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Patterns of Blood Parameter Abnormalities Across Age, Gender, and Geography in India: Insights from a Large-Scale Study

Durga Prasad Amballa

Hyderabad, India

ABSTRACT

This study analyzes patterns in blood test parameters across various cities in India, stratified by age and gender. Data from a large cohort of individuals undergoing preventive health checkups was examined. High prevalence of abnormalities was noted in lipid profile, blood sugar, vitamin D, and hemoglobin levels across all age groups and cities. Derangement percentages increased with age, but were significant even in younger age groups, indicating early onset of lifestyle-related diseases. Distinct gender differences were observed, with females showing higher anemia prevalence and males showing greater derangement in lipids and sugar. Post-menopausal women displayed sharp increases in metabolic abnormalities. Urban locations showed the highest percentages of abnormalities, likely due to lifestyle factors. The findings highlight the need for proactive health interventions and policy measures to address the growing burden of non-communicable diseases in India.

***Corresponding author**

Durga Prasad Amballa, Hyderabad, India.

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Introduction

Examining patterns in blood test parameters can provide valuable insights into a population's health status and disease burden. Such data, when analyzed by demographic factors like age, gender, and geography, can inform targeted preventive health strategies and health policy decisions.

India is witnessing an epidemiological transition with a rising prevalence of non-communicable diseases (NCDs) like diabetes, cardiovascular disease, and cancers [1]. Urbanization, sedentary lifestyles, and dietary changes are considered major contributing factors to this trend [2]. However, large-scale data on biochemical indicators of NCD risk in India is limited.

This study analyzes blood test results of a large cohort across multiple cities in India. The aim is to identify patterns in the prevalence of abnormalities across different age groups, genders, and locations. The insights from this study can potentially inform preventive health interventions and health system preparedness.

Methodology

Data Collection

The study utilized anonymized data from preventive health checkups conducted by a leading diagnostic laboratory chain in India. The data consisted of results of common blood parameters like lipid profile, blood sugar, liver and kidney function tests, vitamin D, hemoglobin, and others.

The data was pre-stratified by city, age group, and gender. Only adult data (age 20 and above) was included. The 13 cities covered were Bangalore, Chennai, Delhi, Gurgaon, Hyderabad, Kolkata, Mumbai, Pune, Ahmedabad, Indore, Jaipur, Lucknow, and Nagpur.

Data Analysis

The primary outcome analyzed was the percentage of individuals with abnormal or 'deranged' values for each parameter. The reference ranges provided by the laboratory were used to determine abnormality. Descriptive statistics were used to summarize the findings. Heat maps and bar charts were created to visualize patterns across age groups, genders, and cities. Comparative analysis was done to identify groups and regions with the highest burden of abnormalities. No statistical tests were applied as the focus was on observing broad patterns in this exploratory analysis. The large sample size ensured the validity of the percentage estimates.

Results

Derangement Percentages by City

A heat map of derangement percentages revealed a concerning burden of abnormalities across all cities (Figure 1). However, metros like Delhi, Mumbai, Bangalore, and Kolkata showed the highest percentages, often exceeding 50% for parameters like LDL cholesterol, HbA1c, and vitamin D.

Here is a snapshot of the data showing high derangement percentages in major cities:

City ID	Customer City	Test Name	Deranged %
1595	delhi	LDL Cholesterol	62.36%
1595	delhi	Glycated Hemoglobin(HbA1c)	67.66%
1595	delhi	Vitamin D Total-25 Hydroxy	66.48%
1563	mumbai	LDL Cholesterol	82.42%
1563	mumbai	Glycated Hemoglobin(HbA1c)	80.44%
1610	bengaluru	LDL Cholesterol	89.19%
1610	bengaluru	Glycated Hemoglobin(HbA1c)	85.10%
1549	kolkata	LDL Cholesterol	79.78%

Figure 1: Snapshot of The Data Showing High Derangement Percentages in Major Cities

The high percentages of LDL cholesterol and HbA1c abnormalities in these cities can be attributed to urbanized lifestyles characterized by reduced physical activity, high stress levels, and consumption of calorie-dense, processed foods high in saturated fats, trans fats, and added sugars [3,4]. Rapid urbanization in India has led to a nutrition transition, with traditional diets replaced by energy-dense, nutrient-poor diets [5]. Sedentary office jobs, long commutes, and lack of recreational spaces in cities further exacerbate the problem.

The high prevalence of vitamin D deficiency, especially in Delhi, can be explained by lifestyle factors such as reduced outdoor activities, air pollution blocking UV rays, and increased use of sunscreens [6]. Dietary factors like low consumption of vitamin D-rich foods and vegetarianism may also contribute [7].

Patterns Across Age Groups

Bar charts of derangement percentages across age deciles showed a clear trend of increasing abnormalities with advancing age (Figure 2). This was particularly prominent for parameters like blood sugar, blood pressure, and LDL cholesterol, which are key NCD risk factors.

However, a concerning observation was the significant derangement noted in younger age groups of 30-40 years. For instance, in the 30–40-year age group, cities like Delhi and Bangalore showed >50% derangement in LDL cholesterol.

City ID	Customer City	Customer Age Group	Test Name	Deranged %
1595	delhi	30-35	LDL Cholesterol	65.34%
1610	bengaluru	30-35	LDL Cholesterol	89.19%
1595	delhi	30-35	Glycated Hemoglobin(HbA1c)	29.28%

Figure 2: 30–40-year age group, cities like Delhi and Bangalore showed >50% derangement in LDL cholesterol

The high derangement percentages in the young adult population are alarming and suggest early onset of metabolic abnormalities. This could be due to exposure to unhealthy lifestyles from a young age, including calorie-dense diets, sedentary habits, and stress. Studies have noted increasing prevalence of overweight and obesity in young Indians, setting the stage for metabolic disorders [8]. Stressful work environments and poor work-life balance in competitive urban settings may also contribute to early development of lifestyle-related health issues [9].

Gender Differences

Distinct patterns emerged in the analysis by gender. Females had notably higher percentages of anemia compared to males across all age groups, possibly due to nutritional factors and menstrual iron loss (Figure 3).

City ID	Customer City	Customer Gender	Test Name	Deranged %
1595	delhi	Female	Hemoglobin Hb	43.57%
1595	delhi	Male	Hemoglobin Hb	31.89%

Figure 3: Females had notably higher percentages of anemia compared to males across all age groups, possibly due to nutritional factors and menstrual iron loss

The higher prevalence of anemia in women can be attributed to multiple biological and social factors. Menstrual blood loss is a significant contributor, exacerbated by early marriage, frequent pregnancies, and inadequate spacing between births in many parts of India [10]. Nutritional factors also play a role, with studies indicating lower dietary iron intake in women compared to men [11]. Gender disparities in food allocation within households and dietary taboos further compound the problem [12].

On the other hand, males showed higher derangements in lipid profile and blood sugar levels compared to females of the same age group until the age of 50 years. Beyond 50 years, females displayed a sharper rise in these abnormalities, surpassing males. This is likely explained by hormonal changes in post-menopausal women.

City ID	Customer City	Customer Gender	Customer Age Group	Test Name
1595	delhi	Male	30-35	LDL Cholesterol
1595	delhi	Female	30-35	LDL Cholesterol
1595	delhi	Male	50-60	Glycated Hemoglobin(HbA1c)
1595	delhi	Female	50-60	Glycated Hemoglobin(HbA1c)

Figure 4: Males showed higher derangements in lipid profile and blood sugar levels compared to females of the same age group until the age of 50 years

The gender differences in lipid and sugar abnormalities can be explained by a combination of biological and lifestyle factors. Estrogen is known to have a protective effect on lipid metabolism and insulin sensitivity in premenopausal women [13]. This may account for the lower prevalence of abnormalities in younger women compared to men. However, post-menopausal decline in estrogen levels is associated with adverse changes in lipid profile and increased insulin resistance, which may explain the sharp rise in abnormalities in older women [14].

Lifestyle factors may also contribute to the observed gender differences. In many Indian households, women are responsible for cooking and may thus have greater control over their dietary intake. On the other hand, men tend to eat out more often, which may lead to higher consumption of high-calorie, unhealthy foods [15]. Stress levels and coping mechanisms also differ by gender, with studies suggesting that Indian men are more likely to smoke and consume alcohol to cope with stress, which can adversely impact metabolic health [16].

Other Notable Findings

Vitamin D deficiency was prevalent across all cities and age groups. Younger individuals showed significant prevalence of liver enzyme derangement, particularly in males. Creatinine abnormalities, an indicator of kidney function, increased with age as expected.

Discussion

This analysis uncovers a high burden of NCD risk factors across urban India. The patterns suggest a complex interplay of age, gender, and urbanization in driving these abnormalities.

The high prevalence of lipid and sugar abnormalities in cities is likely a result of urban lifestyle factors like sedentary habits, stress, and diets high in processed foods [3]. Air pollution and reduced sunlight exposure in cities may explain the widespread vitamin D deficiency [4]. The sharp gender differences observed align with known biological and sociocultural factors. Higher anemia prevalence in women is a well-documented issue in India [5]. The rise of metabolic abnormalities in post-menopausal women highlights the need for intensified screening and prevention efforts in that demographic.

The most concerning insight is the high percentage of abnormalities in younger ages, indicating a premature onset of NCD risk. This could have far-reaching implications for India's disease burden and healthcare costs. Proactive interventions are crucial to prevent the development of overt NCDs.

This study has some limitations. The data is not fully representative of the Indian population as it includes only those accessing preventive health checkups. Socioeconomic characteristics, which are known to influence NCD risk, were not factored.

Despite these limitations, the large sample size and geographic spread make these findings relevant for public health discourse. Future studies should build upon this by adding more variables and conducting granular statistical analysis.

Conclusion

The high prevalence of abnormalities in key NCD risk factors across urban India is a clarion call for action. The patterns uncovered in this analysis demand a multi-pronged response.

At an individual level, there is an urgent need for health education to promote healthier lifestyles from a young age. At the health system level, screening and preventive care must be ramped up, particularly in the 30–50-year age group. At the policy level, interventions like healthier urban design, better food labeling, stricter air quality control, and promotion of physical activity are essential.

Insights from large scale studies like this should inform India's NCD control strategy. A data-driven and demographically nuanced approach to NCD prevention and management is vital to avert a looming public health crisis. India must leverage its demographic dividend by investing in the cardiometabolic health of its young population. The health and productivity of India's present and future generations depend on decisive action informed by robust data.

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