of Mental Health and Neurosciences (NIMHANS). Handbook for Counselors Reducing Risk Factors for Noncommunicable Diseases. Bangalore: Ministry of Health and Family Welfare, Government of India; 2017.
12. James PA, Oparil S, Carter BL, et al. 2014 evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). JAMA. 2014;311(5):507–20.
13. Muninarayana C, Balachandra G, Hiremath SG, et al. Prevalence and awareness regarding diabetes mellitus in rural Tamaka, Kolar. Int J Diabetes Dev Ctries. 2010;30:18–21.
14. Dugee O, Oum S, Buckley BS, et al. Assessment of total cardiovascular risk using WHO/ISH risk prediction charts in three low- and middle-income countries in Asia. BMC Public Health. 2013;13:539.
15. Samaniyan Bavarsad P, Kheiri S, Ahmadi A. Estimation of the 10-Year Risk of Cardiovascular Diseases: Using the SCORE, WHO/ISH, and Framingham Models in the Shahrekord Cohort Study in Southwestern Iran. J Teh Univ Heart Ctr. 2020;15(3):105–12.
16. Umuerri EM, Obiebi IP. Total cardiovascular risk assessment of women in Delta State, Nigeria, using the WHO/ISH risk prediction chart. J Clin Prev Cardiol. 2020;9:2–7.
17. Saeedi MY. Cardiovascular risk assessment in general population at primary health care centers in Saudi Arabia: Using the WHO/ISH risk prediction charts. Int Res J Public Environ Health. 2018;5:46–51.
18. Kumar K, Arya S, Nightingale P, et al. Cardiovascular risk knowledge in patients of South Asian origin living with rheumatoid arthritis: data from India and the UK. BMC Rheumatol. 2020;4(1):57.
19. Unnas U, Kavita K, Thakur JS, Ghai S, Saini SK. Cardiovascular disease risk assessment using WHO/ISH CVD risk prediction charts in rural area of Chandigarh. Nurs Midwifery Res J. 2017.
20. Bhoo-Pathy N, Subramaniam S, Zaharah H, et al. Baseline prevalence of cardiovascular disease (CVD) risk factors in women with breast cancer. Ann Oncol. 2018;29 Suppl 8:viii613.

21. Rajanandh MG, Suresh S, Manobala K, et al. Prediction of cardiovascular risk in cancer patients of South India using WHO/ISH risk prediction charts and Framingham score: a prospective study. J Oncol Pharm Pract. 2017. https://doi.org/10.1177/1078155217707334