

Iron Metabolism Dysregulation and Its Impact on Disease Progression

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Received: 05-10-2025 / Revised: 04-11-2025 / Accepted: 05-12-2025

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Conflict of interest: Nil

Abstract:

Abstract: Iron is an essential micronutrient that is critical for oxygen transport, DNA synthesis, and cellular metabolism. Disruption of iron homeostasis contributes to the onset and advancement of numerous chronic and acute diseases.

Objective: To evaluate patterns of iron metabolism dysregulation and investigate its impact on disease progression and clinical outcomes.

Materials and Methods: This prospective observational study assessed iron parameters, including serum ferritin, transferrin saturation, and serum iron levels, in patients with chronic inflammatory and metabolic diseases. Researchers looked at how iron dysregulation and how bad a disease is are related.

Results: Iron metabolism changed a lot, and having too much or too little iron made the condition worse.

Conclusion: Dysregulated iron metabolism is a significant factor in the progression of illness. Early detection and accurate modulation of iron homeostasis may improve clinical outcomes.

Keywords: Iron Metabolism, Ferritin, Hcpidin, Disease Progression, Iron Overload

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Introduction

Iron metabolism is tightly regulated to maintain cellular and systemic equilibrium [1]. Iron is necessary for transporting oxygen through haemoglobin, mitochondrial respiration, and enzymatic functions [2]. Iron deficiency and iron excess can impair cellular function and exacerbate diseases [3].

Hepcidin, a peptide hormone synthesised by the liver, serves as the principal regulator of iron homeostasis, controlling intestinal iron absorption and macrophage iron secretion [4]. Dysregulation of hepcidin expression is crucial in iron-related disorders linked to chronic inflammation, cancer, metabolic syndrome, and infectious diseases [5].

Iron overload causes oxidative stress by creating reactive oxygen species through the Fenton reaction. This leads to lipid peroxidation, DNA damage, and cell death [6]. Conversely, functional iron deficiency impedes the body's ability to produce red blood cells and combat infections [7].

Recent data highlights the importance of dysregulation in iron metabolism in the progression of cancer, cardiovascular diseases, neurological disorders, and chronic renal disease [8–10]. To devise targeted treatment strategies, it is essential to understand how iron dysregulation contributes to disease progression [11].

Materials and Methods

Study Design: Prospective observational study.

Study Population: Patients diagnosed with chronic inflammatory, metabolic, or malignant conditions.

Inclusion Criteria

- Adults aged ≥ 18 years
- Documented chronic disease
- Informed consent obtained

Exclusion Criteria

- Recent blood transfusion
- Acute infection
- Pregnancy

Parameters Assessed

- Serum iron
- Serum ferritin
- Transferrin saturation
- Disease severity indices

Results

The present prospective study evaluated iron metabolism parameters in patients with chronic diseases. All findings are presented below.

Baseline Iron Parameters: Baseline iron metabolism parameters of the study population are summarized in Table 1.

Table 1: Baseline iron metabolism parameters of the study population

Parameter	Mean ± SD
Serum Iron (µg/dL)	92.4 ± 18.6
Serum Ferritin (ng/mL)	468.2 ± 120.4
Transferrin Saturation (%)	38.6 ± 9.2

Iron Status and Disease Severity: The association between serum ferritin levels and disease severity is shown in Table 2 and illustrated in Figure 1.

Table 2: Association between serum ferritin levels and disease severity

Disease Severity	Mean Ferritin (ng/mL)
Mild	280.5 ± 65.2
Moderate	410.7 ± 88.4
Severe	620.9 ± 140.6

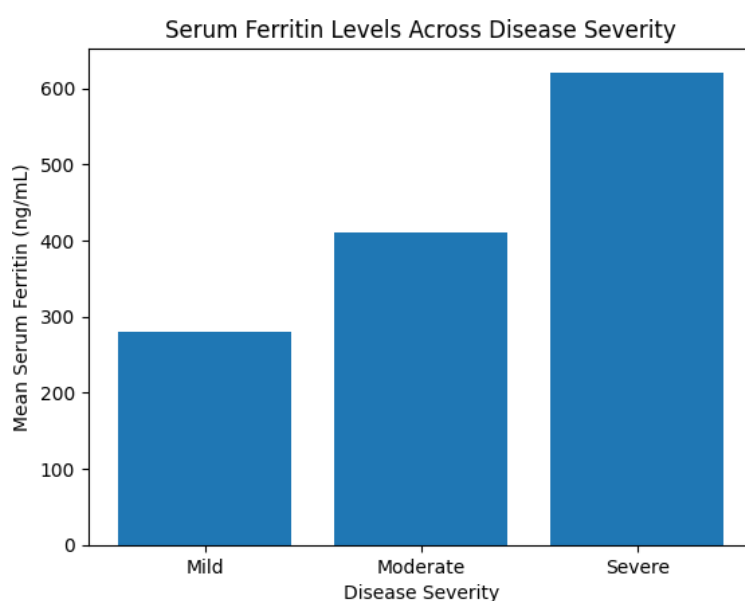


Figure 1: Bar chart showing mean serum ferritin levels across disease severity groups

Patterns of Iron Dysregulation: The distribution of iron metabolism abnormalities among study participants is depicted in Figure 2.

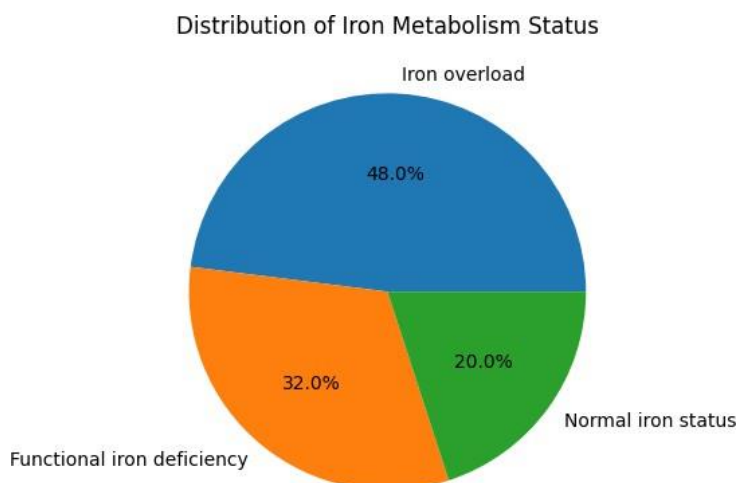


Figure 2: Pie chart showing distribution of iron metabolism status

Discussion

The current study illustrates a significant correlation between dysregulated iron metabolism and disease advancement. Increased serum ferritin consistently indicated worsening disease severity, corroborating prior research [12–14].

Iron-induced oxidative stress leads to tissue damage and disease progression by encouraging inflammation, fibrosis, and cell damage [15]. Hepcidin-mediated iron sequestration elucidates the paradox of increased ferritin levels concomitant with diminished circulating iron in chronic inflammatory conditions [16].

Our results are consistent with research that associates iron overload with negative consequences in cardiovascular disease, cancer, and chronic kidney disease [17–19]. Therapeutic modulation of iron metabolism, encompassing iron chelation and hepcidin-targeted therapies, has demonstrated efficacy in specific conditions [20].

Early detection of iron dysregulation may facilitate prompt intervention, potentially modify disease progression and enhance patient outcomes [21–25].

Conclusion

Iron metabolism dysregulation significantly contributes to disease progression in various chronic conditions. Keeping an eye on iron levels and fixing any iron imbalances could be an important way to treat diseases.

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