Research Article

Cardiovascular Risk Stratification and Its Sociodemographic and Lifestyle Determinants Among Apparently Healthy Adults

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Abstract

Objective: To estimate ten-year cardiovascular disease (CVD) risk among apparently healthy Pakistani adults and identify its sociodemographic and lifestyle determinants.

Methods: This multicenter cross-sectional study enrolled 1,200 adults aged 40–69 years attending preventive health screening at tertiary-care hospitals in Pakistan. Adults with known CVD were excluded. Sociodemographic details, tobacco use, physical activity, diet and sleep duration were recorded, and anthropometry, blood pressure, random glucose and total cholesterol were measured using standardized procedures. Ten-year risk was estimated with the 2019 World Health Organization (WHO) laboratory-based charts for South Asia, and a risk of ≥10% was considered elevated. Independent determinants were identified with multivariable logistic regression.

Results: Mean age was 51.8±8.1 years, and 636 (53.0%) participants were women. Ten-year risk was <5% in 690 (57.5%), 5–<10% in 276 (23.0%), 10–<20% in 156 (13.0%), 20–<30% in 48 (4.0%) and ≥30% in 30 (2.5%). Age ≥55 years, male sex, no formal education, low household income, tobacco use, insufficient physical activity, central obesity, inadequate fruit and vegetable intake and sleep <6 hours were independently associated with elevated risk. The non-laboratory chart agreed substantially with the laboratory chart (weighted kappa 0.71).

Conclusion: Nearly one in five apparently healthy adults had a ten-year cardiovascular risk of 10% or more. Building simple WHO risk assessment into primary care and community screening could identify these adults early enough for prevention to help.

Keywords: Cardiovascular disease, risk assessment, social determinants of health.

Introduction

Cardiovascular disease remains the leading cause of death worldwide, accounting for roughly one-third of global deaths, and most of this burden falls on low- and middle-income countries.[1] Although age-standardized mortality has fallen in many high-income settings, population growth, ageing and continued exposure to modifiable risk factors keep pushing up the absolute number of cardiovascular deaths.[2] South Asians tend to develop atherosclerotic disease earlier in life and often suffer myocardial infarction at levels of conventional risk factors that would seem modest elsewhere.[3] Central adiposity, insulin resistance, diabetes, hypertension, dyslipidemia, tobacco use and socioeconomic disadvantage all contribute to this susceptibility.[4]

Pakistan is passing through rapid demographic, nutritional and epidemiological change, while its health system remains geared mainly toward treating established disease rather than preventing it.[5] Hypertension, diabetes, obesity and tobacco use are common, yet many affected adults are never diagnosed because routine health checks are rare.[6] High systolic blood pressure, raised glucose, excess body weight, abnormal lipids and poor diet together account for a large share of cardiovascular deaths and disability.[7] These factors tend to cluster, and urbanization, sedentary work, limited space for exercise and cheap energy-dense food make the clustering worse.[8]

Because the likelihood of a cardiovascular event depends on several factors acting together, estimating total risk is more useful than assessing each factor in isolation.[9] The revised WHO charts predict the ten-year probability of fatal or non-fatal myocardial infarction and stroke from age, sex, smoking, systolic blood pressure, diabetes and total cholesterol. They are calibrated for 21 global regions, including South Asia, and come in laboratory-based and

non-laboratory versions; the latter uses body mass index in place of cholesterol and diabetes.[10] Their modest data requirements suit primary care facilities where laboratory testing is limited.[11]

Risk is also shaped by social circumstances. Education, income, occupation and access to care influence health literacy, diet, physical activity, tobacco use and the chance of early diagnosis.[12] Behaviors such as smoking, sedentary living, poor diet and inadequate sleep may partly explain how socioeconomic disadvantage translates into cardiovascular disease.[13] In South Asian communities, women and poorer adults may face additional barriers to screening and continued care.[14]

Most Pakistani studies have examined single risk factors, particular occupational groups or patients at one urban hospital, and multicenter data linking total cardiovascular risk with its social and behavioral determinants are scarce. This study therefore estimated ten-year cardiovascular risk among apparently healthy Pakistani adults and identified the sociodemographic and lifestyle factors independently associated with elevated risk.

Materials and Methods

This multicenter cross-sectional study was conducted from January to December 2025 at the tertiary-care hospitals in Pakistan. The centers served urban, peri-urban and rural populations and were chosen to capture geographic and socioeconomic diversity, using procedures feasible in resource-limited settings.

Men and women aged 40–69 years with no previous diagnosis of myocardial infarction, angina, coronary revascularization, stroke, transient ischemic attack, heart failure or peripheral arterial disease were considered apparently healthy and were eligible. Pregnant or critically ill adults, those unable to give reliable information and those receiving long-term corticosteroids or secondary cardiovascular prevention were excluded. Adults with hypertension or diabetes but no established cardiovascular disease were included, since both conditions enter the risk calculation.

Assuming a 20% prevalence of ten-year risk ≥10%, 95% confidence and 2.5% absolute precision, the minimum required sample was 984. This was increased to allow for incomplete data and clustering by center, and 1,200 participants were recruited. Data were collected with a structured questionnaire translated into Urdu and back-translated into English. It covered age, sex, marital status, residence, education, occupation, monthly household income, tobacco use, physical activity, fruit and vegetable intake, sleep duration, diabetes and antihypertensive treatment.

Current tobacco use meant any daily or occasional use of cigarettes, bidi, huqqa or smokeless tobacco in the preceding 30 days. Physical activity was assessed with the short International Physical Activity Questionnaire, and fewer than 600 metabolic equivalent (MET)-minutes per week was classed as insufficient. Fewer than five combined daily servings of fruit and vegetables was considered inadequate.

Weight was measured in light clothing to the nearest 0.1 kg and height without shoes to the nearest 0.1 cm, and body mass index (BMI) was calculated in kg/m². Waist circumference was measured midway between the lowest rib and the iliac crest at the end of normal expiration; central obesity was defined as ≥90 cm in men and ≥80 cm in women.

Blood pressure was measured with a validated automated device after five minutes of seated rest. Two readings were taken five minutes apart and averaged. Random capillary glucose and total cholesterol were measured with quality-controlled point-of-care devices. Participants with abnormal results were counseled and referred for confirmation and management.

Ten-year risk was estimated with the 2019 WHO laboratory-based charts for South Asia and grouped as <5%, 5–<10%, 10–<20%, 20–<30% and ≥30%. A risk of ≥10% was treated as elevated in the regression analysis. Risk was also estimated with the WHO non-laboratory model to judge its usefulness where cholesterol testing is unavailable. Operational definitions are listed in Table 1.

Table 1. Operational definitions used in the study

Variable	Operational definition
Elevated cardiovascular risk	WHO ten-year cardiovascular risk ≥10%
Hypertension at screening	SBP ≥140 mmHg, DBP ≥90 mmHg or antihypertensive treatment
Diabetes	Previous diagnosis, treatment or random glucose ≥200 mg/dL with symptoms
Central obesity	Waist ≥90 cm in men or ≥80 cm in women

Current tobacco use	Smoked or smokeless tobacco use within the preceding 30 days
Insufficient physical activity	<600 MET-minutes per week
Inadequate diet	Fewer than five fruit and vegetable servings daily
Short sleep duration	Average sleep of <6 hours per night
Low household income	Monthly household income below PKR 50,000

Data were analyzed in SPSS version 26.0. Continuous variables are presented as mean±standard deviation and categorical variables as frequencies and percentages, and proportions were compared with the chi-square test. Sociodemographic and lifestyle variables were entered together into a multivariable logistic regression model, with results reported as adjusted odds ratios (AOR) and 95% confidence intervals (CI). Calibration was checked with the Hosmer–Lemeshow test and discrimination with the area under the receiver operating characteristic curve. Agreement between laboratory and non-laboratory risk categories was assessed with weighted kappa, and the sensitivity, specificity and predictive values of the non-laboratory chart were calculated at the 10% threshold, using the laboratory chart as reference. A p-value <0.05 was considered significant.

Results

All 1,200 enrolled adults completed the assessment and were analyzed. Mean age was 51.8±8.1 years; 636 (53.0%) were women and 564 (47.0%) men. Overall, 696 (58.0%) lived in urban areas and 504 (42.0%) in rural or peri-urban areas. No formal education was reported by 282 (23.5%), and 498 (41.5%) had a monthly household income below PKR 50,000. Baseline characteristics are summarized in Table 2.

Table 2. Baseline characteristics of participants (n=1,200); values are mean±SD or n (%)

Characteristic	**Value**
Age, years	51.8±8.1
Male sex	564 (47.0)
Urban residence	696 (58.0)
No formal education	282 (23.5)
Low household income	498 (41.5)
Current tobacco use	234 (19.5)
Insufficient physical activity	510 (42.5)
Inadequate fruit/vegetable intake	792 (66.0)
Short sleep duration	270 (22.5)
BMI, kg/m²	26.8±4.6
Central obesity	534 (44.5)
Hypertension at screening	360 (30.0)
Diabetes	174 (14.5)
Total cholesterol, mg/dL	184.6±38.2

On the laboratory-based WHO charts, 690 (57.5%) participants had a ten-year risk below 5% and 276 (23.0%) a risk of 5–<10%. Risk was elevated in 234 (19.5%): 156 (13.0%) at 10–<20%, 48 (4.0%) at 20–<30% and 30 (2.5%) at ≥30%. Elevated risk rose steeply with age, from 4.5% at 40–49 years to 18.8% at 50–59 years and 48.9% at 60–69 years, and was twice as common in men as in women (26.2% vs 13.5%) (Figure 1).

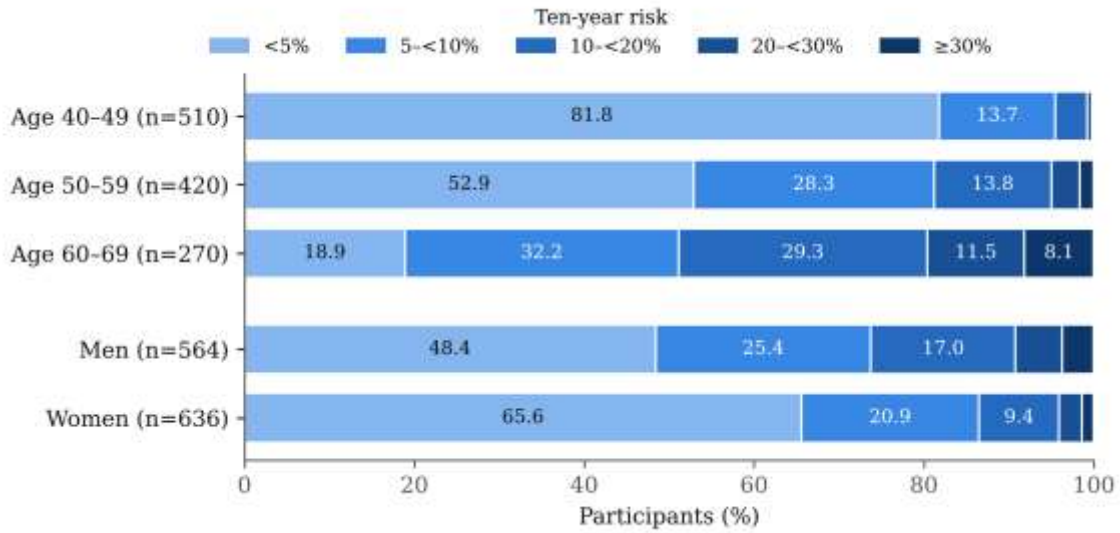


Figure 1. Ten-year cardiovascular risk categories by age group and sex (WHO laboratory-based charts). Values are percentages within each group; segments under 6% are unlabeled.

On bivariate analysis, elevated risk was more frequent among older adults, men, those with no formal education or low income, and those reporting tobacco use, physical inactivity, inadequate fruit and vegetable intake, central obesity or short sleep (all p<0.001; Figure 2).

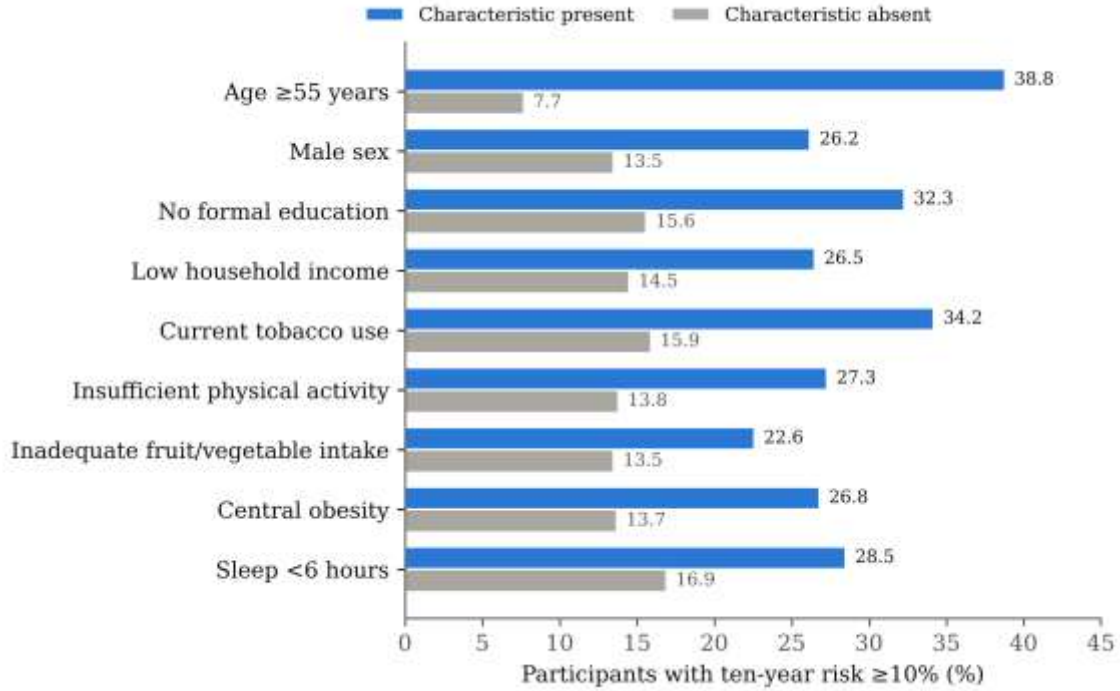


Figure 2. Proportion of participants with ten-year cardiovascular risk ≥10%, by presence or absence of each characteristic (chi-square test, all p<0.001).

After adjustment, age ≥55 years, male sex, no formal education, low household income, current tobacco use, insufficient physical activity, inadequate fruit and vegetable intake, central obesity and sleep <6 hours remained independently associated with elevated risk, whereas rural or peri-urban residence did not (Table 3).

Table 3. Independent determinants of ten-year cardiovascular risk ≥10%

Determinant	Adjusted odds ratio	95% CI	p-value
Age ≥55 years	5.84	4.05–8.42	<0.001
Male sex	1.72	1.23–2.41	0.002
No formal education	1.66	1.14–2.42	0.008
Low household income	1.51	1.08–2.12	0.017
Rural/peri-urban residence	1.19	0.85–1.67	0.309
Current tobacco use	2.31	1.58–3.38	<0.001
Insufficient physical activity	1.64	1.18–2.28	0.003
Inadequate fruit/vegetable intake	1.46	1.01–2.12	0.044
Central obesity	1.79	1.28–2.50	0.001
Sleep duration <6 hours	1.53	1.06–2.21	0.023

The model was well calibrated (Hosmer–Lemeshow p=0.48) and showed good discrimination, with an area under the receiver operating characteristic curve of 0.82 (95% CI: 0.79–0.85).

The non-laboratory chart classified 216 (18.0%) participants as having ≥10% risk, compared with 234 (19.5%) on the laboratory chart. The two charts placed 923 (76.9%) participants in the same risk category and 1,158 (96.5%) within one adjacent category (weighted kappa 0.71; Table 4).

Table 4. Comparison of laboratory and non-laboratory WHO risk assessments

Measure	Result
Risk ≥10% using laboratory chart	234 (19.5%)
Risk ≥10% using non-laboratory chart	216 (18.0%)
Exact risk-category agreement	923 (76.9%)
Agreement within one category	1,158 (96.5%)
Weighted kappa	0.71

Sensitivity	82.1%
Specificity	97.5%
Positive predictive value	88.9%
Negative predictive value	95.7%

Discussion

Nearly one in five apparently healthy adults in this study had a predicted ten-year risk of 10% or more, and 6.5% had a risk of 20% or higher. This is considerably higher than in a nationally representative Bangladeshi survey using the same charts, in which about 15% had a risk of ≥10%.[11] The gap probably reflects the hospital-based screening sample and differences in diabetes prevalence, although predicted risk is also highly sensitive to how a model is calibrated to the target population.[15] Since most cardiovascular events in low- and middle-income countries are attributable to modifiable risk factors, much of this risk is open to prevention.[16]

Age was the strongest determinant. Ageing lengthens exposure to raised blood pressure, metabolic abnormalities, vascular inflammation and tobacco-related injury.[17] Because age, sex and smoking are themselves inputs to the WHO equations, part of their association with elevated risk reflects the structure of the model rather than an independent effect.[10] Smoked and smokeless tobacco use is also far more common among Pakistani men, which helps explain their higher risk.[18] Women, meanwhile, may carry a metabolic burden, such as central obesity, that a ten-year score without waist circumference does not capture.[19]

No formal education and low household income remained independently associated with elevated risk. Socioeconomic disadvantage can limit access to healthy food, safe spaces for exercise, preventive care and reliable health information.[20] Rural residence lost significance once education, income and lifestyle were accounted for, suggesting that socioeconomic circumstances matter more than place of residence alone.[21] Prevention programs should therefore take literacy, affordability and access into account when giving lifestyle advice.

Current tobacco use more than doubled the odds of elevated risk. Tobacco control remains among the most cost-effective cardiovascular prevention strategies, particularly when taxation, smoke-free laws and cessation services are combined.[18,22] Smokeless tobacco deserves particular attention, because its use remains widespread in many Pakistani communities.[18]

Insufficient physical activity, central obesity and inadequate fruit and vegetable intake were each independently associated with elevated risk. These findings support community programs that pair affordable dietary change with realistic opportunities for regular activity.[23] Advice is more likely to work when it fits locally available foods, cultural practices, work routines and neighborhood conditions.

Short sleep was also associated with elevated risk. Insufficient sleep may promote sympathetic activation, insulin resistance, weight gain and higher blood pressure,[24] although a cross-sectional design cannot show which came first. Sleep counseling should consider working hours, household duties and psychological stress rather than treating sleep as purely an individual choice.

The substantial agreement between laboratory and non-laboratory charts matters for resource-limited facilities. Non-laboratory screening could be done in community camps and primary care without cholesterol testing, with laboratory assessment reserved for adults near or above treatment thresholds.[25] This staged approach could lower costs, but the non-laboratory chart missed about 18% of high-risk adults here and may perform less well in people with diabetes.[25]

The multicenter design, standardized measurements, complete outcome data, a regionally calibrated risk model and the joint assessment of social, behavioral and anthropometric factors are strengths of this study. Its main limitations are the cross-sectional design, which precludes causal inference, and the hospital-based screening sample, which may not represent the general population.

Conclusion

Nearly one in five apparently healthy Pakistani adults had a ten-year cardiovascular risk of 10% or more. Older age, male sex, tobacco use, low education and income, physical inactivity, central obesity, inadequate fruit and vegetable intake and short sleep were independently associated with elevated risk. Building WHO risk assessment into primary care, outpatient clinics and community screening could identify high-risk adults early without costly investigations, and a staged approach, with non-laboratory screening followed by targeted blood tests, may suit resource-limited settings best.

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