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Cardiometabolic risk profiles and correlates in a mid-life clinic cohort in Qatar: A cross-sectional analysis

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Abstract

Background: Cardiometabolic diseases remain the leading global causes of morbidity and mortality, with risk factors often clustering in the same individuals. Understanding how this risk factors interact in real-world clinical populations is essential for effective prevention.

Objectives: This study aimed to quantify the central tendency and dispersion of key cardiometabolic risk factors, determine the prevalence of hypertension, diabetes, prediabetes, dyslipidemia, categorical BMI, and vitamin D status, and explore correlations between continuous variables and identify independent predictors of systolic blood pressure and the odds of hypertension and diabetes.

Methods: Cross-sectional analysis of 250 adult clinic attendees aged 40–68 years in Qatar. Standardized definitions were used for all categorical outcomes. Descriptive statistics summarized central tendency and dispersion. Pearson correlations examined bivariate relationships. Multivariable regression models (linear for SBP; logistic for hypertension and diabetes) adjusted for age, sex, BMI, glycemia, lipid profile, and vitamin D.

Results: The cohort was predominantly male (83%) with a mean age of 51.0 years. Mean SBP/DBP were 126.8/79.9 mmHg. Hypertension prevalence was 61.2%, diabetes 14.6%, prediabetes 37.4% (among non-diabetics), and dyslipidemia 68.1%. Overweight/obesity affected 75.9%, and 63.7% had vitamin D deficiency. BMI correlated positively with SBP ($r=0.28$) and triglycerides ($r=0.25$), and inversely with HDL ($r=-0.24$). In adjusted models, BMI (+0.85 mmHg/kg/m^2, $p<0.001$) and LDL (+2.60 mmHg/mmol/L, $p=0.004$) independently predicted higher SBP; both also increased hypertension odds. Diabetes odds rose with age (OR 1.08/year), SBP (OR 1.05/mmHg), and fell with higher HDL and vitamin D.

Conclusions: This mid-life clinic population carries a heavy burden of clustered cardiometabolic risk, with overweight/obesity, hypertension, dyslipidemia, and vitamin D deficiency particularly prevalent. Weight management, lipid control, and early glycemic prevention emerge as key priorities for comprehensive risk reduction.

Keywords: Cardiometabolic Diseases; Risk Factors; Mid-Life Adult; Population

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1. Introduction

Cardiometabolic diseases—including hypertension, type 2 diabetes mellitus, dyslipidemia, and obesity—are among the most pressing global health challenges of the 21st century. Collectively, they account for a substantial proportion of premature mortality and disability worldwide, largely through their contribution to atherosclerotic cardiovascular disease, heart failure, and chronic kidney disease. According to the Global Burden of Disease estimates, elevated blood pressure, high fasting plasma glucose, high body mass index (BMI), and adverse lipid profiles rank among the top modifiable risk factors for death and disability-adjusted life years (DALYs) across all regions [1,2].

These risk factors are rarely independent phenomena. Instead, they tend to cluster within individuals, driven by shared pathophysiological mechanisms such as insulin resistance, low-grade inflammation, endothelial dysfunction, and neurohormonal activation. For example, excess adiposity contributes to both dyslipidemia and hypertension, while hyperglycemia can accelerate vascular injury in the presence of elevated blood pressure. This clustering magnifies cardiovascular risk well beyond the sum of individual factors, a phenomenon observed across diverse populations and age groups [3,4].

Mid-life adults represent a particularly strategic target for cardiometabolic risk assessment and prevention. At this life stage—often defined as ages 40 to 65—many individuals accumulate borderline or overt risk factors but remain asymptomatic. Intervening during this window can delay or prevent the onset of overt cardiovascular disease, yielding significant gains in quality-adjusted life expectancy [5]. Risk factor distributions and correlations may vary by genetic background, diet, activity patterns, and healthcare access. Clinic-based cohorts provide insight into the profiles of patients who are already engaging with the health system, thus offering actionable intelligence for both clinical management and population health strategies. The present study aimed to quantify the central tendency and dispersion of key cardiometabolic risk factors in a mid-life outpatient population in an adult clinic in Qatar; determine the prevalence of hypertension, diabetes, prediabetes, dyslipidemia, categorical BMI classes, and vitamin D status; and examine the correlation structure among continuous risk factors and fit multivariable models to identify independent predictors of systolic blood pressure (SBP) and the odds of hypertension and diabetes.

2. Methods

2.1. Study Design and Setting

We conducted a cross-sectional analysis of consecutive adult patients attending a general adult clinic in Qatar. The study setting provides primary and continuing care to a diverse urban and peri-urban population, with patients presenting for routine check-ups, chronic disease follow-up, or new health concerns.

2.2. Participants

Eligible participants were men and women aged ≥40 years with at least one recorded blood pressure measurement and partial laboratory data for glycemia, lipids, BMI, or vitamin D. We excluded individuals with missing demographic information or documented secondary causes of hypertension or dyslipidemia (e.g., endocrine disorders, nephrotic syndrome). A total of 250 individuals met these criteria and were included in the analysis.

2.3. Data Collection and Measurements

Demographic and Clinical Data: Age and sex were recorded from the patient's medical record. Blood Pressure: Systolic (SBP) and diastolic blood pressure (DBP) were measured in the seated position after at least five minutes of rest using a validated automated device. Two readings were taken one to two minutes apart; the average was used for analysis. Glycemic Parameters: Fasting blood sugar (FBS) was measured in mmol/L after an overnight fast of at least ten hours. Glycated hemoglobin (A1C) was measured as a percentage of total hemoglobin. Lipid Profile: Fasting lipid panels included total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and triglycerides (TG), all expressed in mmol/L. Anthropometry: Height and weight were measured using standardized equipment and protocols. BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Vitamin D: Serum 25-hydroxyvitamin D [25(OH)D] concentrations were measured in nmol/L using immunoassay techniques.

2.4. Operational Definitions of Risk Status

Hypertension: SBP ≥130 mmHg or DBP ≥80 mmHg, based on the 2017 American College of Cardiology/American Heart Association (ACC/AHA) guidelines [6]. Diabetes: A1C ≥6.5% or FBS ≥7.0 mmol/L, according to the American Diabetes Association (ADA) criteria. Prediabetes: A1C 5.7–6.4% or FBS 5.6–6.9 mmol/L, excluding those meeting diabetes criteria [7]. Dyslipidemia: Any of LDL-C ≥3.37 mmol/L, TC ≥5.2 mmol/L, TG ≥1.7 mmol/L, or HDL-C below sex-specific cut-offs (<1.0 mmol/L in men, <1.3 mmol/L in women) [8]. BMI Categories: WHO/NIH classification—Normal (18.5–24.9 kg/m^2), Overweight (25.0–29.9), Obesity I (30.0–34.9), Obesity II (35.0–39.9), Obesity III (≥40) [9]. Vitamin D Status: Deficient (<50 nmol/L), Insufficient (50–74 nmol/L), Sufficient (≥75 nmol/L)[10].

2.5. Statistical Analysis

Continuous variables were assessed for distributional properties. Normally distributed variables were reported as mean ± standard deviation (SD); skewed variables were summarized as median and interquartile range (IQR). Categorical variables were expressed as frequencies and percentages. The prevalence of each categorical risk state was calculated using the relevant denominators for available data. Co-occurrence of hypertension and diabetes was described among participants with both BP and glycemic measurements. Pairwise Pearson correlation coefficients were calculated to describe linear associations among continuous variables, with r values interpreted according to conventional thresholds (weak <0.3, moderate 0.3–0.5, strong >0.5). multivariable models were analyzed and expressed as R^2 (linear) or McFadden's pseudo-R^2 (logistic). A two-sided p-value <0.05 was considered statistically significant. Analyses were performed using standard statistical software packages.

3. Results

A total of 250 participants were included in the analysis, of whom 207 (83.0%) were male and 43 (17.0%) were female. The mean age was 51.0 years (SD 6.6; range 40–68), reflecting a predominantly mid-life cohort as presented in the Table 1.

Table 1 Age and Gender of the Participants' Data

Variables	Category	Number	Percentage
Gender	Male	207	83
	Female	43	17
Ages (years)	40-44	48	19.2
	45-49	62	24.8
	50-54	56	22.4
	55-59	62	24.8
	60-64	16	6.4
	65 and above	6	2.4
Total		250	100

The distribution of blood pressure values indicated that the mean systolic blood pressure (SBP) was 126.8 mmHg (SD 13.4) and the mean diastolic blood pressure (DBP) was 79.9 mmHg (SD 8.6), with most individuals clustering near the upper-normal to stage 1 hypertension range.

Glycemic indices, measured in 247 participants, suggested an overall profile between normoglycemic and borderline elevated. The median fasting blood sugar (FBS) was 5.4 mmol/L (interquartile range [IQR] 5.1–5.9), and the median glycated hemoglobin (A1C) was 5.6% (IQR 5.3–6.3).

Lipid profiles, available for 248 participants, demonstrated moderate dyslipidemia: mean low-density lipoprotein cholesterol (LDL-C) was 3.21 mmol/L (SD 1.07), mean total cholesterol (TC) was 4.99 mmol/L (SD 1.15), and median triglycerides (TG) were 1.17 mmol/L (IQR 0.88–1.65). The mean high-density lipoprotein cholesterol (HDL-C) was 1.26 mmol/L (SD 0.36).

Anthropometric measurements indicated a high prevalence of excess adiposity, with a mean body mass index (BMI) of 28.3 kg/m^2 (SD 4.7) among the 241 participants with available data. Serum 25-hydroxyvitamin D concentrations, assessed in 201 individuals, were low to intermediate, with a median value of 38 nmol/L (IQR 25–66).

Applying standardized clinical cut-points revealed a high burden of categorical risk states as presented in the Table 2.

Table 2 Cardiometabolic Risk Factors of Participants' Data

Risk Factors	Parameters	Cases	Available Data	Percentage	Designated Value (%)
Hypertension	SBP>130 mmHg	112	250	44.8	61.2
	DBP >90 mmHg	153	250	61.2	
DM	HbA1C > 6.5%	36	247	14.6	14.6
	FBS >7 mmol/l	23	247	9.3	
Pre DM	HbA1C 5.5-6.4%	93	247	37.6	37.6
	FBS 5.5-7.0 mmol/l	79	247	31.9	
High Total cholesterol	≥5.2 mmol/L	102	248	41.1	68.1
High LDL	≥3.37 mmol/L	51	248	20.6	
Low HDL	<1.0 mmol/L in men, <1.3 mmol/L in women)	169	248	68.1	
High Triglyceride	≥1.7 mmol/L	121	248	48.8	
Overweight	BMI 25 - <30 kg/m2	105	241	43.6	76
Obesity Class 1	BMI 30 - <35 kg/m2	54	241	22.4	
Obesity Class 2	BMI 35 - <40 kg/m2	19	241	7.9	
Obesity class 3	BMI >40 kg/m2	5	241	2.1	
Vit D Deficiency	<50 nmol/L	128	201	63.7	81.1
Vit D Insufficient	50–74 nmol/L	35	201	17.4	

Hypertension, defined as SBP ≥130 mmHg or DBP ≥80 mmHg, was present in 61.2% of the cohort. Diabetes, defined by an A1C ≥6.5% or FBS ≥7.0 mmol/L, was identified in 14.6%, while prediabetes was present in 37.6% of those without diabetes but with available glycemic measurements. Dyslipidemia, defined by any of elevated LDL-C, TC, TG, or low HDL-C, was found in 68.1%. BMI classification showed that 43.6% overweight, 22.4% had obesity class I, 7.9% obesity class II, and 2.1% obesity class III; thus, 76% of participants were overweight or obese. Vitamin D deficiency (<50 nmol/L) was highly prevalent, affecting 63.7% of those tested, with an additional 17.4% insufficient (50–74 nmol/L) and the total of both was 81.1%. Among 247 participants with complete data on both blood pressure and diabetes status, 50.2% had hypertension only, 3.6% had diabetes only, 10.9% had both conditions, and 35.2% had neither, indicating that approximately one in nine individuals carried the dual burden of hypertension and diabetes.

Correlation analyses showed patterns largely consistent with established physiological relationships. The correlation between SBP and DBP was strong ($r = 0.67$), as was the association between FBS and A1C ($r = 0.87$). BMI exhibited modest positive correlations with SBP ($r = 0.28$), DBP ($r = 0.24$), and TG ($r = 0.25$), and a moderate inverse correlation with HDL-C ($r = −0.24$). LDL-C was only weakly correlated with SBP ($r = 0.10$). Vitamin D concentrations demonstrated weak inverse correlations with SBP ($r = −0.05$) and FBS ($r = −0.09$), suggesting minimal cross-sectional association in this sample.

In multivariable analyses restricted to complete cases ($n \approx 171$) and adjusted for age, sex, BMI, diabetes status, lipid profile, and vitamin D, BMI and LDL-C emerged as the most consistent independent predictors of SBP. In the linear regression model ($R^2 = 0.19$), each 1 kg/m^2 increase in BMI was associated with a 0.85 mmHg higher SBP ($p < 0.001$),

and each 1 mmol/L increase in LDL-C corresponded to a 2.60 mmHg higher SBP (p = 0.004). Diabetes status was associated with a 6.21 mmHg higher SBP, although this effect narrowly missed statistical significance (p = 0.052).

In the logistic regression model for hypertension (pseudo-R^2 = 0.095), higher BMI (odds ratio [OR] 1.14 per kg/m^2; 95% confidence interval [CI] 1.05–1.23; p = 0.001) and higher LDL-C (OR 1.54 per mmol/L; 95% CI 1.10–2.15; p = 0.012) were independently associated with increased odds of meeting hypertension criteria.

For diabetes as the outcome (pseudo-R^2 = 0.22), advancing age (OR 1.08 per year; 95% CI 1.01–1.16; p = 0.016) and higher SBP (OR 1.05 per mmHg; 95% CI 1.00–1.10; p = 0.045) were associated with greater odds of disease. In contrast, higher LDL-C (OR 0.42 per mmol/L; 95% CI 0.23–0.74; p = 0.003), higher HDL-C (OR 0.096 per mmol/L; 95% CI 0.013–0.722; p = 0.023), and higher vitamin D concentrations (OR 0.981 per nmol/L; 95% CI 0.964–0.998; p = 0.029) were associated with lower odds of diabetes. The inverse LDL–diabetes association is likely confounded by lipid-lowering therapy and underlying risk profiles, rather than reflecting a causal protective effect.

Collectively, these findings depict a cohort in which overweight/obesity, hypertension, dyslipidemia, and vitamin D deficiency are highly prevalent, where BMI and LDL-C are central determinants of elevated SBP and hypertension risk, and where glycemic risk is shaped by age, blood pressure, lipid fractions, and vitamin D status.

4. Discussion

In this cross-sectional analysis of 250 mid-life clinic attendees, we found a substantial burden of cardiometabolic risk factors, with high rates of hypertension (61%), diabetes (15%), pre-diabetes (38%), dyslipidemia (68%), overweight/obesity (76%), and vitamin D deficiency and insufficiency (81%). Approximately one in nine participants had both hypertension and diabetes, underscoring the degree of risk clustering in this population. BMI and LDL-C emerged as independent predictors of higher systolic blood pressure and hypertension risk, while diabetes odds were shaped by age, SBP, HDL-C, LDL-C, and vitamin D status.

The prevalence of hypertension observed in our cohort exceeds recent national estimates for similar age groups in Qatar, which was 32% in community-based studies [11], suggesting either a higher baseline risk among clinic attendees or potential referral bias. Our dyslipidemia prevalence is also in line with reports from other middle-income settings, where lifestyle transitions and dietary changes have driven a rise in lipid disorders among adults aged 40–65.

The finding that BMI is strongly associated with both SBP and hypertension odds aligns with the robust global literature demonstrating the direct effects of adiposity on vascular hemodynamics. The positive association between LDL-C and SBP—though less frequently reported—has been observed in some large-scale cohorts and may reflect shared dietary, metabolic, and inflammatory pathways that promote both arterial stiffness and lipid accumulation [12,13].

The inverse association between LDL-C and diabetes odds in our multivariable model contrasts with the well-documented adverse metabolic consequences of elevated LDL-C. This counterintuitive result is most likely due to treatment-related confounding, particularly the widespread use of statins among high-risk patients. Statin therapy is known to modestly increase glycemia and diabetes incidence [14,15], but such effects may be masked or even reversed in cross-sectional analyses if those with lower LDL-C are also those already diagnosed and treated for diabetes.

Adiposity contributes to hypertension through multiple mechanisms, including activation of the sympathetic nervous system, increased renal sodium reabsorption, and hormonal alterations involving the renin–angiotensin–aldosterone system [16]. Elevated LDL-C may worsen endothelial function and reduce vascular compliance, indirectly raising blood pressure. Conversely, higher HDL-C levels are consistently associated with improved insulin sensitivity, reduced systemic inflammation, and better glycemic control, which may explain the inverse association with diabetes in our study [17].

The observed inverse association between vitamin D levels and diabetes odds, although modest, supports hypotheses linking vitamin D to improved insulin secretion and sensitivity. However, given the cross-sectional design, residual confounding cannot be excluded, and causal inference is not possible.

These findings have clear implications for both individual patient management and population-level prevention. The very high prevalence of overweight/obesity positions weight reduction as a central target for risk modification, with the potential to simultaneously improve blood pressure, lipid profile, and glycemic control. Lifestyle interventions—dietary improvement, increased physical activity, and behavioral counseling—should be integrated into routine care, with pharmacological therapy considered for those with severe obesity or multiple risk factors.

LDL-C control appears particularly relevant in this cohort, given its association with both SBP and hypertension. Aggressive lipid management, including statin therapy where indicated, could contribute to overall cardiovascular risk reduction. In addition, the sizable prediabetic population highlights an urgent need for targeted prevention strategies, as lifestyle interventions in this group can significantly delay or prevent the onset of diabetes.

Vitamin D deficiency, while not conclusively linked to cardiometabolic risk in interventional studies, remains a common and easily modifiable condition. Screening and supplementation in deficient individuals—especially those with multiple risk factors—may offer ancillary benefits, even if cardiovascular impact remains uncertain.

Strengths and limitations

Strengths of this study include the use of standardized clinical definitions, detailed laboratory and anthropometric measurements, and analysis of both continuous and categorical variables, allowing for nuanced risk characterization. The examination of correlation structures and multivariable associations provides insight into the interdependence of risk factors in this clinical population.

However, several limitations warrant caution. The cross-sectional design precludes causal inference and may be subject to reverse causality, particularly in the case of lipid–diabetes associations influenced by treatment. The clinic-based sample may not be representative of the general population, potentially overestimating the burden of risk factors. Additionally, some measurements, such as vitamin D, were available only in a subset of participants, introducing the possibility of selection bias.

5. Conclusion

This mid-life clinic cohort demonstrates a high prevalence and clustering of cardiometabolic risk factors, with BMI and LDL-C emerging as central, modifiable determinants of elevated blood pressure. Early detection and aggressive management of these risk factors—combined with targeted prevention in prediabetic individuals—offer the best opportunity to curb future cardiovascular morbidity. Further longitudinal research is warranted to clarify causal relationships, particularly regarding lipid profiles, vitamin D status, and glycemic outcomes.

Compliance with ethical standards

Disclosure of conflict of interest

All authors declared no conflict of interest.

Statement of ethical approval

Ethical approval was not required for this study because the data used were secondary and provided to the team in an anonymized format.

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