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A Study Of Iron Profile Test Reports And Prevalence Of Iron Deficiency Anaemia

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ABSTRACT

Iron deficiency anemia (IDA) remains one of the most widespread nutritional disorders globally, disproportionately affecting women and individuals in low- and middle-income countries. This retrospective cross-sectional study analyzed 52 iron profile reports from Washim City, Maharashtra, India, to determine the prevalence, severity, and demographic patterns of IDA. Iron profile parameters such as serum iron, ferritin, total iron-binding capacity (TIBC), transferrin saturation, and unsaturated iron-binding capacity (UIBC) were evaluated to assess iron metabolism and its correlation with anemia. Results indicated that over 80% of the population exhibited some degree of anemia, with mild cases being the most common. Women, particularly of reproductive age, were significantly more affected than men, and the age group 31–40 years showed the highest representation. Low serum iron, high UIBC, and low transferrin saturation were strongly associated with anemia severity. The findings underscore the urgent need for targeted public health interventions, including routine screening, nutritional education, and iron supplementation programs, to combat the growing burden of IDA and improve overall community health outcomes.

KEYWORDS

Iron deficiency anemia, Serum iron, Ferritin, Transferrin saturation, Total iron-binding capacity, Unsaturated iron-binding capacity, Nutritional deficiency, Public health, Gender disparity, Anemia prevalence, Iron metabolism, Retrospective study, Hemoglobin levels, India, Washim City.

INTRODUCTION

Iron deficiency anemia is a common type of anemia that occurs when the body lacks enough iron to produce adequate levels of hemoglobin, a protein in red blood cells responsible for transporting oxygen throughout the body. As one of the most widespread nutritional disorders globally, iron deficiency anemia affects individuals of all ages, genders, and socioeconomic backgrounds, with particularly high prevalence among women of reproductive age, young children, and individuals in developing countries. This condition can lead to a range of symptoms that impact daily functioning, such as fatigue, weakness, shortness of breath, and reduced cognitive and physical performance. Iron is an essential mineral that plays a vital role in various physiological processes. Most of the body's iron is found in hemoglobin, but it is also stored in the liver, spleen, and bone marrow, and is used in other proteins such as myoglobin and enzymes. The body obtains iron from dietary sources, primarily in two forms: heme iron, which is derived from animal products and is more easily absorbed, and non-heme iron, found in plant-based foods. A deficiency can result from several causes, including insufficient dietary intake, poor absorption, increased iron demands during growth or pregnancy, or chronic blood loss due to menstruation, gastrointestinal conditions, or internal bleeding.[1,2]

Pathophysiology

Iron plays a critical role in various physiological functions, notably in the formation of hemoglobin, myoglobin, and certain enzymes. The body acquires iron through dietary intake, primarily from heme sources (animal-based) and non-heme sources (plant-based).factors such as inadequate dietary intake, impaired absorption, increased physiological demands (e.g., pregnancy, growth periods), and chronic blood loss (e.g., menstruation, gastrointestinal bleeding) can lead to iron deficiency.[3,18]The development of iron deficiency anemia typically occurs in stages. Initially, the body uses up its stored iron (iron depletion), followed by a decrease in the production of red blood cells (iron-deficient erythropoiesis), and ultimately a reduction in hemoglobin levels leading to anemia. During this progression, symptoms may gradually appear and worsen if left untreated. These may include pallor, brittle nails, dizziness, cold hands and feet, and in severe cases, chest pain or heart palpitations. In children, iron deficiency can also impair growth, learning, and behavior.[1,15]

Table No.1: Causes of Iron Deficiency Anemia

Causes	
• Inadequate Iron Intake • Poor Iron Absorption • Increased Iron Requirements • Chronic Blood Loss • Poor diet • Vegetarian/vegan diet • Infants on cow's milk-heavy diets	• Frequent blood donation • Pregnancy • Breastfeeding • Rapid growth • Intense physical activity • Celiac disease • Inflammatory bowel disease

Diagnosis

Diagnosis of iron deficiency anemia involves a combination of clinical evaluation and laboratory tests. A complete blood count (CBC) often reveals low hemoglobin and hematocrit levels, along with smaller and paler red blood cells (microcytic, hypochromic anemia). Further tests, such as serum ferritin, serum iron, total iron-binding capacity (TIBC), and transferrin saturation, help confirm the diagnosis and assess the severity of the deficiency.[18]

Management

The primary treatment for iron deficiency anemia is iron supplementation. Oral iron preparations, such as ferrous sulfate, are commonly prescribed and are effective in most cases. In situations where oral iron is not tolerated or insufficient, intravenous iron therapy may be necessary. Additionally, dietary modifications to include iron-rich foodssuch as red meat, leafy greens, legumes, and fortified cereals along with vitamin C to enhance absorption, play a crucial role in both treatment and prevention.[5]

Prevention

- Balanced diet with adequate iron intake
- Iron supplements during pregnancy or menstruation if needed
- Fortified foods in populations at risk

Stages of Iron Deficiency

1. Iron Depletion – Low iron stores (low ferritin)
2. Iron-Deficient Erythropoiesis – Decreased iron for red blood cell production
3. Iron Deficiency Anemia – Low hemoglobin and microcytic, hypochromic red blood cells

Symptoms

- Fatigue and weakness
- Pale skin (pallor)
- Shortness of breath
- Dizziness or light-headedness
- Cold hands and feet
- Headaches

Risk Factors

1. Women of childbearing age
2. Infants and young children
3. Adolescents (especially girls)
4. Pregnant women
5. People with chronic illness

Parameter to be analyze during iron deficiency anaemia

Iron Saturation

It refers to the percentage of transferrin, a blood protein that is bound with iron. It is an important parameter used to assess iron metabolism and is commonly evaluated in iron studies along with serum iron, total iron-binding capacity (TIBC), and ferritin levels. Transferrin is responsible for transporting iron throughout the body.[6]

and iron saturation is calculated using the formula

$$\text{Transferrin Saturation (\%)} = \frac{\text{(Total Iron-Binding Capacity (TIBC)(µg/dL)}_{x\ 100}}{\text{Serum Iron (µg/dL)}}$$

Table No.2: Effects of Iron Saturation

Effects of Iron Saturation		
Low Iron Saturation	High Iron Saturation	Normal Iron Saturation
• Indicates iron deficiency • Can lead to iron deficiency anemia • Causes fatigue, weakness, and pallor • Reduced oxygen-carrying capacity of red blood cells • Higher risk of developing cognitive and immune system issues • Increased transferrin levels as the body tries to capture more iron	• Suggests iron overload (e.g., hemochromatosis) • Can lead to organ damage (especially liver, heart, and pancreas) • May increase the risk of chronic diseases due to iron-induced oxidative stress • Associated with excess iron accumulation in tissues • Can cause joint pain, fatigue, and liver dysfunction	• Reflects a healthy balance of iron in the body • Supports proper red blood cell production • Ensures optimal oxygen transport and energy production • Indicates normal iron storage and utilization • Indicates a well-functioning immune system and metabolic processes

Serum Iron

Serum iron refers to the amount of iron present in the liquid portion of the blood and is an important marker used to assess the body's iron status. It represents the iron that is bound to transferrin, a transport protein that carries iron through the bloodstream to various tissues, including the bone marrow where it is used for red blood cell production. Measuring serum iron helps in diagnosing and monitoring conditions related to iron deficiency or overload. Normal serum iron levels typically range from 60 to 170 micrograms per deciliter (µg/dL), but this can vary based on age, sex, and laboratory standards. Low serum iron levels may indicate iron deficiency anemia, chronic disease, or poor dietary intake, while elevated levels may be associated with iron overload disorders such as hemochromatosis or excessive iron supplementation. However, serum iron levels can fluctuate throughout the day and be affected by recent meals or infections, so it is often evaluated alongside other tests like total iron-binding capacity (TIBC), transferrin saturation, and ferritin to provide a more complete picture of iron metabolism.[10]

Table No.3: Effects of Serum Iron

Effects of Serum Iron	
Low Serum Iron (Hypoferremia)	High Serum Iron (Hyperferremia)
• Fatigue and weakness • Pallor (pale skin) • Shortness of breath • Dizziness and headaches • Brittle nails and hair loss • Cold hands and feet • Increased heart rate • Weakened immune system • Iron deficiency anemia • Restless legs syndrome	• Organ damage • Increased risk of oxidative stress • Joint pain and inflammation • Fatigue and weakness • Skin discoloration • Liver dysfunction • Increased risk of diabetes • Heart problems • Weakened immune function • Risk of developing hemochromatosis

Ferritin

Ferritin is a blood protein that serves as the primary storage form of iron in the body, making it a crucial indicator of the body's iron reserves. It stores iron in a safe and readily available form, mainly in the liver, spleen, and bone marrow, and releases it when the body needs it for processes such as red blood cell production, energy metabolism, and immune function. Measuring ferritin levels through a blood test helps assess whether the body has adequate, deficient, or excessive iron. Low ferritin levels are one of the earliest signs of iron deficiency, even before anemia develops, while high levels may indicate iron overload disorders such as hemochromatosis, chronic inflammation, liver disease, or infections, since ferritin also acts as an acute-phase reactant. Normal ferritin ranges vary by age and sex but generally fall between 20 to 500 nanograms per milliliter (ng/mL), with levels below 30 ng/mL often considered deficient. Because it reflects long-term iron status, ferritin is a more stable and reliable marker than serum iron, making it essential in diagnosing and monitoring various health conditions related to iron metabolism.[10]

Table No.4: Effects of Ferritin

Effects of Ferritin	
Low Ferritin Levels	**High Ferritin Levels**
• Indicates low iron stores • Suggests iron deficiency, even before anemia develops • Causes fatigue and weakness • Leads to poor concentration • May result in hair loss • Can cause brittle nails • Increases risk of iron deficiency anemia • May cause restless legs syndrome	• Iron overload • Liver damage • Inflammation marker • Joint pain • Fatigue • Increased risk of diabetes • Oxidative stress • Possible indicator of infection or cancer • Heart problems

Transferrin

Transferrin is a glycoprotein produced primarily by the liver that plays a crucial role in iron metabolism by binding and transporting iron throughout the bloodstream to various tissues, including the bone marrow for red blood cell production. Each transferrin molecule can bind up to two iron ions, and the iron-bound form is referred to as holotransferrin, while the unbound form is apotransferrin. Since free iron is highly reactive and potentially toxic, transferrin ensures that iron remains in a safe, bio available form during circulation. Transferrin levels are often measured in blood tests as part of an iron panel, especially to calculate transferrin saturation, which reflects how much of the transferrin is carrying iron. In conditions of iron deficiency, transferrin levels typically increase as the body tries to maximize iron transport. Conversely, in chronic diseases or iron overload conditions, transferrin levels may be low or normal. Abnormal transferrin levels can help diagnose iron deficiency anemia, iron overload disorders, malnutrition, or chronic illnesses. Thus, transferrin is vital for maintaining proper iron homeostasis and ensuring that cells receive the iron they need without exposing the body to iron toxicity.[10]

Table No.5: Effects of Transferrin Levels

Effects of Transferrin Levels	
Low Transferrin	**High Transferrin**
• Reduced iron transport in blood • Decreased iron delivery to tissues • Can lead to anemia • May indicate liver dysfunction • Often seen in chronic diseases or inflammation • Associated with protein malnutrition • May cause fatigue and weakness • Low iron-binding capacity in blood • Risk of iron buildup in tissues	• Indicates iron deficiency • Increased iron-binding capacity • Body trying to capture more iron • Common in early-stage anemia • May lead to fatigue and weakness • Suggests low iron stores • Can affect red blood cell production • Often seen in pregnancy or blood loss

Total Iron-Binding Capacity (TIBC)

Total Iron-Binding Capacity (TIBC) is a blood test that measures the maximum amount of iron that can be bound by proteins in the blood, primarily transferrin, which is the main iron-transport protein. TIBC reflects the body's capacity to transport iron and is an indirect measure of transferrin levels. When iron levels are low, the liver increases transferrin production, causing TIBC to rise in an effort to capture and transport more iron. Conversely, when iron levels are high, transferrin production decreases, leading to a lower TIBC. Therefore, TIBC is a useful diagnostic tool in assessing iron status, helping distinguish between different types of anemia. A high TIBC typically indicates iron deficiency anemia, whereas a low TIBC may be seen in chronic inflammatory diseases, liver disorders, or conditions of iron overload like hemochromatosis. TIBC is often measured alongside serum iron and transferrin saturation to provide a comprehensive view of how iron is managed in the body.[10]

Table No.6: Effects of TIBC Levels

Effects of TIBC Levels	
Low Transferrin	**High Transferrin**
• Indicates iron overload • Seen in chronic diseases or inflammation • May suggest liver dysfunction • Reduced transferrin production • Risk of iron accumulation in tissues	• Indicates iron deficiency • Increased transferrin availability • Body trying to bind and transport more iron • Often seen in blood loss or poor iron intake • Can lead to iron deficiency anemia

UIBC (Unsaturated Iron-Binding Capacity)

UIBC is a blood test that measures the reserve capacity of transferrinthe portion that is not yet bound to iron. It reflects how much more iron transferrin in the blood can still carry. UIBC is part of the broader iron panel and is used alongside tests like TIBC (Total Iron-Binding Capacity) and serum iron to evaluate a person's iron status. Essentially, UIBC helps estimate the amount of available binding sites for iron in the bloodstream. It is calculated by subtracting serum iron from TIBC (UIBC = TIBC − Serum Iron). A high UIBC usually indicates iron deficiency, as more transferrin is free and not occupied by iron. In contrast, a low UIBC may suggest iron overload, where most of the binding sites are already saturated with iron. UIBC plays a key role in identifying conditions such as iron deficiency anemia, hemochromatosis, and chronic diseases that affect iron metabolism. It is a valuable tool for assessing how the body handles iron and for guiding appropriate treatment strategies.[10]

Table No.7: Effects of TIBC Levels

Effects of TIBC Levels	
Low Transferrin	**High Transferrin**
• Indicates iron overload • Suggests reduced transferrin capacity • Seen in chronic inflammation or liver disease • May reflect iron saturation is high • Risk of iron toxicity and organ damage	• Indicates iron deficiency • Reflects increased transferrin capacity • Body is trying to bind more iron • Seen in anemia or blood loss • May lead to fatigue and low oxygen transport

Roles of Determination of Various Factors

Table No.8: Roles of Determination of Various Factors

Sr. No.	Factor	Roles
1	Iron Saturation	• Regulates iron transport via transferrin • Indicates iron availability in the body • Helps diagnose iron deficiency and overload • Supports red blood cell production • Prevents free iron toxicity • Balances absorption and storage • Reflects dietary iron use • Supports immunity • Boosts energy production • Aids brain function • Monitors iron therapy • Tracks chronic disease impact
2	Serum Iron	• Transports oxygen via hemoglobin • Supports red blood cell production • Aids energy production in cells • Involved in DNA synthesis • Supports muscle function (myoglobin) • Helps immune system function • Assists brain and nerve function • Indicator of iron status in the body • Monitors iron therapy and nutritional status
3	Ferritin	• Stores iron safely in cells • Releases iron when needed • Prevents iron toxicity • Maintains iron balance • Reflects total body iron stores • Helps in red blood cell production • Acts as an antioxidant (limits free radical damage) • Indicator for diagnosing iron disorders • Responds to inflammation (also an acute-phase protein)
4	Transferrin	• Binds and transports iron in the blood • Delivers iron to cells (especially bone marrow) • Regulates iron absorption from the gut • Maintains iron balance in the body • Prevents free iron toxicity • Helps in diagnosing iron deficiency or overload • Responds to body's iron needs (levels rise in deficiency) • Supports red blood cell production indirectly
5	TIBC	• Measures blood's capacity to bind iron with transferrin • Indicates transferrin availability

		• Helps assess iron status in the body • Increases in iron deficiency • Decreases in iron overload or chronic disease • Aids in diagnosing anemia types • Reflects body's demand for iron • Supports evaluation of iron metabolism disorders
6	UIBC	• Measures unused iron-binding sites on transferrin • Helps calculate total iron-binding capacity (TIBC) • Assists in assessing iron status • Increases in iron deficiency • Decreases in iron overload • Indicates body's potential to bind more iron • Supports diagnosis of anemia and iron disorders • Complements serum iron and transferrin tests

Age

Table No.9: Effect of Age on Iron Deficiency Anemia

Effect of Age on Iron Deficiency Anemia		
In Children	**In Adults**	**In Elderly**
• Delayed growth and development • Poor cognitive performance • Behavioral issues • Increased susceptibility to infections	• Fatigue and reduced work capacity • Impaired concentration and memory • Cold intolerance • Decreased immune function	• Greater risk of chronic diseases worsening • Increased risk of falls and frailty • Confusion or cognitive decline • Worsening of existing heart conditions • Slower recovery from illness

Gender

Table No.10: Effect of Gender

Effect of Gender	
Male	**Female**
• Generally lower risk due to no menstrual blood loss • Iron deficiency in men is often related to poor diet, blood loss (e.g., ulcers), or chronic disease • Older men may face increased risk due to gastric bleeding or chronic health conditions • Young males have lower risk unless there is significant blood loss or poor nutrition	• Higher risk due to menstrual blood loss • Increased iron demand during pregnancy • Pregnant women need significantly more iron to support fetal growth • Teenage girls may experience iron deficiency due to rapid growth and menstruation • Risk of iron deficiency anemia increases with heavy menstrual cycles

Table No.11: Gender-Based Iron Deficiency Risks and Solutions

Summary: Gender-Based Iron Deficiency Risks and Solutions

Gender	Risk Factors	Key Solutions
Female	Menstruation, pregnancy, childbirth, poor diet	Iron supplements, treat heavy periods, balanced diet, prenatal care
Male	Occult GI bleeding, poor diet, intense exercise	GI screening, dietary education, supplement if needed

METHODOLOGY

1. **Study Design**

This was a retrospective cross-sectional observational studyconducted to assess the prevalence of iron deficiency in Washim City. The study analyzed previously recorded biochemical parameters from iron profile reports obtained from diagnostic laboratories and hospitals. No direct patient interaction or intervention was involved.

2. **Study Area and Duration**

The study was carried out in Washim City, Maharashtra, India. Data were retrospectively collected from multiple local diagnostic centers and hospitals over a three-month period (January 2025 to March 2025)**,** covering reports generated during that time.

3. **Study Population**

The study population consisted of patients who had undergone iron profile testing as part of their clinical evaluation. A total of 52 iron profile reports meeting eligibility criteria were included in the final analysis.

4. Inclusion Criteria

- Reports from individuals of any age and gender.
- Reports must include acomplete iron profile, specifically:
- Serum Iron (µg/dL)
- Unsaturated Iron Binding Capacity (UIBC) (µg/dL)

5. Exclusion Criteria

- Incomplete reports missing any required parameter.
- Reports of patients currently on iron supplementation or treatment.
- Reports from patients with known chronic illnesses affecting iron metabolism, including:
- Chronic kidney disease
- Liver cirrhosis
- Malignancies
- Chronic inflammatory conditions (e.g., rheumatoid arthritis)
- Pediatric reports for children under 1 year (due to differing reference ranges).

6.Data Collection Procedure

Data were manually retrieved from archived laboratory records with permission from laboratory authorities. Each report was anonymized and assigned a unique study code to ensure confidentiality. The following data were extracted from each report and entered into a structured Microsoft Excel sheet:

- Serum Iron (µg/dL)
- UIBC (µg/dL)
- Total Iron Binding Capacity (TIBC) – calculated
- Transferrin Saturation (%) – calculated
- Serum Ferritin (ng/mL)

7.Criteria for Iron Deficiency

Iron deficiency was defined based on clinical diagnostic criteria, with classification made when **two or more** of the following parameters were below established reference thresholds:

- Low Serum Iron
- High UIBC
- Low Transferrin Saturation
- Low Serum Ferritin

8.Data Management and Statistical Analysis

Data were cleaned, validated, and analyzed using Microsoft Excel 365 Statistical methods included:

- Descriptive statistics: Mean, median, standard deviation (for continuous variables); frequencies and percentages (for categorical variables).
- Prevalence estimation: Percentage of reports meeting iron deficiency criteria.
- Subgroup analysis (if age and gender data were available): Distribution across gender and age groups.
- Visualization**:** Bar charts, pie charts, and histograms for visual representation.

9. Ethical Considerations

- The study was approved by the Institutional Ethics Committee.
- As this was a retrospective study using anonymized data**,** informed consent was not required**.**
- Patient confidentiality and data privacy were strictly maintained throughout the study.

RESULT& DISCUSSION

Result

Table No.12: Result

Variables	Unit	Min	Max	Mean	Standard Deviation
Iron (µg/Dl)	µg/Dl	12.00	4108.00	297.88	952.56
TIBC (µg/Dl)	µg/Dl	200.00	464.00	303.44	54.33
Transferrin Saturation (%)	%	5.20	46.00	24.01	13.29
Ferritin (µg/L)	µg/L	20.00	1000.00	273.88	289.64
UIBC (µg/Dl)	µg/Dl	50.00	280.00	179.27	71.81
Age (Years)	Years	19.00	85.00	46.25	15.42

The descriptive analysis of clinical and demographic parameters provides key insights into the characteristics of the study population and the variability of important iron-related biomarkers. Serum Iron levels varied widely, ranging from 12.0 to 4108.0 µg/dL, with a high mean of 297.88 µg/dL and a standard deviation of 952.56, indicating the presence of extreme outliers or a highly heterogeneous sample. This large spread suggests that while some individuals may be iron deficient, others might have abnormally elevated iron levels possibly due to clinical conditions like iron overload or data recording anomalies.

The Total Iron Binding Capacity (TIBC), which reflects the blood's capacity to bind iron with transferrin, ranged from 200.0 to 464.0 µg/dL, with a mean of 303.44 µg/dL and a standard deviation of 54.33. These values fall within the expected physiological range and show moderate variability, supporting its reliability as an indicator for assessing iron metabolism.

Transferrin Saturation, a derived parameter representing the proportion of transferrin saturated with iron, had a mean of 24.01%, ranging between 5.2% and 46.0%, and a standard deviation of 13.29. A mean value at the lower end of the normal range suggests that a significant portion of the population may have suboptimal iron availability, consistent with possible iron deficiency anemia.

Ferritin, the intracellular protein that stores iron, displayed values from 20.0 to 1000.0 µg/L, with a mean of 273.88 µg/L and a standard deviation of 289.64, reflecting high interindividual variability. While elevated ferritin may indicate adequate or excess iron stores, it can also rise in inflammatory conditions, making it important to interpret in clinical context.

Unsaturated Iron Binding Capacity (UIBC), another marker of transferrin capacity, ranged from 50.0 to 280.0 µg/dL, with a mean of 179.27 µg/dL and standard deviation of 71.81, indicating considerable variability in the iron transport system among individuals.

Lastly, the Age of participants spanned 19 to 85 years, with a mean age of 46.25 years and standard deviation of 15.42, showing a mature adult population with balanced representation from young to older adults.

GENDER

Table No.13: Gender

Test Parameter	Reference Range (Male)	Reference Range (Female)	Interpretation Notes
Serum Iron	65 – 175 µg/dL	50 – 170 µg/dL	↓ in iron deficiency anemia; ↑ in hemochromatosis or hemolysis
TIBC (Total Iron Binding Capacity)	250 – 450 µg/dL	250 – 450 µg/dL	↑ in iron deficiency; ↓ in anemia of chronic disease
UIBC (Unsaturated Iron Binding Capacity)	Calculated (TIBC – Serum Iron)	Calculated (TIBC – Serum Iron)	↑ in iron deficiency; ↓ in iron overload
Transferrin Saturation (%)	20 – 50%	20 – 50%	<15–20% = Iron deficiency; >50% = Iron overload
Ferritin	21 – 300 ng/mL (µg/L)	15 – 200 ng/mL (µg/L)	↓ in iron deficiency; ↑ in inflammation, iron overload (Acute Phase Reactant)
Transferrin (g/L or mg/dL)	176 – 280 mg/dL	176 – 280 mg/dL	↑ in iron deficiency; ↓ in chronic disease or malnutrition

The table above presents a gender-specific interpretation of key iron study parameters commonly used in diagnosing and monitoring iron-related conditions. These tests include serum iron, TIBC (Total Iron Binding Capacity), UIBC (Unsaturated Iron Binding Capacity), transferrin saturation, ferritin, and transferrin levels. Although reference ranges are generally similar for both males and females, slight physiological differences exist—especially due to menstrual blood loss, pregnancy, and hormonal influences in women.

Serum iron measures the amount of circulating iron in the blood and tends to be lower in females. A low value typically indicates iron deficiency, while elevated levels may suggest iron overload or conditions like hemolysis. TIBC reflects the blood's capacity to transport iron, increasing in cases of iron deficiency and decreasing during chronic illnesses. UIBC, derived by subtracting serum iron from TIBC, is also elevated in iron deficiency and reduced when the body is overloaded with iron.

Transferrin saturation, the percentage of iron bound to transferrin, is a crucial marker: values below 20% often point to deficiency, while levels exceeding 50% suggest iron overload. Ferritin, the body's main iron storage protein, helps evaluate long-term iron status. It drops in true deficiency and rises with inflammation or iron overload, acting as an acute-phase reactant. Transferrin levels themselves rise in iron deficiency and decline in chronic disease or poor nutritional states.

Understanding these variations and reference ranges enables accurate diagnosis of iron-related disorders, especially when combined with patient history and clinical symptoms.

Age Distribution

Table No.13: Age distribution

Age Group	Percentage
0–18	0.0%
19–30	13.5%
31–40	34.6%
41–50	15.4%
51–60	17.3%
61–70	13.5%
71+	5.8%

The table above presents the age distribution among patients based on a pie chart analysis. The majority of patients fall within the 31–40 age group, accounting for 34.6% of the total. This is followed by the 51–60 age groups at 17.3% and the 41–50 groups at 15.4%. The 19–30 and 61–70 age groups are equally represented each comprising 13.5% of the patient population. The 71+ age group makes up a smaller portion at 5.8%, while no patients were reported in the 0–18 age group (0.0%). This distribution indicates that most patients are middle-aged adults, with minimal representation from younger and older age brackets.

Anemia Distribution on Basis of Severity

Table No.14: Anemia Distribution on Basis of Severity

Severity Level	Percentage
Mild	44.2%
Moderate	17.3%
Normal	15.4%
Severe	23.1%

The anemia severity distribution among the patient population is illustrated in the accompanying pie chart and summarized in the table. The analysis reveals that **mild anemia** is the most common condition, affecting **44.2%** of patients. This suggests that nearly half of the patient cohort experiences a low but clinically relevant reduction in hemoglobin levels, which may be attributed to factors such as nutritional deficiencies, chronic disease, or early-stage anemia.**Severe anemia** accounts for **23.1%** of cases, representing a considerable portion of the population with significantly reduced hemoglobin levels. This group may require urgent medical attention and further investigation into underlying causes such as gastrointestinal bleeding, hemolysis, or bone marrow suppression.**Moderate anemia** is present in **17.3%** of the patients. This intermediate stage may still lead to symptoms like fatigue and shortness of breath, and often necessitates medical intervention, dietary changes, or iron supplementation depending on the cause.Interestingly, only **15.4%** of patients fall into the **normal** category, indicating adequate hemoglobin levels and no clinical anemia. This small percentage highlights a concerning trend in which the majority of the studied population exhibits some degree of anemia.

Anemia Severity in Male

Table No.15: Anemia Severity In Male

Severity Level	Percentage
Mild	35.0%
Moderate	25.0%
Normal	25.0%
Severe	15.0%

The chart and corresponding table illustrate the distribution of anemia severity among male patients. The findings show that **mild anemia** is the most prevalent condition, affecting **35.0%**of the male population. This suggests that over one-third of the male patients have a slight reduction in hemoglobin levels, which, while not immediately critical, may indicate early signs of iron deficiency or other underlying health conditions requiring attention.

Moderate anemia and **normal hemoglobin levels** are equally represented, each accounting for **25.0%** of the male population. The moderate category implies a more significant reduction in red blood cell concentration, which may manifest in clinical symptoms such as fatigue, pallor, and reduced physical performance. This group may benefit from diagnostic evaluation to determine the cause and initiate appropriate interventions. On the other hand, the 25.0% with normal hemoglobin levels reflect a portion of the population not currently affected by anemia.**Severe anemia**, though the least common among the severity levels, still affects **15.0%** of male patients. This indicates a serious health concern, as severe anemia is often associated with substantial clinical symptoms and may point to chronic diseases, acute blood loss, or bone marrow disorders. These individuals likely require immediate medical management and further diagnostic investigation.

Overall, the data indicates that **75.0%** of male patients suffer from some degree of anemia, with mild and moderate forms being most common. The relatively low percentage of normal hemoglobin levels emphasizes the importance of regular screening and proactive healthcare measures among the male population to detect and address anemia early in its course.

Anemia Severity in Female

Table No.16: Anemia Severity in Female

Severity Level	Percentage
Mild	50.0%
Severe	28.1%
Moderate	12.5%
Normal	9.4%

The chart and accompanying table provide a breakdown of anemia severity among female patients. The data reveals a concerning trend, with **50.0%** of the female population experiencing **mild anemia**, making it the most prevalent category. This suggests that half of the females have hemoglobin levels slightly below normal. While mild anemia may not present severe symptoms initially, it can significantly impact energy levels, productivity, and quality of life if left unaddressed. It often results from nutritional

deficiencies, particularly iron, which is common among women due to menstruation, pregnancy, or dietary factors.

A notable **28.1%** of the female population is affected by **severe anemia**, representing a significant public health concern. Severe anemia typically indicates a substantial reduction in red blood cell or hemoglobin levels and is associated with serious symptoms such as dizziness, fatigue, shortness of breath, and increased cardiac workload. This group is at a higher risk for complications and may require immediate medical intervention, including detailed diagnostic workups and possibly hospitalization.

Moderate anemia affects **12.5%** of the female population. This level of anemia may still be symptomatic and can interfere with daily activities. It often necessitates medical evaluation and management, including dietary modification, iron supplementation, or treatment of underlying causes such as chronic disease or menstrual disorders.Only **9.4%** of female patients are found to have **normal hemoglobin levels**, which is the lowest proportion among the severity categories. This underscores the high burden of anemia in the female population, with over **90%** of individuals displaying some degree of anemia.

Overall, the data highlights a pressing need for increased awareness, routine screening, and preventive healthcare measures targeted at women. Public health interventions such as nutrition education, iron supplementation programs, and reproductive health services may play a crucial role in reducing the prevalence and severity of anemia in this demographic.

Iron Distribution

Table No.17: Iron Distribution

Iron (µg/dL)	Mild Anemia (n)	Mild (%)	Moderate Anemia (n)	Moderate (%)	Normal (n)	Normal (%)
35–160	11	21.2%	4	7.7%	19	36.5%
<35	4	7.7%	4	7.7%	7	13.5%
>160	1	1.9%	0	0.0%	2	3.8%

For iron levels**,** patients withsevere anemia (Hb< 7 g/dL)primarily had very low iron, with all falling into the <35 µg/dLcategory. Immoderateanemia (Hb 7–10 g/dL)**,** the majority (9 patients) also had iron levels below 35 µg/dL, while only one fell into the normal range (35–160 µg/dL), confirming iron deficiency as a likely cause. In mild anemia (Hb 10–12 g/dL)**,** most individuals had iron in the 35–160 µg/dLrange, though a few still showed deficient levels (<35 µg/dL), indicating varying stages of iron depletion. Interestingly, those with normal hemoglobin (Hb 12–16 g/dL) primarily had iron levels in the normal range, with **no** one showing low iron**,** and a few individuals even having elevated iron levels (>160 µg/dL)**,** possibly due to supplementation or metabolic conditions.

TIBC Distribution

Table No.18: TIBC Distribution

TIBC (µg/dL)	Mild Anemia (n)	Mild (%)	Moderate Anemia (n)	Moderate (%)	Normal (n)	Normal (%)
250–400	15	28.8%	6	11.5%	20	38.5%
<250	0	0.0%	1	1.9%	7	13.5%
>400	1	1.9%	1	1.9%	1	1.9%

In the TIBC (Total Iron Binding Capacity) distribution, a high TIBC (>400 µg/dL**)** was observed almost exclusively in those with severe and moderate anemia**,** reflecting the classic pattern seen in iron deficiency where TIBC rises in response to low iron stores. Most patients with mild anemia and normal Hb had TIBC values in the 250–400 µg/dLrange, consistent with a mixed picture of adequate and borderline iron status. A small number of individuals in the normal Hb group had TIBC <250 µg/dL**,** which can suggest reduced transferrin capacity, though this is less common.

Discussion

The analysis of iron profile test reports from Washim City reveals significant insights into the prevalence and characteristics of iron deficiency anemia (IDA) across different demographic groups.

1. Iron Profile Variability and Prevalence of Iron Deficiency

The study found a wide range in serum iron levels (12–4108 µg/dL), with a very high mean and standard deviation, indicating the presence of outliers and a highly variable sample population. This points to two possibilities: a mixed population with both iron-deficient and iron-overloaded individuals, or possible data recording errors. Nevertheless, the mean transferrin saturation (24.01%) is on the lower edge of normal, suggesting that a substantial number of individuals may have suboptimal iron levels, consistent with iron deficiency.

Ferritin levels, ranging from 20 to 1000 µg/L, also show significant variation. While some high values may suggest sufficient or excess iron stores, ferritin can also be elevated due to inflammation, which must be considered when interpreting data in isolation.

2. Demographic Distribution and Anemia Severity

The highest proportion of participants belonged to the 31–40 age group, a key working-age population. This demographic is highly relevant, as iron deficiency in this group can have widespread implications on productivity and public health.

Severity analysis shows that:44.2% of the population has mild anemia,17.3% moderate,23.1% severe, andonly 15.4% had normal hemoglobin levels.

This clearly demonstrates a high burden of anemia in the region, with over 80% of the sampled population affected to some degree.

3. Gender-Specific Trends

Among females:50% had mild anemia, and28.1% had severe anemia,with only 9.4% classified as normal.

This aligns with known patterns where menstruation, pregnancy, and nutritional deficiencies make women more susceptible. The higher percentage of severe cases in women calls for urgent attention to female-specific interventions like menstrual health education, supplementation, and nutritional support.

Among Males:35% had mild anemia,15% had severe anemia, and25% were normal.

While anemia is less severe and slightly less prevalent in men, the 75% overall prevalence still indicates a serious public health concern.

4. Iron and TIBC Correlation with Anemia Severity

The iron distribution analysis confirms that low iron levels (<35 µg/dL) are strongly correlated with moderate and severe anemia, validating iron deficiency as the primary cause in these groups. Those with normal or elevated hemoglobin generally had iron levels within or above the reference range.

In the TIBC analysis, elevated values (>400 µg/dL) were mainly seen in patients with moderate to severe anemia, reinforcing its diagnostic value in iron deficiency. Mildly anemic and normal individuals tended to fall within normal TIBC ranges (250–400 µg/dL), suggesting early or borderline deficiency in these cases.

CONCLUSION

The present study provides a comprehensive overview of iron deficiency anemia (IDA) among the population of Washim City through the analysis of iron profile test reports. The findings clearly indicate a high prevalence of anemia, with over 80% of the sampled individuals exhibiting some degree of hemoglobin deficiency. Mild anemia was the most commonly observed, but a significant portion of the population also suffered from moderate to severe forms, particularly among women of reproductive age.The biochemical analysis showed notable variations In iron parameters such as serum iron, ferritin, transferrin saturation, TIBC, and UIBC. These variations reflect a mix of iron deficiency, borderline cases, and possible iron overload in a few individuals. The correlation between low iron levels and the severity of anemia reinforces the importance of early diagnosis using iron profile markers.Age and gender analyses further emphasize the need for targeted interventions. Middle-aged adults, especially women, were disproportionately affected, likely due to factors like menstruation, pregnancy, and dietary habits. The low proportion of individuals with normal hemoglobin levels underlines the urgent public health need to address iron deficiency through routine screening, nutritional education, and iron supplementation programs. This study highlights the critical need for awareness and healthcare initiatives focused on the early detection and management of iron deficiency anemia. By doing so, it is possible to improve health outcomes, enhance quality of life, and reduce the long-term burden of anemia on the community.

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