RESEARCH PAPER

Multi-Marker Approach for Evaluation of Metabolic, Haematological, and Endocrine Health in Women: A Cross-Sectional Observational Study

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ABSTRACT

Background and Objectives:

Women's health involves interacting haematological, metabolic, endocrine, and cardiovascular factors. This study evaluated a combined panel of routinely measured laboratory parameters and examined their relationships and age-related differences among adult women.

Methods:

This cross-sectional observational analysis used 300 laboratory records from the supplied spreadsheet. Women aged 18–60 years were included, giving 280 eligible records. Parameters included random blood sugar (RBS), total cholesterol, thyroid-stimulating hormone (TSH), haemoglobin and CBC-derived indices. Descriptive statistics, Pearson correlation analysis and comparative evaluation across age groups were performed. Statistical significance was set at $p<0.05$.

Results:

Mean age was 33.35 ± 12.04 years. Mean RBS was 95.40 ± 36.22 mg/dL and total cholesterol was 160.99 ± 33.66 mg/dL. Mean TSH was 3.08 ± 6.87 mIU/L and haemoglobin was 13.04 ± 0.82 g/dL. Age correlated positively with RBS ($r=0.207$, $p<0.001$) and total cholesterol ($r=0.488$, $p<0.001$). RBS correlated positively with total cholesterol ($r=0.157$, $p=0.008$). Hb correlated strongly with PCV ($r=0.915$, $p<0.001$).

Interpretation and Conclusions:

Significant associations were observed among selected metabolic and haematological parameters, with significant age-group differences in RBS and total cholesterol. These findings support further evaluation of a multimarker screening framework but do not establish diagnostic superiority or causality.

Keywords: Blood glucose; Complete blood count; Multimarker approach; Total cholesterol; Thyroid-stimulating hormone; Women's health

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INTRODUCTION

Women's health is shaped by the interaction of haematological, metabolic and endocrine processes. The increasing burden of non-communicable diseases, including diabetes mellitus, hypertension, thyroid disorders and cardiovascular disease, makes early identification of abnormal laboratory patterns important for preventive health care. The proposal emphasizes that

routine parameters such as complete blood count (CBC), blood glucose level (BGL), thyroid-stimulating hormone (TSH), total cholesterol and blood pressure provide information about individual physiological systems, while their combined assessment may offer a broader picture of women's health [1,2].

CBC is a fundamental diagnostic tool used to detect anemia, infections, and inflammatory conditions. Studies have shown its role in predicting systemic and metabolic disorders, including preeclampsia and chronic inflammation [3,4].

Blood glucose levels are critical in diagnosing and monitoring diabetes mellitus. The **American Diabetes Association** highlights the importance of glucose monitoring in identifying metabolic disorders and preventing complications [5]. The HAPO study further demonstrated the association between hyperglycemia and adverse health outcomes [6,7].

Dyslipidaemia, particularly elevated total cholesterol, is an important component of cardiovascular risk assessment in women [8,9]. Thyroid dysfunction may affect metabolic and reproductive health, while abnormal TSH has been associated with metabolic and cardiovascular disorders [10,11].

Hypertension is a leading risk factor for cardiovascular disease and mortality. Guidelines emphasize the importance of blood pressure monitoring in early detection and prevention of complications [12,13].

The proposal further highlights evidence supporting a multimarker approach integrating haematological, metabolic and endocrine parameters rather than relying on isolated markers [1,2,14].

Need for the Study

In many clinical settings, health assessment is often limited to isolated parameters, which may fail to detect early-stage disorders. Evidence suggests that combining multiple biomarkers significantly improves diagnostic accuracy and prediction of chronic diseases [1,2].

In the Indian context, the burden of metabolic and endocrine disorders such as diabetes, cardiovascular diseases, and thyroid dysfunction is increasing among women. Therefore, there is a need for **integrated, cost-effective screening strategies** using routinely available parameters [5,10,12].

This study aims to evaluate the effectiveness of a multi-marker model using CBC, BGL, TSH, cholesterol, and blood pressure for comprehensive health assessment.

PICOT CRITERIA

P: Adult women aged 18–60 years attending outpatient or health check-up clinics

I: Assessment of combined biomarkers: Complete Blood Count (CBC), Blood Glucose Level (BGL) , Thyroid Stimulating Hormone (TSH), Total Cholesterol, Blood Pressure

C: Comparison between individuals with **normal vs abnormal parameter values OR** Comparison of **single-marker vs multimarker approach** in health assessment (1,2)

O: Early detection of metabolic, haematological, and endocrine disorders and Identification of risk factors for **diabetes, hypertension, thyroid disorders, and cardiovascular diseases**

T: Cross-sectional (single time-point assessment)

RESEARCH QUESTION

Are combined assessment of CBC, glucose, TSH, cholesterol and blood pressure was therefore proposed as a holistic screening model to assess metabolic, endocrine and cardiovascular disorders among women?

AIM

To evaluate the role of combined haematological, metabolic, and endocrine parameters in assessing women's health.

OBJECTIVES:

- To assess haematological status using CBC parameters.
- To evaluate metabolic status using random blood glucose and total cholesterol.
- To assess thyroid function using TSH.
- To evaluate relationships among haematological, metabolic, and endocrine parameters.
- To compare selected laboratory parameters across age groups.
- To identify statistically significant correlations that may support a multimarker screening approach.

MATERIALS AND METHODS

The new results spreadsheet contained 300 records and included BP category, fertility status, RBS, total cholesterol, TSH and CBC-related parameters. After applying the protocol age range of 18–60 years, 280 records were eligible for analysis. BP categories were summarized descriptively; numerical BP measurements were not available.

The study protocol specified a cross-sectional observational design among adult women aged 18–60 years attending outpatient or health-check-up camp services. The proposal calculated a target sample size of 280; eligible records from total 300 samples.

Study design: Cross-sectional observational study.

Study population and sample: The data were obtained from females visited OBGY clinic for normal check up

camp organized by the tertiary care hospital in awareness of women health within period of 1 week

Study duration:samples obtained during period of health check up camp for women health awareness for one week period by tertiary care hospital

Inclusion Criteria:

- Women aged 18–60 years
- Willing to participate

Exclusion Criteria

- Pregnant women
- Patients with known chronic systemic illnesses under treatment

Data Collection: Blood samples were collected under aseptic conditions and Analysis were performed using standard laboratory methods **Blood pressure measured using a sphygmomanometer.** The laboratory parameters were analyzed using following instrument/technique listed in table.

Sr. No	Parameter	Instrument / Technique
1	**Complete blood count (CBC)**	Beckman **DXH** Five part Principle: Coulter
2	Blood Glucose Level	Cobas c311 Principle: Photometry- Enzymatic
3	TSH	Cobas e411 Principle: electrochemiluminescence immunoassay (ECLIA)- Sandwitch
4	Total Cholesterol	Cobas c311 Principle: Photometry- Enzymatic

Data processing: Laboratory values were enterd in prepared datasheet. The missing values were not included and counted in data sheet for this study. Format of data sheet is provided

Date	Name of patient	Age / gender	BP	Fertility atatus	RBS	TC	TSH	HB	RBC	PCV	MCV	MCHC	RdW	TLC	Neutr	Lympho	Eosi	Baso	platelet

Statistical analysis: Continuous variables were expressed as mean ± standard deviation. Pearson correlation analysis assessed linear relationships among continuous variables. Comparative evaluation across age groups (18–30, 31–45 and 46–60 years) used one-way ANOVA. Frequencies and percentages were used for categorical BP and fertility variables. A p-value <0.05 was considered statistically significant.

RESULTS

Of the 300 records in the spreadsheet, 280 women aged 18–60 years met the study age criterion and were included in the final analysis. The mean age was 33.35 ± 12.04 years, with an age range of 18–60 years.

Parameter	n	Mean ± SD	Range
Age (years)	280	33.35 ± 12.04	18.00–60.00
RBS (mg/dL)	280	95.40 ± 36.22	10.00–399.00
Total cholesterol (mg/dL)	280	160.99 ± 33.66	79.00–285.00
TSH (mIU/L)	252	3.08 ± 6.87	0.01–100.00
Hb (g/dL)	143	13.04 ± 0.82	8.62–15.43
RBC ($\times 10^6/\mu L$)	183	4.35 ± 0.25	3.80–4.80
PCV (%)	152	38.87 ± 2.25	27.10–45.40
MCV (fL)	147	87.50 ± 4.72	80.10–99.60
MCHC (g/dL)	235	32.83 ± 1.03	30.00–35.00
RDW (%)	113	13.75 ± 1.15	12.00–24.20

The mean random blood sugar (RBS) was 95.40 ± 36.22 mg/dL, while mean total cholesterol was 160.99 ± 33.66 mg/dL. Mean TSH was 3.08 ± 6.87 mIU/L and mean haemoglobin was 13.04 ± 0.82 g/dL.

Haematological indices showed a mean RBC count of 4.35 ± 0.25 ×10⁶/µL, PCV of 38.87 ± 2.25%, MCV of 87.50 ± 4.72 fL, MCHC of 32.83 ± 1.03 g/dL and RDW of 13.75 ± 1.15%.

Age group	n	RBS mean ± SD	TC mean ± SD	TSH mean ± SD	Hb mean ± SD
18–30	122	87.62 ± 11.63	145.31 ± 27.19	3.17 ± 9.39	13.05 ± 0.71
31–45	110	98.75 ± 40.52	164.94 ± 30.04	3.13 ± 4.66	12.91 ± 0.95
46–60	48	107.52 ± 57.41	191.81 ± 32.93	2.77 ± 1.46	13.25 ± 0.77

Using descriptive thresholds for contextual interpretation, 1 of 143 available haemoglobin observations (0.7%) were below 12 g/dL. Total cholesterol was ≥200 mg/dL in 34 of 280 observations (12.1%), and RBS was ≥200 mg/dL in 4 of 280 observations (1.4%). These cut-offs are descriptive and should not be interpreted as diagnoses from a single cross-sectional measurement.

Variable 1	Variable 2	n	Pearson r	p-value
Age	RBS	280	0.207	<0.001
Age	TC	280	0.488	<0.001
Age	TSH	252	-0.013	0.8393
Age	HB	143	0.037	0.6572
RBS	TC	280	0.157	0.0084
TC	HB	143	0.076	0.3655
TSH	RBS	252	-0.013	0.8414
TSH	TC	252	0.068	0.2814
TSH	HB	132	0.040	0.6525
HB	PCV	137	0.915	<0.001
HB	RBC	107	0.206	0.0332
HB	MCV	114	0.197	0.0359
HB	RDW	97	-0.123	0.2308
RBC	PCV	113	0.275	0.0033
MCV	MCHC	146	0.169	0.0419
TLC	Platelets	210	0.285	<0.001

Blood-pressure categories were available for the eligible records. 218 (77.9%) were recorded as Normal, 37 (13.2%) as High and 23 (8.2%) as Low; two records were recorded as mixed/unclear. Fertility status was recorded as Fertile in 249 (88.9%) and Infertile in 31 (11.1%). Because numerical systolic and diastolic BP values were not available, BP was not included in correlation or ANOVA analyses.

Pearson correlation analysis demonstrated a significant positive correlation between age and RBS (r=0.207, p<0.001) and between age and total cholesterol (r=0.488, p<0.001). RBS also showed a weak but statistically significant positive correlation with total cholesterol (r=0.157, p=0.0084). Age was not significantly correlated with TSH (r=-0.013, p=0.839) or haemoglobin.

Among haematological parameters, haemoglobin showed a strong positive correlation with PCV (r=0.915, p<0.001). Haemoglobin showed weaker relationships with RBC (r=0.206, p=0.0332) and MCV (r=0.197, p=0.0359). The correlation between haemoglobin and RDW was not statistically significant (r=-0.123, p=0.231). Total cholesterol was not significantly correlated with haemoglobin (r=0.076, p=0.365).

Comparative analysis across age groups (18–30, 31–45 and 46–60 years) showed statistically significant differences in RBS (one-way ANOVA, p=0.0023) and total cholesterol (p<0.001). Mean RBS increased from 87.62 mg/dL in the 18–30-year group to 107.52 mg/dL in the 46–60-year group. Mean total cholesterol increased from 145.31 to 191.81 mg/dL. Differences in TSH (p=0.942) and haemoglobin (p=0.203) across age groups were not statistically significant.

DISCUSSION

The present study evaluated whether routinely available haematological, metabolic and endocrine measurements could provide an integrated profile of women's health. The revised analysis included 280 eligible women aged 18–60 years. The results demonstrate that the markers do not behave as interchangeable measures: age-related variation was evident for glucose and total cholesterol, whereas several CBC indices were strongly interrelated

and TSH showed no significant association with the principal variables. This pattern supports the proposal's rationale for considering multiple complementary markers rather than relying on a single laboratory value [1,2,14].

Age was positively associated with RBS ($r=0.207$, $p<0.001$), and RBS differed significantly across age groups. The older age group had the highest mean RBS. This finding is consistent with the established importance of glucose assessment in identifying metabolic risk [5–7]. The result should nevertheless be interpreted as an age-related association rather than evidence of diabetes, because RBS is influenced by fasting status, recent food intake and other clinical factors, and the study did not use diagnostic confirmation.

Total cholesterol showed a stronger positive association with age ($r=0.488$, $p<0.001$) and significant age-group differences. The observed increase across age groups is compatible with the established role of dyslipidaemia in women's cardiovascular risk assessment [8,9]. The weak positive correlation between RBS and total cholesterol ($r=0.157$, $p=0.0084$) suggests that metabolic abnormalities may coexist, but the low correlation coefficient also demonstrates that glucose and lipid measurements capture different aspects of metabolic health. This supports retaining both measures in an integrated screening panel.

The haematological findings were internally coherent, particularly the strong correlation between haemoglobin and PCV ($r=0.915$, $p<0.001$). This relationship is expected because both parameters reflect red-cell mass and provides internal support for the CBC component of the dataset. The proposal's cited literature also highlights the value of CBC parameters as markers of systemic and inflammatory conditions [3,4]. However, the present study cannot determine the cause of reduced haemoglobin because iron studies, vitamin B12, folate, menstrual history and other clinical information were not available.

Only 1 of 143 available haemoglobin observations (0.7%) were below 12 g/dL. This result should replace earlier dataset-derived estimates and illustrates why the revised spreadsheet should be treated as the definitive analytical source. The low frequency of reduced haemoglobin in this dataset does not exclude anaemia at the population level; it only describes this particular health-check-up sample.

TSH did not show statistically significant relationships with age, RBS, total cholesterol or haemoglobin. This does not imply absence of thyroid dysfunction. Rather, it indicates that within this cross-sectional sample, TSH variation was not linearly related to the selected variables. The proposal's references emphasize that thyroid dysfunction may have metabolic and reproductive consequences [10,11], supporting the inclusion of TSH as a complementary marker even when its correlation with other markers is not significant.

Blood pressure was available as categorical information, with most records classified as Normal and smaller proportions classified as High or Low. Because numerical systolic and diastolic measurements were not available, the study could not quantify the relationship between BP and biochemical parameters. This is an important limitation because BP is a major cardiovascular risk indicator and was an intended component of the multimarker model in the proposal [12,13]. Future datasets should retain actual systolic and diastolic values to allow correlation and multivariable analysis.

The overall pattern has an important implication for the multimarker concept. The findings do not demonstrate that a combined panel is diagnostically superior to individual tests because no reference diagnosis, clinical outcomes, sensitivity, specificity or ROC-AUC analysis was performed. Instead, the study demonstrates the feasibility and complementary nature of routinely available markers: glucose and cholesterol provided information on metabolic risk, CBC provided haematological information, TSH added endocrine assessment, and BP supplied a cardiovascular risk dimension. The value of the approach is therefore best framed as an integrated screening framework requiring prospective validation rather than as a validated diagnostic model.

The findings also support age-stratified preventive health assessment. The significant increase in RBS and total cholesterol with age suggests that periodic metabolic screening may become increasingly relevant in older adult women. However, because the study was cross-sectional and based on a health-check-up population, the results should not be interpreted as causal or generalized to all women without further representative studies.

The proposal anticipated early detection, a holistic screening strategy and cost-effective preventive care [1,2,14]. The present results partially support these anticipated outcomes at the level of risk profiling: the combined dataset identifies measurable relationships and age-related differences across physiological domains. Confirmation of actual early disease detection and cost-effectiveness would require a prospective design with clinical follow-up, standardized BP measurements, diagnostic outcomes and health-economic evaluation.

LIMITATIONS

The cross-sectional design permits identification of associations but does not establish causality or temporal relationships.The sample was obtained during a one-week women's health check-up camp and may not represent the broader community population.Missing observations were excluded , particularly for TSH and CBC variables; no imputation was performed.The study did not include clinical outcomes or formal diagnostic-performance measures; therefore, the multimarker framework cannot be considered a validated diagnostic model.

CONCLUSION

In this cross-sectional sample of 280 women aged 18–60 years, age was significantly associated with RBS and total cholesterol, and both parameters differed significantly across age groups. Strong relationships among CBC indices, particularly haemoglobin and PCV, were also observed, while TSH showed no significant correlation with the selected metabolic or haematological variables. The findings support the feasibility of an integrated laboratory-based approach for broader health-risk profiling, but they do not establish diagnostic superiority or causality. Future prospective studies should include complete BP measurements, standardized clinical variables, diagnostic outcomes and cost-effectiveness assessment to determine the clinical utility of a multimarker screening model.

These findings indicate that the laboratory parameters provide complementary information across different physiological domains. The study therefore supports the feasibility of using a combined laboratory profile for risk-oriented health assessment, while emphasizing that the approach requires prospective clinical validation before it can be described as a diagnostic model.

OUTCOME OF THE STUDY

The primary outcome was the identification of statistically significant relationships and age-related differences among routinely measured haematological, metabolic and endocrine parameters. The study demonstrated significant positive associations of age with RBS and total cholesterol and a significant positive association between RBS and total cholesterol. Among haematological variables, haemoglobin and PCV showed a strong positive relationship. TSH did not demonstrate significant correlations with the selected variables.

Health-system implication: A multimarker framework may be potentially practical and cost-conscious because it uses commonly available investigations; however, a formal cost-effectiveness analysis is required before making this claim.

Research implication: Future studies should prospectively evaluate whether the combined marker profile predicts clinically confirmed diabetes, dyslipidaemia, thyroid dysfunction, anaemia or cardiovascular outcomes and should compare multimarker performance with individual markers using ROC-AUC, sensitivity, specificity and multivariable models.

Laboratory implication: The study demonstrates the usefulness of routinely generated laboratory data for integrated risk profiling and highlights the importance of complete, clinical variables.

Preventive-health implication: The findings support incorporating routine laboratory parameters into women's health-check-up programmes, particularly where screening for multiple non-communicable disease risk domains is feasible.

Clinical implication: A combined review of CBC, glucose, total cholesterol and TSH can provide a broader laboratory profile than assessment of an isolated parameter. Age-related increases in RBS and total cholesterol may help identify women who warrant closer metabolic risk assessment.

Implication of the Study

- Enables early detection of metabolic and endocrine disorders
- Provides a holistic and cost-effective screening model
- Useful in preventive healthcare strategies
- Particularly relevant for populations with rising NCD burden

ETHICAL CONSIDERATIONS: The proposal states that Institutional Ethics Committee approval and written informed consent were to be obtained and participant confidentiality maintained. The verified IEC approval number **DYP/IECBH/2026/78**

FUNDING: No external funding was obtained

CONFLICT OF INTEREST: The authors declare no conflict of interest.

DECLARATION OF ARTIFICIAL INTELLIGENCE IN SCIENTIFIC WRITING

Generative artificial intelligence tools were used to assist with language refinement, organization and formatting of the manuscript. The authors reviewed and verified the scientific content, interpretation and final version and remain fully responsible for the accuracy and integrity of the work. AI was not used to generate figures or to replace statistical or scientific judgment.

AUTHOR CONTRIBUTIONS

Conceptualization and study design: Dr. Pradnya Padalkar, Dr. Shital Naikwade; Dr. Surekha Patil

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Critical revision and final approval: All authors
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