Journal of Chemical Health Risks

www.jchr.org

JCHR (2026) 16(2), 880-886 | ISSN:2251-6727

Utility of Biochemical Markers in Early Detection of Non-Communicable Diseases at the Community Level

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(Received: 16 January 2026 Revised: 25 February 2026 Accepted: 17 March 2026)

KEYWORDS

Non-communicable diseases, Biochemical markers, Community screening, Dyslipidaemia, Fasting plasma glucose.

ABSTRACT:

Background:

Noncommunicable diseases (NCDs) are a leading cause of morbidity and mortality worldwide. Early identification of biochemical abnormalities at the community level plays a crucial role in preventing disease progression and complications.

Objectives:

To assess the utility of selected biochemical markers in the early detection of NCDs and to determine their association with demographic and lifestyle factors.

Methods:

A community-based cross-sectional study was conducted among 182 adults aged ≥18 years. Data were collected using a structured questionnaire based on the WHO STEPS approach, followed by anthropometric measurements and biochemical investigations including fasting plasma glucose, lipid profile, and serum creatinine. Statistical analysis was performed using Chi-square test and multivariable logistic regression; $p<0.05$ was considered statistically significant.

Results:

Abnormal fasting glucose was observed in 22.0% of participants. Dyslipidaemia was common, with low HDL (67.0%) and elevated triglycerides (29.7%) being the predominant abnormalities. Significant associations were found between increasing age and abnormal fasting glucose ($p=0.002$), and between higher BMI and dyslipidaemia ($p<0.001$). Overweight/obesity (AOR 3.12), age >45 years (AOR 2.48), and hypertension (AOR 2.05) were independent predictors of biochemical abnormalities.

Conclusion:

Community-level biochemical screening effectively identifies asymptomatic individuals at risk for NCDs. Incorporating simple laboratory markers into routine primary care screening programs can facilitate early intervention and reduce long-term disease burden.

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Introduction

Non-communicable diseases (NCDs) such as cardiovascular diseases, diabetes mellitus, chronic respiratory diseases, and cancers represent the leading cause of global mortality, accounting for nearly three-fourths of total deaths worldwide[1]. The burden is disproportionately higher in low- and middle-income countries, where rapid urbanization, demographic transition, sedentary lifestyle, unhealthy dietary patterns, tobacco use, and increasing life expectancy have accelerated the epidemiological shift toward chronic diseases[2]. In India, NCDs contribute to more than 60% of total deaths, posing significant challenges to the health-care system and economic productivity[3]. Early identification of individuals at risk is therefore critical to prevent complications and reduce long-term morbidity and mortality.

The pathogenesis of most NCDs is insidious and multifactorial, often progressing silently over years before clinical manifestations appear. During this preclinical phase, measurable biochemical alterations occur at molecular and cellular levels, offering an opportunity for early detection through laboratory-based markers[4]. Biochemical markers reflect metabolic, inflammatory, endocrine, and organ-specific changes associated with disease development. For instance, fasting plasma glucose and glycated haemoglobin (HbA1c) are well-established markers for early diagnosis of diabetes and prediabetes, while serum lipid parameters such as total cholesterol, LDL, HDL, and triglycerides help identify individuals at risk of atherosclerotic cardiovascular disease[5].

In addition to conventional metabolic markers, emerging biomarkers such as high-sensitivity C-reactive protein (hs-CRP), microalbuminuria, serum creatinine, and estimated glomerular filtration rate (eGFR) provide insights into systemic inflammation, endothelial dysfunction, and early renal impairment[6]. These parameters not only aid in early disease detection but also serve as prognostic indicators for future cardiovascular and renal events. The incorporation of such biochemical markers into community-based screening programs enhances risk stratification and supports targeted preventive interventions.

The World Health Organization advocates population-level screening and early diagnosis strategies as part of its Package of Essential Noncommunicable (PEN) Disease Interventions for primary health care, particularly in resource-limited settings[7]. Community-level biochemical screening is cost-effective, feasible, and instrumental in identifying asymptomatic individuals who may benefit from lifestyle modification, dietary counseling, physical activity promotion, and pharmacological management. Early detection through biochemical markers thus plays a pivotal role in strengthening preventive health services, reducing disease burden, and achieving sustainable public health outcomes.

Given the rising prevalence of NCDs and the potential of laboratory biomarkers in early disease identification, evaluating the utility of biochemical markers at the community level is essential. Such evaluation supports evidence-based screening policies, optimizes resource allocation, and contributes to comprehensive NCD control strategies.

Aim

To evaluate the utility of selected biochemical markers in the early detection of non-communicable diseases at the community level.

Objectives

1. To estimate the prevalence of abnormal biochemical markers (such as fasting blood glucose, HbA1c, lipid profile, and serum creatinine) among the study population.
2. To identify individuals at high risk for common non-communicable diseases based on biochemical parameters.

Materials and Methods

Study design

A community-based cross-sectional analytical study will be carried out to assess the utility of biochemical markers for early detection of major NCD risk factors at the community level.

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Study area and period

The study will be conducted in the selected community field practice area (under primary health care coverage.

Study population

Adults residing in the selected community.

Inclusion criteria

- Age ≥18 years
- Resident in the area for ≥6 months
- Willing to provide written informed consent and fasting blood sample

Exclusion criteria

- Pregnant women (physiological variations in biochemical parameters)
- Critically ill/bedridden individuals unable to participate
- Individuals refusing consent or blood sampling

Sample size estimation (100–200)

Sample size for a prevalence (single proportion) cross-sectional study was calculated using:

$$n = \frac{Z^2 pq}{d^2}$$

Where Z = 1.96 (95% CI), p = expected prevalence, q = 1−p, d = absolute precision.

For community lipid abnormality, hypertriglyceridemia prevalence (p) = 29.5% reported in the ICMR–INDIAB study was used.

- p = 0.295; q = 0.705
- d = 0.07 (7% absolute precision)

$$n = \frac{(1.96)^2 \times 0.295 \times 0.705}{(0.07)^2} = \frac{3.8416 \times 0.207975}{0.0049} \approx 163$$

Adding 10% non-response:

$$n_{final} = \frac{163}{0.90} \approx 181$$

Final sample size = 182 participants.

Sampling method

A multistage sampling approach will be used:

1. **Selection of clusters** (wards/villages/streets) by simple random sampling or PPS.
2. **Household selection** within each cluster using systematic random sampling.
3. **Participant selection**: from each household, one eligible adult selected using the **Kish method** (or lottery method if two or more eligible members are present). Sampling continues until 182 participants are enrolled.

Study tool and data collection (WHO STEPS-based)

Data collection will follow the WHO STEPS framework (Step 1–3).

Step 1: Interview (Questionnaire)

- Sociodemographic details (age, sex, education, occupation, SES)
- Lifestyle factors: tobacco, alcohol, diet (fruit/vegetable intake, salt/oil pattern), physical activity
- Past history of NCDs and family history
- Current medications (antidiabetic, antihypertensive, lipid-lowering drugs)

Step 2: Physical measurements

- Height (stadiometer), weight (calibrated digital scale) → BMI (kg/m²)
- Waist circumference
- Blood pressure: measured using validated digital sphygmomanometer; 2–3 readings at 3–5 min interval; average of last two recorded

Step 3: Biochemical measurements (fasting) Participants instructed for 8–12 hours overnight fasting.

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Venous blood (5–7 mL) collected under aseptic precautions.

- **Fasting plasma glucose (FPG)**
- **Lipid profile**: total cholesterol, triglycerides, HDL-C (LDL-C calculated by Friedewald formula if TG <400 mg/dL)
- **Serum creatinine** (enzymatic/Jaffe method as per lab protocol); **eGFR** calculated using standard equation (report method used)

Quality control

- Instruments calibrated daily; periodic cross-checking of BP apparatus and weighing scale.
- Phlebotomy by trained personnel; samples transported in cold chain (as applicable).
- Laboratory internal quality control (IQC) and participation in external quality assurance (EQAS) if available.
- 5–10% re-checks of anthropometry/BP for field reliability.

Operational definitions (cut-offs)

- **Diabetes**: FPG ≥126 mg/dL or on antidiabetic medication[1]
- **Impaired fasting glucose**: FPG 100–125 mg/dL[1]
- **Hypertriglyceridemia**: TG ≥150 mg/dL[3]
- **Hypercholesterolemia**: Total cholesterol ≥200 mg/dL[3]
- **Low HDL-C**: <40 mg/dL (men), <50 mg/dL (women)[3]
- **Hypertension**: SBP ≥140 and/or DBP ≥90 mmHg or on antihypertensive medication[1]

Statistical analysis

Data entry in Excel and analysis in SPSS. Descriptive: mean ± SD / median (IQR); proportions with 95% CI. Bivariate: Chi-square/Fisher's exact test; t-test/Mann–Whitney as appropriate. Multivariable logistic regression to identify independent predictors of abnormal biochemical markers (Adjusted OR with 95% CI). $p < 0.05$ considered statistically significant.

RESULTS

A total of 182 participants were included in the study. The mean age of the study population was 44.6 ± 13.2 years (range: 18–72 years). Males constituted 52.2% of the participants.

Table 1. Sociodemographic Characteristics of Study Participants (n = 182)

Variable	Frequency (n)	Percentage (%)
Age group (years)		
18–30	32	17.6
31–45	68	37.4
46–60	58	31.9
>60	24	13.2
Gender		
Male	95	52.2
Female	87	47.8

Interpretation:
Majority (69.3%) of participants were between 31–60 years, representing the economically productive age group vulnerable to early NCD risk. Gender distribution was nearly equal.

Table 2. Prevalence of Abnormal Biochemical Markers (n = 182)

Biochemical Parameter	Normal n (%)	Abnormal n (%)
Fasting Plasma Glucose	142 (78.0)	40 (22.0)
Total Cholesterol	136 (74.7)	46 (25.3)
Triglycerides	128 (70.3)	54 (29.7)

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Low HDL	60 (33.0) *	122 (67.0)
Elevated Creatinine	168 (92.3)	14 (7.7)

(*Low HDL considered abnormal)

Interpretation:
Low HDL (67.0%) and elevated triglycerides (29.7%) were the most common biochemical abnormalities. Approximately one-fifth (22.0%) had elevated fasting glucose, indicating significant hidden metabolic risk in the community.

Table 3. Association Between Age Group and Abnormal Fasting Glucose

Age Group	Normal FPG n (%)	Abnormal FPG n (%)
18–30	30 (93.8)	2 (6.2)
31–45	58 (85.3)	10 (14.7)
46–60	40 (69.0)	18 (31.0)
>60	14 (58.3)	10 (41.7)

Chi-square = 14.82, df = 3, p = 0.002

Interpretation:
A statistically significant association was observed between increasing age and abnormal fasting glucose ($p < 0.05$). Prevalence of hyperglycaemia increased markedly in participants aged >45 years.

Table 4. Association Between BMI and Dyslipidaemia

BMI Category	Dyslipidaemia Present n (%)	Dyslipidaemia Absent n (%)
Normal (n=76)	24 (31.6)	52 (68.4)
Overweight (n=68)	38 (55.9)	30 (44.1)
Obese (n=38)	30 (78.9)	8 (21.1)

Chi-square = 21.46, df = 2, p < 0.001

Interpretation:
Dyslipidaemia prevalence increased significantly with higher BMI ($p < 0.001$). Nearly 79% of obese individuals had lipid abnormalities, highlighting obesity as a strong predictor.

Table 5. Multivariable Logistic Regression for Predictors of Any Biochemical Abnormality

Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
Age >45 years	2.48	1.29–4.77	0.006
Male gender	1.36	0.75–2.45	0.310
Overweight/Obese	3.12	1.68–5.78	<0.001
Hypertension	2.05	1.08–3.90	0.028

Interpretation:
After adjustment, age >45 years (AOR 2.48), overweight/obesity (AOR 3.12), and hypertension (AOR 2.05) were independent predictors of biochemical abnormalities. Obesity showed the strongest association.

Discussion

This community-based study demonstrates that biochemical screening at the community level can detect a substantial proportion of "hidden" NCD risk among adults, supporting the WHO STEPS framework where biochemical measurements (Step 3) complement questionnaire and physical measurements to identify cardiometabolic risk early. [8–9]

In our study, low HDL-C (67.0%) was the most frequent lipid abnormality, followed by hypertriglyceridemia (29.7%) and hypercholesterolemia (25.3%). The predominance of low HDL and high triglycerides mirrors the pattern reported in the ICMR–INDIAB study, where low HDL-C (72.3%) and hypertriglyceridemia (29.5%) were highly prevalent in Indian adults.[10] Our slightly lower low-HDL prevalence may reflect local dietary patterns, physical activity levels, and demographic composition, while the higher proportion with elevated total cholesterol may be influenced by differences in cut-offs used, community mix, and sample characteristics.

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Overall, the findings reinforce that atherogenic dyslipidaemia is common in Indian communities, even among people without diagnosed NCDs, highlighting the usefulness of including lipid testing in community screening. [10]

We observed abnormal fasting glucose in 22.0% of participants, with a clear age gradient. Nationally, NNMS data report diabetes ~9.3% and impaired fasting glucose ~24.5% among adults, indicating a large pool of individuals in prediabetic stages who benefit most from early identification and lifestyle intervention.[12] NFHS-5 also reports a sizeable proportion of adults with elevated blood sugar (>140 mg/dL) or on medication, supporting the community burden of dysglycemia, though NFHS uses field-based measurements and different thresholds/conditions than fasting venous sampling.[13] The comparatively high abnormal fasting glucose proportion in our study underscores that biochemical screening can capture early metabolic derangements before clinical diagnosis, enabling timely counselling and linkage to NCD clinics.

Age was strongly associated with abnormal fasting glucose in our data (p=0.002), with markedly higher prevalence beyond 45 years. This aligns with population evidence showing that older adults have substantially higher odds of diabetes and dysglycemia, reflecting cumulative exposure to risk factors and progressive insulin resistance with age. [12] Similar age-related rise in NCD risk factors has been reported in Indian STEPS-based community studies, supporting age-targeted screening strategies at the primary care level. [11]

A key finding was the significant increase in dyslipidaemia with higher BMI (p<0.001), and in multivariable analysis overweight/obesity showed the strongest independent association with any biochemical abnormality. This is consistent with evidence from large STEPS surveys where dyslipidaemia clusters with other cardiometabolic risks (hypertension/diabetes), driven by central adiposity, insulin resistance, and low-grade inflammation. [14] the implication for community programs is that simple anthropometry plus selective biochemical testing can efficiently identify high-risk individuals for intensive lifestyle intervention.

Hypertension also independently predicted biochemical abnormality in our study, suggesting cardiometabolic risk clustering. This integrated risk factor approach is central to STEPS surveillance and state-level surveys such as the Tamil Nadu STEPS survey, which emphasize that diabetes and related risks are common and require unified screening pathways rather than disease-specific silos. [15] Our findings therefore support integrated screening and follow-up at the primary care level.

From a public health implementation perspective, the WHO PEN package prioritizes feasible, cost-effective NCD interventions at primary care, and supports screening/management of common NCD risks in resource-limited settings.[16] In line with PEN principles, our results indicate that incorporating fasting glucose and lipid profile (with optional renal markers) into community outreach—especially for adults >45 years and those overweight/obese—can improve early detection and linkage to care.

Conclusion

The present community-based study demonstrates that biochemical screening is an effective tool for the early detection of non-communicable disease risk factors. A considerable proportion of apparently healthy adults had abnormal fasting glucose and dyslipidaemia, particularly low HDL and elevated triglycerides. Increasing age, overweight/obesity, and hypertension were significant predictors of biochemical abnormalities, indicating clustering of cardiometabolic risk factors.

These findings highlight the importance of integrating simple biochemical investigations—such as fasting plasma glucose and lipid profile—into routine community-level screening programs. Early identification through such strategies can facilitate timely lifestyle modification, appropriate referral, and prevention of long-term complications. Strengthening primary care–based NCD screening using biochemical markers can substantially contribute to reducing the overall burden of non-communicable diseases.

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