

Prevalence and Clustering of Major Cardiovascular Risk Factors Among Community- Dwelling Older Adults in Rural Enugu State, Nigeria: A Cross-Sectional Study

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Abstract

Background

Cardiovascular disease and stroke remain leading causes of morbidity and mortality globally, with disproportionate burden in low- and middle-income countries. Older adults in semi-rural Nigerian communities may experience high cardiometabolic risk, yet locally specific epidemiologic data remain limited. This study estimated the prevalence and clustering of major cardiovascular risk factors among community-dwelling older adults in Abor, Enugu State, Nigeria.

Methods

A community-based cross-sectional study was conducted among 107 adults aged ≥ 60 years. Sociodemographic and clinical data were collected using standardized procedures. Blood pressure and anthropometric indices were measured, and biochemical assays were performed for glycaemic and lipid indices. Hypertension was defined as systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg. Overweight/obesity was defined as BMI ≥ 25 kg/m². Diabetes was defined using biochemical criteria as fasting blood glucose ≥ 126 mg/dL and/or HbA1c $\geq 6.5\%$ and was reported using an ascertainment denominator where laboratory values were available. Dyslipidaemia was defined as any of elevated total cholesterol, elevated LDL cholesterol, elevated triglycerides, or low HDL cholesterol. Prevalence estimates were reported with Wilson 95% confidence intervals, and associations with age and sex were examined using modified Poisson regression with robust variance to estimate prevalence ratios (PRs).

Results

Of 107 participants, 57 (53.3%) were men and 50 (46.7%) women; mean age was 70.9 ± 5.8 years among those with available age data. Hypertension prevalence was 58.9% (63/107; 95% CI 49.4–67.7), overweight/obesity was 69.2% (74/107; 95% CI 59.9–77.1), and diabetes prevalence was 67.0% (71/106; 95% CI 57.6–75.2). Any dyslipidaemia affected 72.0% (77/107; 95% CI 62.8–79.6), driven largely by low HDL cholesterol (51.4%). Risk factor clustering (≥ 2 of hypertension, overweight/obesity, and diabetes) occurred in 70.1% (75/107; 95% CI 60.8–77.9). In adjusted models, women had higher prevalence of dyslipidaemia than men (PR 1.47; 95% CI 1.14–1.90; $p = 0.003$), while age and sex were not significantly associated with hypertension, overweight/obesity, diabetes, or clustering (all $p > 0.05$).

Conclusion

Older adults in Abor community exhibit a substantial burden of hypertension, dysglycaemia, overweight/obesity, and dyslipidaemia, with frequent clustering of major cardiometabolic risk factors. These findings support strengthening integrated cardiovascular risk screening and prevention strategies for older adults in semi-rural Nigerian settings, with emphasis on multi-risk-factor management.

Background of the study

Cardiovascular diseases (CVDs) remain the leading cause of mortality worldwide, accounting for roughly one-third of all deaths, with a disproportionate share occurring in low- and middle-income countries (LMICs) [1]. Major clinical outcomes including stroke, myocardial infarction, and heart failure are driven largely by a cluster of modifiable exposures: elevated blood pressure, dysglycaemia/diabetes, dyslipidaemia, tobacco use, harmful alcohol consumption, physical inactivity, unhealthy diet, and excess adiposity [1, 2]. These risk factors typically accumulate over time and may remain clinically silent for years, ultimately expressing as disability, costly complications, and premature mortality. The consequences are especially pronounced in older adults, in whom biological ageing interacts with long-standing metabolic and behavioural exposures to amplify absolute cardiovascular risk [3].

Global population ageing is accelerating, and the World Health Organization has documented rapid growth in both the number and proportion of persons aged ≥ 60 years, with continued expansion expected in coming decades [4, 5]. Importantly, the burden of chronic disease in later life reflects cumulative risk across the life course rather than chronological age alone, and it is compounded by barriers to prevention, early detection, and sustained treatment barriers that are often more severe for older people because of reduced mobility, income constraints, and limited access to healthcare [4, 5]. In many LMICs, health systems historically structured around infectious diseases and maternal-child health are now managing a dual burden as noncommunicable diseases (NCDs) rise alongside persistent communicable conditions [1, 4]. This epidemiologic transition is linked to urbanisation, dietary change, reduced physical activity, improved survival into older age, and broader social and economic shifts [4, 5].

Sub-Saharan Africa is experiencing a particularly rapid escalation in cardiometabolic risk within contexts where routine screening and long-term chronic care remain limited. Hypertension sits at the centre of this burden because it is common, frequently undiagnosed, and strongly associated with stroke and other adverse cardiovascular outcomes [6]. A systematic review among older adults in Africa reported high pooled hypertension prevalence, underscoring substantial unmet need for detection and control in this demographic [6]. Beyond blood pressure, the accumulation of diabetes, obesity, and lipid abnormalities further elevates cardiovascular risk in settings where prevention and treatment coverage are inadequate [1, 2]. Nigeria, as Africa's most populous country, contributes substantially to the regional CVD burden. National evidence indicates high hypertension prevalence with marked geographic variation and persistent shortfalls in awareness, treatment, and control [7, 8]. These deficits carry particular consequences for older adults, in whom uncontrolled hypertension is closely linked to stroke, disability, and caregiver burden [1, 7]. Meanwhile, dyslipidaemia and related metabolic risk factors appear to be increasing, consistent with changing diets, physical activity patterns, and adiposity prevalence [9]. However, much of the Nigerian literature remains facility-based, focused on general adult populations, or under-represents rural and semi-rural communities where access to preventive screening is often minimal [7–9]. Within Southeast Nigeria, including Enugu State, community studies have documented substantial hypertension prevalence alongside low awareness in rural populations [10]. These findings imply that many individuals may live with undiagnosed or untreated risk factors until complications occur [7, 10]. Yet cardiovascular risk profiles can vary considerably across communities due to differences in settlement patterns, livelihoods, diet, mobility demands, poverty, and access to primary healthcare. As a result, state- or regional-level estimates may be insufficient for designing targeted prevention strategies, strengthening the case for locally specific prevalence data. Older adults warrant particular attention because cardiometabolic risks often peak in later life while the capacity to mitigate illness through income, mobility, and healthcare access may decline [4, 5].

Accordingly, the overarching aim of this study was to estimate the prevalence and distribution of major cardiovascular risk factors among community-dwelling older adults aged ≥ 60 years in Abor community, Enugu

State, Nigeria, and to quantify the extent of risk factor clustering. Specifically, the study objectives were to (i) determine the prevalence of key cardiovascular risk factors including hypertension, diabetes, overweight/obesity, central obesity, dyslipidaemia, behavioural risk factors, and physical inactivity among older adults in Abor community; (ii) describe the distribution of these risk factors by sex and age group, with corresponding 95% confidence intervals; (iii) estimate the prevalence of cardiovascular risk factor clustering, defined as the presence of two or more major risk factors, and examine its distribution across demographic subgroups; and (iv) evaluate associations of age and sex with individual risk factors and clustering using prevalence ratios derived from regression models appropriate for common outcomes.

Study Design

This study used a community-based cross-sectional design to estimate the prevalence and clustering of major cardiovascular risk factors among older adults in Abor community, Enugu State, Nigeria.

Study Setting

Abor is a semi-rural community characterized by mixed subsistence and informal economic activities, limited structured preventive health services, and restricted routine cardiovascular screening coverage. Data were collected over a six-month study period (May to October, 2025), during which household-based assessments were conducted by trained field investigators.

Study Population

The target population comprised community-dwelling older adults aged ≥ 60 years residing in Abor community; Enugu State, Nigeria.

Participants

Inclusion criteria

Eligible participants were older adults aged ≥ 60 who were permanent residents of Abor community, had lived in the community for at least six months prior to data collection and had provided written informed consent. The age threshold of 60 years was adopted in line with international definitions of older adulthood used in cardiovascular and ageing research [12].

Exclusion criteria included:

1. acute or critical illness preventing participation in interview or measurement procedures;
2. severe cognitive impairment rendering the individual unable to provide informed consent or respond reliably to interview questions, as determined by interviewer assessment and caregiver confirmation where applicable; and
3. physical inability to undergo anthropometric or blood pressure measurements (e.g., inability to sit or stand safely).

Institutionalized older adults were not present within the community; all participants were community residents.

Sample Size Considerations

Given the absence of recent community-specific prevalence data for Abor, a precision-based approach was used to assess adequacy of the achieved sample size. Because recruitment was conducted within a defined community population, an a priori sample size calculation was not performed. Instead, the sample size achieved was evaluated in terms of statistical precision for prevalence estimation, consistent with recommendations for reporting observational studies [13, 14, 15]. The required sample size for estimating a single proportion was guided by the standard formula: $d = Z \times \sqrt{\frac{p(1-p)}{n}}$ where: n = required sample size, Z = standard normal deviate corresponding to the desired confidence level (1.96 for 95% confidence), p = anticipated prevalence (assumed to be 0.5 to maximize sample size in the absence of prior data), d = desired precision (margin of error). Using $p = 0.5$, the achieved sample size of 107 participants yields a 95% confidence interval half-width (precision) given by:

$$d = 1.96 \times \sqrt{\frac{0.5 \times 0.5}{107}} = 0.095$$

This corresponds to an approximate $\pm 9.5\%$ margin of error around prevalence estimates near 50%. This level of precision was considered adequate for estimating common cardiovascular risk factors in a community-based setting and for conducting exploratory subgroup comparisons.

Sampling Procedure

A multi-stage sampling strategy was employed. Abor community was purposively selected to generate community-specific estimates in a semi-rural setting with limited locally available cardiovascular risk factor data. Within the community, a household enumeration framework was developed in collaboration with local leaders. A total of approximately 320 households were identified and listed. Households were systematically sampled using a fixed sampling interval (k), calculated as: $k = \frac{N}{n}$ where N is the total number of households and n is the target sample size. Based on this, the sampling interval was: $k = \frac{320}{107} \approx 3$

A random starting point between 1 and 3 was selected, after which every 3rd household was approached for inclusion. In each selected household, all eligible individuals aged ≥ 60 years were identified. Where more than one eligible participant was present, one individual was selected using simple random selection (e.g., ballot method) to minimize within-household clustering. Non-response and ineligible households were documented, and the next eligible household in sequence was approached to maintain sampling continuity.

Data Collection Procedures

Quantitative Variables

Age was summarized using means and standard deviations and also categorized for descriptive stratification. In regression models, age was treated as a continuous variable and mean-centered to improve interpretability. Blood pressure, BMI, and waist circumference were analyzed both as continuous measures (descriptively) and as categorical variables using clinical thresholds for prevalence estimation.

Fasting venous blood samples were collected from participants by trained phlebotomists following an overnight fast of at least 8–10 hours. Samples were analysed for fasting blood glucose (FBG) and glycated haemoglobin

(HbA1c) using standard laboratory procedures at a certified diagnostic laboratory. Fasting blood glucose was measured using an enzymatic glucose oxidase method, while HbA1c was determined using a high-performance liquid chromatography–based assay. Internal quality control procedures were followed according to manufacturer and laboratory standards. All eligible participants were invited to undergo biochemical assessment irrespective of prior diagnosis status to reduce differential testing bias. Blood samples were obtained during scheduled morning visits, and participants were reminded of fasting requirements the day before sample collection.

Questionnaire Data

Data were collected by trained health research assistants using a structured interviewer-administered questionnaire adapted from the World Health Organization STEPwise Approach to Noncommunicable Disease Risk Factor Surveillance (WHO STEPS) [16]. The questionnaire captured sociodemographic characteristics (age, sex, education, occupation, and marital status); behavioural risk factors (tobacco use, alcohol consumption, physical activity, and dietary practices); and self-reported physician-diagnosed hypertension or diabetes and current medication use. Interviews were conducted in English or the local language as appropriate, and responses were recorded using standardized categorical options consistent with WHO STEPS guidance.

Physical Measurements

1. Blood Pressure:

Blood pressure was measured using a calibrated digital sphygmomanometer. Participants were seated comfortably with back supported and feet flat on the floor after resting for at least five minutes. An appropriately sized cuff was applied to the upper arm at heart level. Two measurements were taken at 1-2-minute intervals, and the average of the two readings was recorded. When the difference between readings exceeded 10 mmHg for systolic pressure, a third measurement was taken and the average of the closest two values was recorded. [17].

2. Anthropometry:

Weight was measured using a calibrated digital scale with participants wearing light clothing and no shoes. Height was measured using a portable stadiometer. Body mass index (BMI) was calculated as weight (kg) divided by height (m²).

Waist circumference was measured using a non-stretchable tape at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest, with the participant standing and breathing normally. Measurements were recorded to the nearest 0.1 cm. Two readings were obtained, and the average value was used for analysis to minimise measurement error. [18]. Measurements were taken over light clothing or directly on the skin according to participant comfort, ensuring the tape remained horizontal and snug without compression of soft tissue.

Variables and Operational Definitions

Primary Outcomes

The primary outcomes were the prevalence of major cardiovascular risk factors and the prevalence of risk factor clustering.

Definitions of Cardiovascular Risk Factors

Risk factors were defined according to established international criteria:

1. **Hypertension:** Systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg, or self-reported use of antihypertensive medication.
2. **Overweight:** BMI 25.0–29.9 kg/m².
3. **Obesity:** BMI ≥ 30.0 kg/m².
4. **Central Obesity:** Waist circumference ≥ 102 cm in men and ≥ 88 cm in women.
5. **Diabetes (known diabetes):** Self-reported prior physician diagnosis of diabetes and/or current use of glucose-lowering medication.
6. **Current Smoking:** Self-reported current use of tobacco products.
7. **Harmful Alcohol Use:** Self-reported alcohol consumption exceeding standard recommended limits.
8. **Physical Inactivity:** Not meeting recommended levels of moderate-to-vigorous physical activity according to WHO guidelines.
9. **Unhealthy Diet:** Self-reported low fruit and vegetable intake below recommended daily servings.
10. **Risk factor clustering** was defined as the presence of two or more of the following major risk factors: hypertension, overweight/obesity, central obesity, diabetes, smoking, harmful alcohol use, physical inactivity, and unhealthy diet.
11. **Covariates:** The main covariates were age (years) and sex (male/female). Age was analyzed both descriptively in categories and as a continuous variable in regression models.

Bias and Data Quality Assurance

All research assistants received standardized training on questionnaire administration and measurement protocols before data collection. Study instruments were pretested in a comparable community prior to the survey. Measuring devices were calibrated daily, and field supervisors conducted on-site reviews of completed questionnaires to ensure completeness, consistency, and adherence to study procedures. Duplicate anthropometric measurements were performed in a subset of participants to verify measurement consistency. To minimize selection bias within households, only one eligible participant was randomly selected from each household.

Statistical Analysis

Data were entered into a secure database and analysed using Stata (version 27) (StataCorp, College Station, TX, USA). Continuous variables were summarised as means and standard deviations, while categorical variables were presented as frequencies and percentages. Prevalence estimates were reported with 95% confidence intervals calculated using the Wilson score method. Associations between age, sex, and individual risk factors were evaluated using modified Poisson regression with robust variance estimation to directly estimate prevalence ratios (PRs), appropriate for common outcomes. Age was treated as a continuous variable and mean-centered prior to regression modelling to improve interpretability. Multivariable models adjusted for sex and age where appropriate. Clustering of cardiovascular risk factors (≥ 2 risk factors) was analysed similarly using prevalence ratios. A two-

sided p-value < 0.05 was considered statistically significant. Missing data were assessed, and complete-case analysis was applied where missingness was minimal.

RESULTS

The study included 107 community-dwelling older adults. Clinical and anthropometric measurements were complete for all participants, while age and selected laboratory variables had incomplete availability. Diabetes ascertainment was based on fasting blood glucose and/or HbA1c, yielding an ascertainment denominator of 106. Age-stratified and regression analyses were restricted to participants with available age data (n = 100). Figure 1 shows participant inclusion and variable-specific data completeness.

Participant Characteristics

A total of 107 community-dwelling older adults were included in the analysis (Table 1a). Variable-specific completeness was high for clinical measures but varied for selected laboratory assays (fasting blood glucose: 77/107; HbA1c: 105/107), and age was missing for 7 participants; detailed missingness by variable is provided in Table 1b. Of these, 57 (53.3%) were men and 50 (46.7%) were women. Age was available for 100 participants (93.5%), with a mean age of 70.94 ± 5.77 years. Age distribution was as follows: 60–69 years (n = 48; 44.9%), 70–79 years (n = 42; 39.3%), and ≥ 80 years (n = 10; 9.3%), with 7 participants (6.5%) missing age data (Table 1).

Mean systolic blood pressure was 142.27 ± 22.52 mmHg and mean diastolic blood pressure was 77.07 ± 12.92 mmHg. The mean body mass index (BMI) was 27.43 ± 3.43 kg/m². Biochemical parameters showed mean fasting blood glucose of 101.56 ± 30.95 mg/dL (n = 77) and mean HbA1c of $7.93 \pm 2.22\%$ (n = 105). Lipid parameters were as follows: total cholesterol 4.78 ± 1.81 mmol/L, LDL cholesterol 2.80 ± 1.51 mmol/L, HDL cholesterol 1.26 ± 0.54 mmol/L, and triglycerides 1.21 ± 0.55 mmol/L (Table 1).

Table 1
a. Sociodemographic and clinical characteristics of participants in Abor community (N = 107)

Characteristic	Value
Sex (Men)	57 (53.3%)
Sex (Women)	50 (46.7%)
Age (years), mean $\pm$ SD	70.94 $\pm$ 5.77 (n = 100)
Age band 60–69 years	48 (44.9%)
Age band 70–79 years	42 (39.3%)
Age band 80 + years	10 (9.3%)
Age missing	7 (6.5%)
Systolic BP (mmHg), mean $\pm$ SD	142.27 $\pm$ 22.52 (n = 107)
Diastolic BP (mmHg), mean $\pm$ SD	77.07 $\pm$ 12.92 (n = 107)
BMI (kg/m ²), mean $\pm$ SD	27.43 $\pm$ 3.43 (n = 107)
Fasting blood glucose (mg/dL), mean $\pm$ SD	101.56 $\pm$ 30.95 (n = 77)
HbA1c (%), mean $\pm$ SD	7.93 $\pm$ 2.22 (n = 105)
Total cholesterol (mmol/L), mean $\pm$ SD	4.78 $\pm$ 1.81 (n = 107)
LDL-C (mmol/L), mean $\pm$ SD	2.80 $\pm$ 1.51 (n = 105)
HDL-C (mmol/L), mean $\pm$ SD	1.26 $\pm$ 0.54 (n = 107)
Triglycerides (mmol/L), mean $\pm$ SD	1.21 $\pm$ 0.55 (n = 107)
Footnotes (Table 1): Age is missing for 7 participants; age-band totals therefore sum to 107 only when “Missing age” is included. Continuous variables are reported as mean $\pm$ SD, with n shown when missing values are present.	

Table 1
b. Missing data summary for key variables (N = 107)

Variables	Available n (%)	Missing n (%)
Sex	107 (100.0)	0 (0.0)
Age	100 (93.5)	7 (6.5)
Systolic blood pressure	107 (100.0)	0 (0.0)
Diastolic blood pressure	107 (100.0)	0 (0.0)
Body mass index (BMI)	107 (100.0)	0 (0.0)
Waist circumference	107 (100.0)	0 (0.0)
Fasting blood glucose (FBS)	77 (72.0)	30 (28.0)
HbA1c	105 (98.1)	2 (1.9)
Total cholesterol	107 (100.0)	0 (0.0)
LDL cholesterol	105 (98.1)	2 (1.9)
HDL cholesterol	107 (100.0)	0 (0.0)
Triglycerides	107 (100.0)	0 (0.0)
Footnote: <i>Diabetes ascertainment required availability of fasting blood glucose and/or HbA1c. One participant lacked both measures, resulting in diabetes ascertainment for 106 participants.</i>		

Prevalence of Cardiovascular Risk Factors

Prevalence estimates with Wilson 95% confidence intervals are presented in Table 2. Hypertension prevalence was 63/107 (58.9%; 95% CI 49.4–67.7). Overweight/obesity (BMI ≥ 25 kg/m²) was observed in 74/107 (69.2%; 95% CI 59.9–77.1). Diabetes defined as fasting blood glucose ≥ 126 mg/dL and/or HbA1c $\geq 6.5\%$ was present in 71/107 (66.4%; 95% CI 57.0–74.6).

Central obesity, defined using waist circumference thresholds (≥ 102 cm for men; ≥ 88 cm for women), was not observed (0/107; 0.0%; 95% CI 0.0–3.5).

Lipid abnormalities were common

elevated total cholesterol occurred in 26/107 (24.3%; 95% CI 17.1–33.5), elevated LDL cholesterol in 25/107 (23.4%; 95% CI 16.3–32.5), and elevated triglycerides in 15/107 (14.0%; 95% CI 8.6–22.1). Low HDL cholesterol was observed in 55/107 (51.4%; 95% CI 42.0–60.7). Overall, any dyslipidaemia (meeting ≥ 1 lipid criterion) occurred in 77/107 (72.0%; 95% CI 62.8–79.6) (Table 2).

Table 2
Prevalence of cardiovascular risk factors among older adults in Abor community (N = 107)

Risk factor	Prevalence n/N (%) [Wilson 95% CI, %]
Hypertension	63/107 (58.9%) [49.4, 67.7]
Overweight/obesity (BMI ≥ 25 kg/m ²)	74/107 (69.2%) [59.9, 77.1]
Diabetes (FBS ≥ 126 mg/dL and/or HbA1c $\geq 6.5\%$)	71/106 (67.0%) [57.6, 75.2]
Central obesity (waist circumference threshold)	0/107 (0.0%) [0.0, 3.5]
High total cholesterol (TC ≥ 5.2 mmol/L)	26/107 (24.3%) [17.1, 33.5]
High LDL-C (LDL ≥ 3.4 mmol/L)	25/107 (23.4%) [16.3, 32.5]
High triglycerides (TG ≥ 1.7 mmol/L)	15/107 (14.0%) [8.6, 22.1]
Low HDL-C (men < 1.0 ; women < 1.3 mmol/L)	55/107 (51.4%) [42.0, 60.7]
Any dyslipidaemia (any lipid criterion above)	77/107 (72.0%) [62.8, 79.6]
Footnotes (Table 2): Values are n/N (%) with Wilson 95% confidence intervals.	

^a Hypertension: SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg.

^b Overweight/obesity: BMI ≥ 25 kg/m².

^c Diabetes denominator is 106 because one participant is missing both fasting blood glucose (FBS) and HbA1c, so diabetes could not be ascertained for that participant.

^d Diabetes was defined as fasting blood glucose ≥ 126 mg/dL and/or HbA1c $\geq 6.5\%$. Diabetes

prevalence is reported using an ascertainment denominator because one participant lacked both

^e FBS and HbA1c. Accordingly, overall diabetes prevalence is reported as 71/106, and stratum-specific denominators vary where laboratory ascertainment is incomplete. All diabetes denominators reconcile across sex- and age-stratified tables.

^f Central obesity: WC ≥ 102 cm (men) or ≥ 88 cm (women).

^g Lipid thresholds use mmol/L: TC ≥ 5.2 ; LDL ≥ 3.4 ; TG ≥ 1.7 ; HDL low < 1.0 (men) or < 1.3 (women). Any dyslipidaemia" indicates ≥ 1 lipid criterion. Sex-stratified ascertainment denominators

^h Men: diabetes ascertainment 57/57

ⁱ Women: diabetes ascertainment 49/50 (1 missing both FBS and HbA1c)

Sex-Stratified Prevalence

Sex-stratified prevalence estimates are shown in Table 3. Hypertension prevalence was similar in men (33/57; 57.9%) and women (30/50; 60.0%). Diabetes prevalence was also comparable between men (37/57; 64.9%) and

women (34/50; 68.0%). Overweight/obesity was more frequent in women (39/50; 78.0%) than men (35/57; 61.4%). Marked sex differences were observed for lipid abnormalities. Low HDL cholesterol was present in 37/50 (74.0%) women compared with 18/57 (31.6%) men, and any dyslipidaemia affected 42/50 (84.0%) women compared with 35/57 (61.4%) men (Table 3). Confidence intervals for sex-stratified estimates are provided in Table 3 to reflect sampling variability.

Table 3
Sex-stratified prevalence of cardiovascular risk factors (N = 107)

Risk factor	Men (n = 57) n/N (%) [95% CI, %]	Women (n = 50) n/N (%) [95% CI, %]
Hypertension	33/57 (57.9%) [45.0, 69.8]	30/50 (60.0%) [46.2, 72.4]
Overweight/obesity (BMI $\geq$ 25 kg/m ²)	35/57 (61.4%) [48.4, 72.9]	39/50 (78.0%) [64.8, 87.2]
Diabetes (FBS $\geq$ 126 mg/dL and/or HbA1c $\geq$ 6.5%)	37/57 (64.9%) [51.9, 76.0]	34/49 (69.4%) [55.5, 80.5]
Central obesity (waist circumference threshold)	0/57 (0.0%) [0.0, 6.3]	0/50 (0.0%) [0.0, 7.1]
High total cholesterol (TC $\geq$ 5.2 mmol/L)	11/57 (19.3%) [11.0, 31.7]	15/50 (30.0%) [18.6, 44.4]
High LDL-C (LDL $\geq$ 3.4 mmol/L)	10/57 (17.5%) [9.7, 29.6]	15/50 (30.0%) [18.6, 44.4]
High triglycerides (TG $\geq$ 1.7 mmol/L)	5/57 (8.8%) [3.8, 18.9]	10/50 (20.0%) [10.7, 34.1]
Low HDL-C (men < 1.0; women < 1.3 mmol/L)	18/57 (31.6%) [20.5, 45.2]	37/50 (74.0%) [60.4, 84.2]
Any dyslipidaemia (any lipid criterion above)	35/57 (61.4%) [48.4, 72.9]	42/50 (84.0%) [71.3, 91.7]
Hypertension	33/57 (57.9%) [45.0, 69.8]	30/50 (60.0%) [46.2, 72.4]
Overweight/obesity (BMI $\geq$ 25 kg/m ²)	35/57 (61.4%) [48.4, 72.9]	39/50 (78.0%) [64.8, 87.2]
Footnotes (Table 3): Values are n/N (%) with Wilson 95% confidence intervals. Definitions and thresholds as in Table 2. Diabetes denominators are ascertainment-based (participants with FBS and/or HbA1c available). In the 60–69 band, 1 participant lacked both FBS and HbA1c, hence diabetes is reported as 34/47 rather than 34/48. In the 70–79 and $\geq$ 80 bands, diabetes ascertainment was complete (42/42 and 10/10, respectively).		

Age-Stratified Prevalence

Age-stratified prevalence estimates were computed among participants with non-missing age (n = 100) using the prespecified age bands (Table 4). Hypertension prevalence was 29/48 (60.4%) in ages 60–69 years, 28/42 (66.7%) in ages 70–79 years, and 3/10 (30.0%) in ages $\geq$ 80 years. Overweight/obesity prevalence was 35/48 (72.9%), 28/42 (66.7%), and 6/10 (60.0%) across these age bands, respectively. Diabetes prevalence was 35/48 (72.9%) in ages 60–69 years, 26/42 (61.9%) in ages 70–79 years, and 6/10 (60.0%) in ages $\geq$ 80 years (Table 4). Lipid abnormalities were observed across age groups, with any dyslipidaemia present in 33/48 (68.8%), 33/42 (78.6%), and 8/10 (80.0%) for ages 60–69, 70–79, and $\geq$ 80 years, respectively (Table 4). Confidence intervals widened substantially in the $\geq$ 80 years group due to the smaller stratum size (Table 4).

Table 4
Age-stratified prevalence of cardiovascular risk factors (participants with non-missing age; n = 100)

Risk factor	60–69 (n = 48) n/N (%) [95% CI, %]	70–79 (n = 42) n/N (%) [95% CI, %]	80+ (n = 10) n/N (%) [95% CI, %]
Hypertension	29/48 (60.4%) [46.3, 73.0]	28/42 (66.7%) [51.6, 79.0]	3/10 (30.0%) [10.8, 60.3]
Overweight/obesity (BMI $\geq$ 25 kg/m ²)	35/48 (72.9%) [58.9, 83.5]	28/42 (66.7%) [51.6, 79.0]	6/10 (60.0%) [31.3, 83.2]
Diabetes (FBS $\geq$ 126 mg/dL and/or HbA1c $\geq$ 6.5%)	34/47 (72.3%) [58.2, 83.1]	29/42 (69.0%) [54.0, 80.9]	5/10 (50.0%) [23.7, 76.3]
Central obesity (waist circumference threshold)	0/48 (0.0%) [0.0, 7.4]	0/42 (0.0%) [0.0, 8.4]	0/10 (0.0%) [0.0, 27.8]
High total cholesterol (TC $\geq$ 5.2 mmol/L)	11/48 (22.9%) [13.4, 36.5]	12/42 (28.6%) [17.1, 43.8]	2/10 (20.0%) [5.7, 51.0]
High LDL-C (LDL $\geq$ 3.4 mmol/L)	8/48 (16.7%) [8.6, 29.9]	14/42 (33.3%) [20.2, 49.7]	3/10 (30.0%) [10.8, 60.3]
High triglycerides (TG $\geq$ 1.7 mmol/L)	4/48 (8.3%) [3.3, 19.6]	8/42 (19.0%) [9.8, 33.1]	3/10 (30.0%) [10.8, 60.3]
Low HDL-C (men < 1.0; women < 1.3 mmol/L)	23/48 (47.9%) [34.2, 62.0]	24/42 (57.1%) [42.2, 70.9]	5/10 (50.0%) [23.7, 76.3]
Any dyslipidaemia (any lipid criterion above)	33/48 (68.8%) [54.7, 80.0]	33/42 (78.6%) [64.6, 88.2]	8/10 (80.0%) [49.0, 94.3]
Footnotes (Table 4): Values are n/N (%) with Wilson 95% confidence intervals. Age is missing for 7 participants, so age-stratified analyses use n = 100. Diabetes was defined as fasting blood glucose $\geq$ 126 mg/dL and/or HbA1c $\geq$ 6.5%. Diabetes prevalence is reported using an ascertainment denominator because one participant lacked both FBS and HbA1c. Accordingly, overall diabetes prevalence is reported as 71/106, and stratum-specific denominators vary where laboratory ascertainment is incomplete. All diabetes denominators reconcile across sex- and age-stratified tables.			

Adjusted Associations with Age and Sex

Adjusted prevalence ratios (PRs) estimated using modified Poisson regression with robust variance are presented in Table 5 (restricted to participants with non-missing age; n = 100). After adjustment for age, women did not have statistically different prevalence of hypertension (PR 1.13; 95% CI 0.81–1.57; p = 0.468), overweight/obesity (PR 1.19; 95% CI 0.90–1.57; p = 0.215), or diabetes (PR 1.06; 95% CI 0.81–1.39; p = 0.690) compared with men. Age (per one-year increase) was not significantly associated with hypertension (PR 1.00; 95% CI 0.97–1.03; p = 0.804), overweight/obesity (PR 0.99; 95% CI 0.97–1.02; p = 0.544), or diabetes (PR 0.99; 95% CI 0.97–1.02; p = 0.524). In contrast, women had higher prevalence of any dyslipidaemia relative to men after age adjustment (PR 1.47; 95% CI 1.14–1.90; p = 0.003). Age was not significantly associated with dyslipidaemia in adjusted analyses (PR 1.01; 95% CI 1.00–1.03; p = 0.149) (Table 5).

Sensitivity Analyses for Diabetes Definition

Using HbA1c-only versus the primary definition yielded essentially identical diabetes prevalence (~ 67%) and clustering (~ 70%), indicating robustness, whereas FBS-only produced substantially lower estimates due to limited availability and differing capture of dysglycaemia (Tables 5A, 5B, 5C, and 5D). Diabetes prevalence estimates were robust when restricted to HbA1c-only ascertainment. Using HbA1c $\geq$ 6.5% alone (available for 105/107), diabetes

prevalence was 70/105 (66.7%; 95% CI 57.2–75.0), closely matching the primary definition (Table 2). Using FBS $\geq$ 126 mg/dL alone (available for 77/107), diabetes prevalence was 10/77 (13.0%; 95% CI 7.2–22.3). In sex- and age-adjusted models, conclusions were unchanged for the primary outcomes: using either the combined definition or HbA1c-only definition, neither age nor sex was associated with diabetes (all $p > 0.05$); in the FBS-only model, estimates were imprecise due to the smaller denominator, but age and sex remained non-significant (Table 5, with sensitivity shown in Table 5B, C, D). Tables 5A, B, C and D present Sex- and age-adjusted prevalence ratios (PRs) for cardiovascular risk factors (participants with non-missing age; $n = 100$): Table 5C presents the sensitivity analyses for diabetes definition and its impact on diabetes prevalence and cardiometabolic risk-factor clustering

Figure 2 presents adjusted prevalence ratios (PRs) and 95% confidence intervals (CIs) were estimated using modified Poisson regression with robust variance, including sex and age in the same model. The dashed vertical line indicates PR = 1.0 (no difference). Only dyslipidaemia showed a statistically significant sex difference (PR 1.47; 95% CI 1.14–1.90), while hypertension, overweight/obesity, diabetes, and clustering were not significantly different by sex. Figure 2B shows adjusted prevalence ratios per year of age for cardiovascular risk factors. Across outcomes, age showed no statistically significant association with hypertension, overweight/obesity, diabetes, dyslipidaemia, or clustering (CIs largely overlapping 1.0).

Table 5
A: Primary models (main outcomes)

Outcome	Women vs Men PR (95% CI)	p-value	Age PR per + 1 year (95% CI)	p-value
Hypertension	1.13 (0.81–1.57)	0.468	1.00 (0.97–1.03)	0.804
Overweight/obesity (BMI $\geq$ 25)	1.19 (0.90–1.57)	0.215	0.99 (0.97–1.02)	0.544
Diabetes (FBS and/or HbA1c)	1.06 (0.81–1.39)	0.690	0.99 (0.97–1.02)	0.524
Any dyslipidaemia	1.47 (1.14–1.90)	0.003	1.01 (1.00–1.03)	0.149
Clustering ($\geq$ 2 of HTN/BMI/DM)	1.25 (0.97–1.61)	0.091	0.99 (0.96–1.01)	0.363

Table 5
B: Sensitivity analyses for diabetes definition (adjusted PRs)

Diabetes definition (sensitivity outcomes)	Model n	Women vs Men PR (95% CI)	p-value	Age PR per + 1 year (95% CI)	p-value
Primary (FBS $\geq$ 126 and/or HbA1c $\geq$ 6.5%)	99	1.057(0.805–1.388)	0.690	0.991 (0.966–1.018)	0.524
HbA1c-only (HbA1c $\geq$ 6.5%)	98	1.030 (0.780–1.361)	0.833	0.993 (0.967–1.020)	0.629
FBS-only (FBS $\geq$ 126 mg/dL)	74	3.101 (0.797–12.073)	0.103	1.018 (0.936–1.106)	0.681
Footnotes (Table 5): PRs estimated using modified Poisson regression with robust (sandwich) variance. Models include sex and age simultaneously. Reference for sex is Men. Age is modelled continuously; PR represents change per 1-year increase (age mean-centered for interpretability).					

Panel A uses participants with non-missing age ($n = 100$); for diabetes specifically, the primary definition requires HbA1c and/or FBS ascertainment, hence Model n differs in Panel B because of laboratory missingness.

Panel 5C. Diabetes mellitus (ascertainment-specific prevalence and adjusted PRs)

Diabetes definition	Diabetes cases n/N (%)	Model N (age complete)	Adjusted PR (Women vs Men) [95% CI], p	Adjusted PR per + 1 year age [95% CI], p
Primary definition (FBS and/or HbA1c)	71/106 (67.0%)	99	1.08 (0.82–1.41), p = 0.589	0.99 (0.96–1.02), p = 0.453
HbA1c-only ($\geq 6.5\%$)	70/105 (66.7%)	98	1.04 (0.79–1.36), p = 0.803	0.99 (0.97–1.02), p = 0.613
FBS-only (≥ 126 mg/dL)	10/77 (13.0%)	74	3.10 (0.80–12.07), p = 0.103	1.02 (0.94–1.11), p = 0.681

Panel 5D. Clustering of ≥ 2 cardiometabolic risk factors (HTN + BMI ≥ 25 + diabetes; definition-specific)

Clustering definition (≥ 2 of HTN, BMI ≥ 25 , diabetes)	≥ 2 risk factors n/N (%)	Model N (age complete)	Adjusted PR (Women vs Men) [95% CI], p	Adjusted PR per + 1 year age [95% CI], p
Primary diabetes (FBS and/or HbA1c)	74/106(69.8%)	99	1.24(0.96–1.61), p = 0.099	0.99 (0.97–1.01), p = 0.381
HbA1c-only diabetes	74/105(70.5%)	98	1.23(0.95–1.58), p = 0.118	0.99 (0.97–1.01), p = 0.428
FBS-only diabetes	39/77 (50.6%)	74	1.17(0.73–1.88), p = 0.509	0.96 (0.92–1.01), p = 0.096

Footnote: Diabetes ascertainment denominators differ because fasting blood glucose (FBS) and HbA1c were not available for all participants; diabetes was defined as FBS ≥ 126 mg/dL and/or HbA1c $\geq 6.5\%$ where at least one measure was present (primary definition). Regression models additionally required non-missing age, resulting in smaller model Ns. Clustering was defined as ≥ 2 of hypertension (SBP ≥ 140 and/or DBP ≥ 90), overweight/obesity (BMI ≥ 25), and diabetes using each definition.

Figure 2A. Adjusted prevalence ratios for cardiovascular risk factors (women vs men).

Clustering of Cardiovascular Risk Factors

Clustering was defined a priori as the presence of ≥ 2 of 3 risk factors: hypertension, overweight/obesity, and diabetes (Table 6). Overall, clustering occurred in 75/107 (70.1%; 95% CI 60.8–77.9). Sex-stratified clustering prevalence was 36/57 (63.2%; 95% CI 50.2–74.5) among men and 39/50 (78.0%; 95% CI 64.8–87.2) among women (Table 6). Age-stratified clustering (restricted to participants with non-missing age) was 37/48 (77.1%) in ages 60–69 years, 28/42 (66.7%) in ages 70–79 years, and 5/10 (50.0%) in ages ≥ 80 years, with wide confidence intervals in the oldest band (Table 6). Among those with missing age (n = 7), clustering occurred in 5/7 (71.4%) (Table 6). In adjusted models, clustering did not differ significantly by sex (PR 1.25; 95% CI 0.97–1.61; p = 0.091) or age (PR 0.99 per year; 95% CI 0.96–1.01; p = 0.363) (Table 5).

Table 6
Clustering of cardiovascular risk factors among older adults in Abor community (N = 107)

Stratum	Clustering (≥ 2 risk factors) n/N (%) [95% CI, %]
Overall (N = 107)	75/107 (70.1%) [60.8, 77.9]
Men (n = 57)	36/57 (63.2%) [50.2, 74.5]
Women (n = 50)	39/50 (78.0%) [64.8, 87.2]
Age 60–69 (n = 48)	37/48 (77.1%) [63.5, 86.7]
Age 70–79 (n = 42)	28/42 (66.7%) [51.6, 79.0]
Age 80+ (n = 10)	5/10 (50.0%) [23.7, 76.3]
Age missing (n = 7)	5/7 (71.4%) [35.9, 91.8]
Footnotes (Table 6): Clustering defined as presence of ≥ 2 of 3 major risk factors: hypertension, overweight/obesity (BMI ≥ 25), and diabetes (FBG ≥ 126 mg/dL and/or HbA1c $\geq 6.5\%$). Values are n/N (%) with Wilson 95% CIs. Age-stratified rows use age-band denominators; "Age missing" is shown to preserve the full N = 107 accounting.	

Summary of Key Findings

In this semi-rural community sample of older adults, a high burden of cardiometabolic risk was observed, with substantial prevalence of hypertension, overweight/obesity, diabetes, and lipid abnormalities. Risk factor clustering was common, affecting approximately seven in ten participants. While age and sex were not significantly associated with most individual cardiometabolic risk factors after adjustment, women demonstrated a significantly higher prevalence of dyslipidaemia. Overall, these findings highlight the extent of cardiovascular risk accumulation in this older community-dwelling population.

DISCUSSION

This community-based study demonstrates a substantial burden of cardiometabolic risk among older adults in Abor, Enugu State, Nigeria. Hypertension and overweight/obesity were highly prevalent, dyslipidaemia was common, and clustering of major risk factors occurred in a large proportion of participants. Importantly, diabetes prevalence was high when defined using biochemical ascertainment, indicating that abnormal glycaemic status is a prominent component of the local risk profile. Overall, these patterns suggest that cardiovascular risk is not confined to a small high-risk subgroup but is broadly distributed within this older population, reinforcing the importance of integrated screening and prevention strategies in semi-rural settings [7, 10, 11]. In this study, Diabetes mellitus is defined as fasting blood glucose ≥ 126 mg/dL and/or HbA1c $\geq 6.5\%$, reported using an ascertainment denominator (participants with fasting glucose and/or HbA1c available). This definition is applied consistently across the Methods, Results, and Discussion to ensure internal validity and comparability within the study.

Comparison with prior evidence

The hypertension burden observed in this study aligns with evidence from older adult populations in Nigeria and other LMIC contexts, where elevated blood pressure is common and contributes materially to stroke burden [7, 10, 11]. The high prevalence of overweight/obesity similarly fits the broader regional pattern of nutritional transition and

ageing-related reductions in physical activity and lean mass, which can increase cardiometabolic vulnerability even in non-urban communities [19]. Dyslipidaemia, including a high prevalence of low HDL cholesterol, is also consistent with reports indicating that lipid abnormalities often co-occur with hypertension and dysglycaemia in older adults, compounding vascular risk [22].

The diabetes prevalence in this study appears higher than many community estimates reported in comparable settings; however, direct comparisons require caution because studies differ in ascertainment approach (self-report versus laboratory measures), biochemical thresholds (fasting glucose alone versus HbA1c versus combined criteria), participant age structure, and sampling frame [20, 21]. By using biochemical criteria (fasting glucose and/or HbA1c), the current study captures both diagnosed and potentially undiagnosed dysglycaemia, which may partly explain the higher prevalence than self-reported estimates in the literature [20, 21]. This reinforces the epidemiological point that diabetes prevalence is strongly dependent on diagnostic strategy, especially in settings where underdiagnosis is likely.

Mechanisms proposed as hypotheses

Although causal inference is not possible due to the cross-sectional design, the observed clustering of hypertension, dysglycaemia, overweight/obesity, and dyslipidaemia is consistent with established cardiometabolic pathways that may plausibly operate in older populations. First, age-related vascular stiffening and endothelial dysfunction can elevate systolic blood pressure, while long-term exposure to high-salt diets, psychosocial stressors, and physical inactivity may further exacerbate these changes [23–25]. Second, overweight/obesity may contribute to insulin resistance and lipid dysregulation through neuroendocrine and inflammatory pathways, thereby increasing the likelihood that multiple risk factors occur concurrently [26–28]. Third, the higher prevalence of dyslipidaemia among women in adjusted analyses may reflect sex-specific differences in adiposity distribution, menopausal metabolic changes, dietary practices, and physical activity patterns; however, this remains a hypothesis requiring investigation using more detailed behavioural, hormonal, and life-course data [29].

An unexpected finding was the complete absence of central obesity despite a high prevalence of BMI-defined overweight/obesity (69.2%) and a mean BMI within the overweight range. This discordance between generalized and abdominal adiposity represents an unusual anthropometric profile that warrants careful interpretation. Although waist circumference was measured using standardized procedures, methodological studies have shown that waist circumference estimates vary according to measurement site and protocol, while conventional waist circumference thresholds developed largely from European and North American populations may not accurately identify abdominal adiposity or cardiometabolic risk in older African populations [30–33]. Methodological factors alone, however, may not fully explain the observed pattern. Previous Nigerian studies suggest that rural populations may engage in higher levels of habitual physical activity than their urban counterparts, while mobility, social participation, and environmental context remain important determinants of health in later life [36–38]. In addition, selective survival may contribute to the observed anthropometric profile, as older adults who remain healthy enough to participate in community-based studies may represent a biologically and behaviourally distinct subgroup with unique life-course exposures [41, 42].

The finding is clinically and epidemiologically important because waist circumference is intended to capture abdominal adiposity, which is more strongly associated with cardiometabolic risk than BMI alone [33]. Consequently, the coexistence of high overweight/obesity prevalence and absent central obesity raises questions regarding the appropriateness of applying conventional waist circumference thresholds in older Nigerian populations. Age-related changes in body composition including sarcopenia, altered fat distribution, and increased

ectopic fat deposition may further weaken the relationship between BMI and abdominal adiposity in later life [34, 35]. If conventional waist circumference thresholds underestimate abdominal adiposity in this population, the burden of obesity-related cardiovascular risk may be systematically underestimated in community-based surveillance and screening programmes.

Future studies should evaluate the comparative performance of waist circumference, waist-to-height ratio, waist-to-hip ratio, and direct body-composition measures against cardiometabolic outcomes in older African populations. Such evidence would inform the development of population-specific cardiovascular risk assessment strategies for healthy ageing in sub-Saharan Africa.

Public health and policy implications

The findings have clear implications for stroke and cardiovascular prevention in semi-rural Nigerian communities. First, the high prevalence and clustering of risk factors supports implementation of integrated cardiometabolic screening for older adults at community and primary healthcare levels. Operationally, this should include routine blood pressure measurement; glycaemic screening using fasting glucose and/or HbA1c where feasible; targeted lipid assessment based on risk profile; and structured counselling on physical activity, diet quality, and medication adherence when indicated [19, 43]. Second, because clustering was common, interventions should be designed and delivered as multi-risk-factor programmes rather than siloed hypertension-only or diabetes-only initiatives, improving efficiency and aligning with how risk factors manifest in real-world older populations.

At a systems level, these results support the prioritization of older adults in non-communicable disease programming, including community outreaches, periodic risk checks, and referral pathways for treatment initiation and follow-up. Given the likely constraints of laboratory access, pragmatic approaches such as stepwise screening (BP first, then glycaemia, then lipids where indicated) may maximize coverage while managing cost. Critically, all recommendations in this Discussion are grounded in the observed distribution of risk factors in Abor, Enugu State, Nigeria (not any other region), correcting the earlier geographical error.

Strengths and limitations

This study's strengths include a community-based sampling approach suited to generating local estimates in a semi-rural setting and the use of standardized clinical and biochemical measurements to characterize multiple cardiovascular risk domains. Reporting prevalence with Wilson confidence intervals improves transparency around estimate precision, particularly for less frequent outcomes.

Several limitations warrant emphasis. First, the cross-sectional design precludes establishing temporal or causal relationships between risk factors. Second, laboratory data were not complete for all participants; therefore, diabetes prevalence was reported using an ascertainment denominator, and this approach should be consistently stated in Methods and table footnotes to avoid misinterpretation. Third, subgroup precision was limited in the ≥ 80 years age band due to small stratum size; therefore, non-significant age differences should be interpreted as limited evidence of differences rather than definitive absence of age gradients. Finally, the absence of central obesity by waist circumference thresholds highlights the need to audit the measurement protocol and threshold suitability; replication with enhanced anthropometric quality control is recommended.

Conclusion

In this semi-rural Nigerian community, older adults exhibit a high burden of hypertension, overweight/obesity, dyslipidaemia, and biochemically ascertained diabetes, with frequent clustering of major cardiometabolic risk factors. These findings support strengthening integrated, community- and primary care-based cardiovascular risk screening and prevention strategies targeting older adults in Enugu State and similar settings, with explicit attention to measurement rigor, laboratory ascertainment transparency, and the practical reality that multiple risk factors commonly co-occur [7, 10, 11, 19, 43].

Abbreviations

BMI

Body Mass Index

BP

Blood Pressure

CI

Confidence Interval

CVD

Cardiovascular Disease

DBP

Diastolic Blood Pressure

FBS

Fasting Blood Sugar

FBG

Fasting Blood Glucose

HbA1c

Glycated Haemoglobin

HDL-C

High-Density Lipoprotein Cholesterol

LDL-C

Low-Density Lipoprotein Cholesterol

LMICs

Low- and Middle-Income Countries

NCDs

Non-Communicable Diseases

NHANES

National Health and Nutrition Examination Survey

PR

Prevalence Ratio

SBP

Systolic Blood Pressure

SD

Standard Deviation

TC

Total Cholesterol

TG

Triglycerides

WC

Waist Circumference

WHO

World Health Organization

WHO STEPS

World Health Organization STEPwise Approach to Non-Communicable Disease Risk Factor Surveillance

Declarations

Ethics approval and consent to participate

The study was registered with the Pan African Clinical Trials Registry (PACTR) (Trial registration: PACTR202506842802044; registered on 10 June 2025) and ethical approval obtained from University of Nigeria Teaching Hospital: NHREC/05/01/2008B-FWA00002458-1RB000002323. Permission was obtained from community leadership prior to study commencement. Written informed consent was obtained from all participants. For individuals with limited literacy, the consent form was read aloud and a thumbprint was used in the presence of an independent witness. Confidentiality of participant information was maintained, and participation was voluntary, with the right to withdraw at any time without consequence.

Consent to publish

Not applicable

Competing interests

The authors declare that there is no conflict of interest

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Author Contribution

EJL and SCI conceived the study, participated in literature search and review, developed the study design, coordinated data collection, performed data analysis and interpretation, and drafted the manuscript. EJL led field implementation and data management under the supervision of SCI, EC, AIO and KEF supported literature review, field coordination, data collection, and manuscript review. GCI and OCP contributed to study coordination, interpretation of findings, and critical revision of the manuscript for intellectual content. All authors read and approved the final manuscript.

Data Availability

The datasets supporting the conclusions of this article are available in the institutional University of Nigeria repository and will be made easily available on request when required. All requests for the study data should be addressed to the corresponding author via email: sam.ibeneme@unn.edu.ng.

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Figures

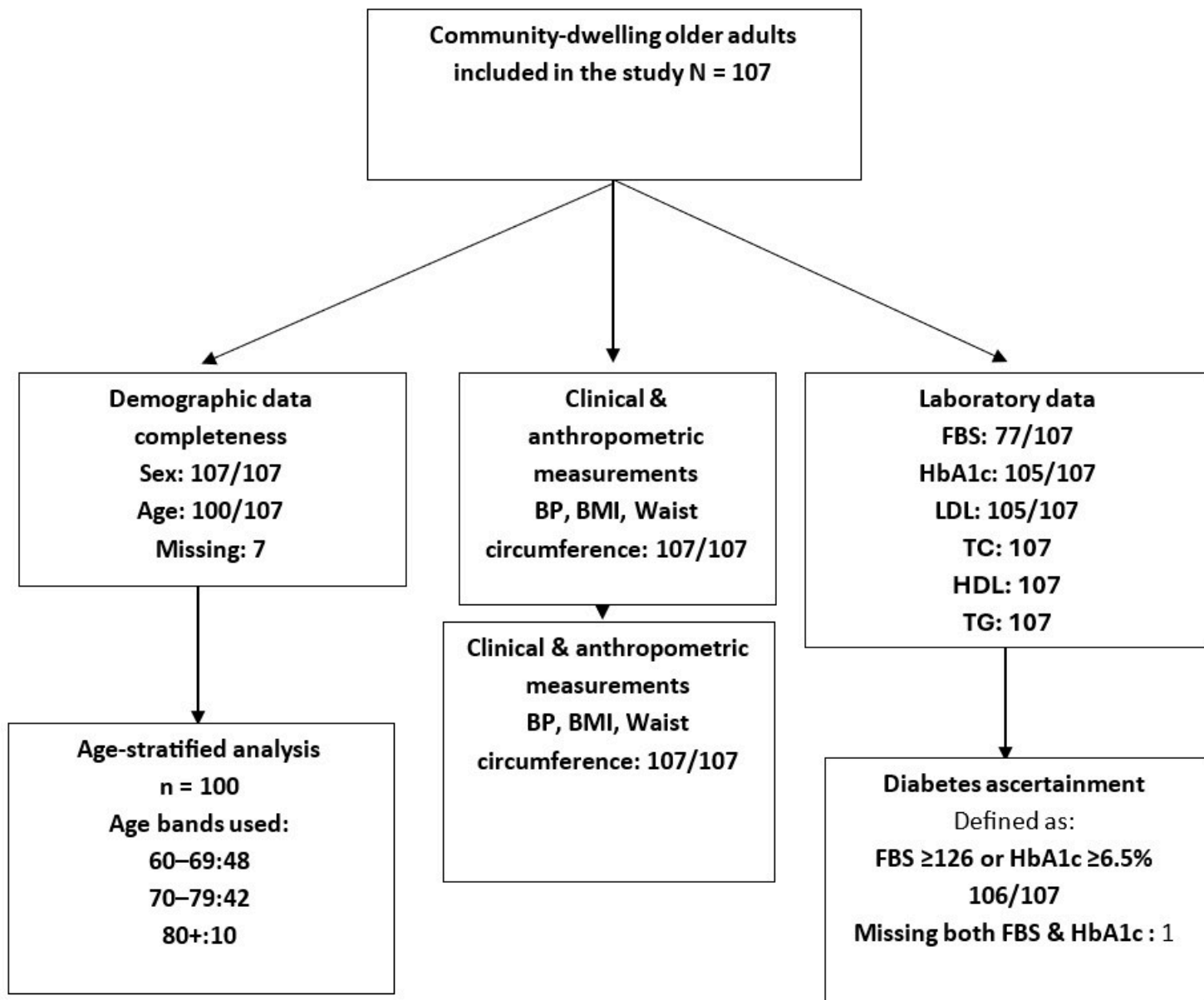


Figure 1

Participant inclusion and variable-specific data completeness

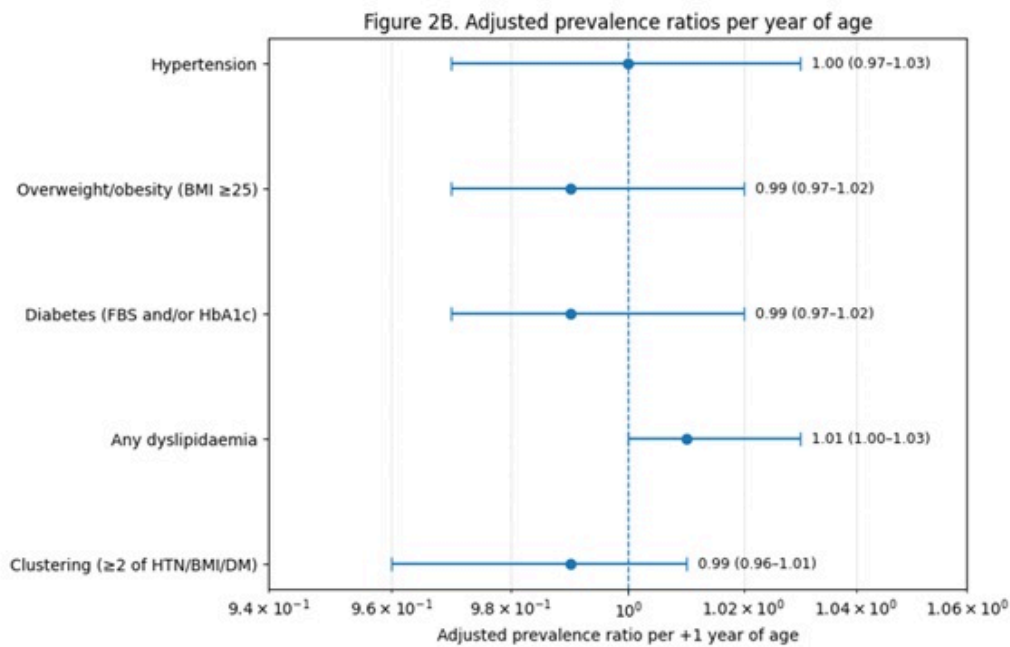
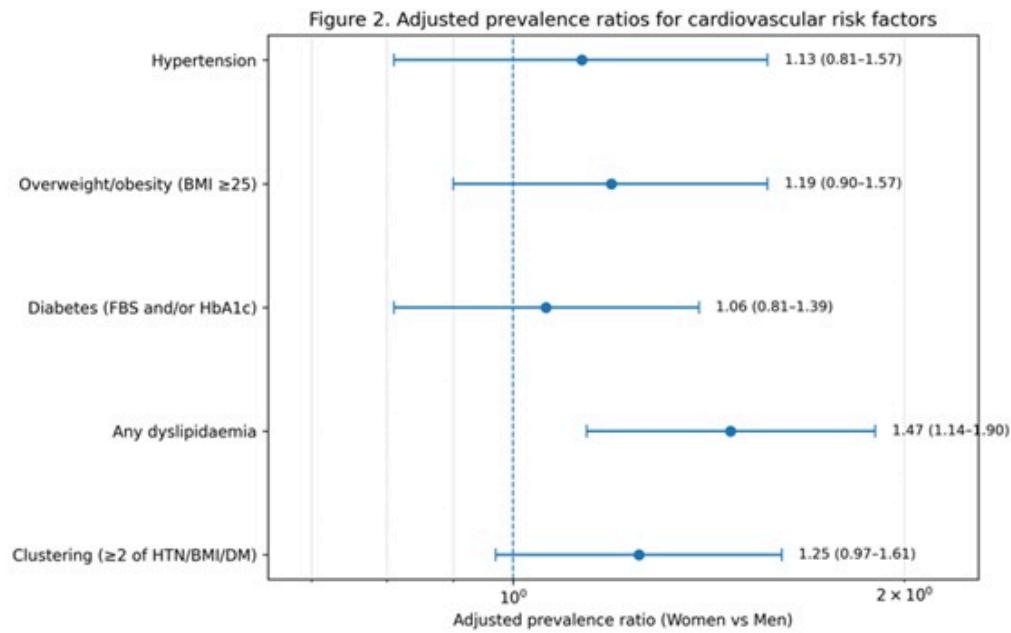


Figure 2

A. Adjusted prevalence ratios for cardiovascular risk factors (women vs men).

B. Adjusted prevalence ratios per year of age

Figure 3. Distribution of cardiometabolic risk factor clustering

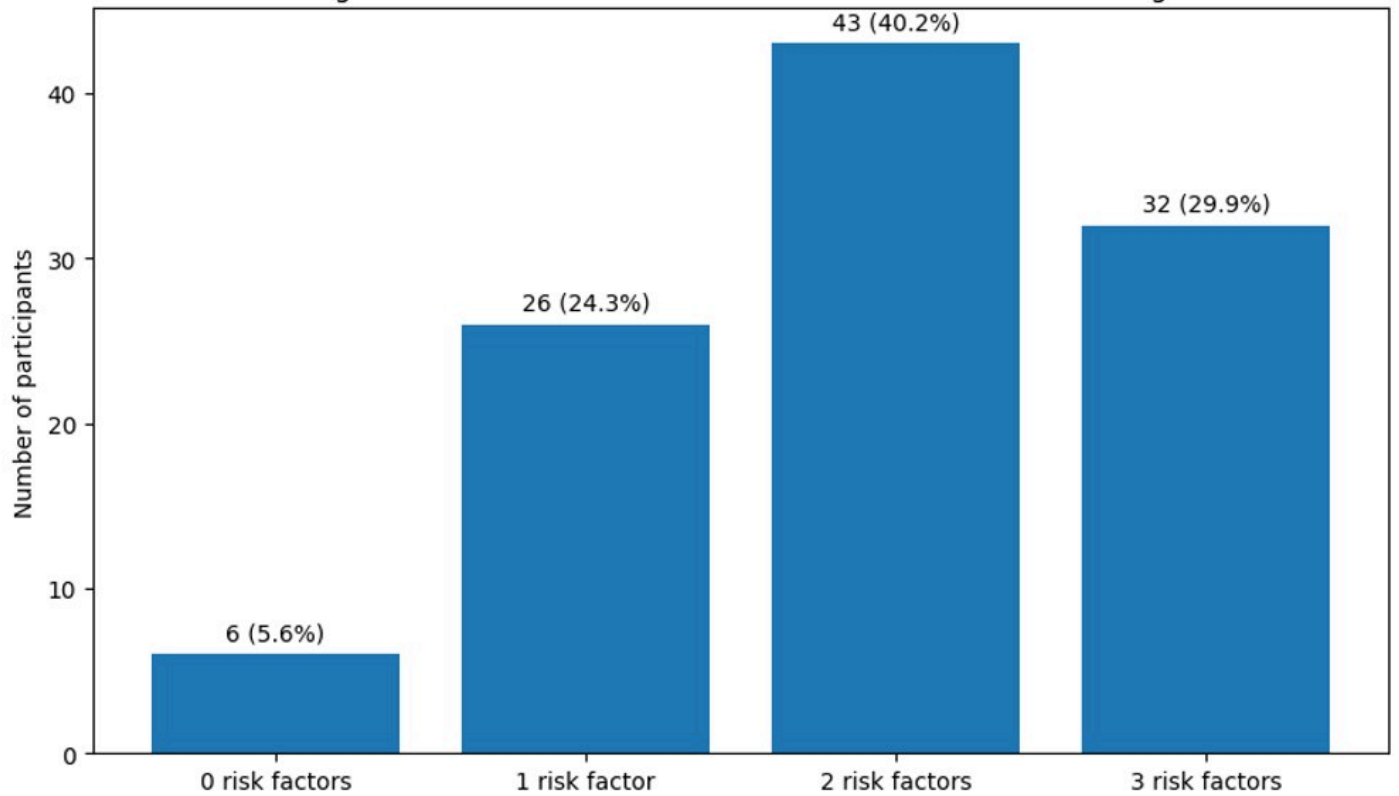


Figure 3

Distribution of cardiometabolic risk factor clustering. Bars show the number (and percentage) of participants with 0, 1, 2, or 3 major cardiometabolic risk factors at baseline, defined as hypertension (SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg), overweight/obesity (BMI ≥ 25 kg/m²), and diabetes (fasting blood glucose ≥ 126 mg/dL and/or HbA1c $\geq 6.5\%$). Percentages use N=107; participants without fasting glucose and HbA1c were retained in the denominator and treated as non-diabetic for clustering classification to preserve comparability with Table 6.