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SYSTEMATIC REVIEW OF MICROGRAVITY INDUCED ALTERATIONS IN IRON ABSORPTION  
AND GUT MOTILITY: IMPLICATIONS FOR ASTRONAUTS HEALTH AND SPACE NUTRITION  
STRATEGIES

**Abstract**

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Iron is an essential micronutrient critical for oxygen transport, energy production, and immune function. However, in microgravity, the mechanisms of iron absorption and metabolism are significantly altered, posing unique challenges to astronaut health during long-duration space missions. Microgravity induces physiological changes in the gastrointestinal (GI) tract, including reduced motility, altered transit times, and changes in the activity of enterocytes, which may impair the absorption of dietary iron in the duodenum. Additionally, disruptions in gastric acid secretion can reduce the solubility and bioavailability of non-heme iron, further exacerbating absorption challenges.

This systematic review aims to synthesize current evidence in microgravity-induced changes in iron metabolism focusing on iron absorption, gut motility, systemic iron regulation, and potential countermeasures for maintaining iron homeostasis in astronauts.

A systematic research was conducted across PubMed, Scopus, and Web of Science for peer-reviewed articles published between 2015-2025. Studies investigating iron metabolism, gastrointestinal function, and hepcidin regulation in microgravity or spaceflight analogs (e.g., bed rest, parabolic flight, hindlimb unloading) were included. Articles were screened based on relevance, study design, and methodological rigor. Data were extracted on iron absorption kinetics, erythropoiesis, oxidative stress markers, and proposed nutritional countermeasures.

Findings indicate that microgravity alters iron metabolism through: (1) reduced GI motility and changes in enterocyte function, impairing dietary iron absorption; (2) disrupted gastric acid secretion, reducing non-heme solubility and bioavailability; (3) hepcidin upregulation due to spaceflight-induced inflammation, leading to functional iron deficiency; and (4) paradoxical iron overload due to reduced erythropoiesis and bone resorption. Studies suggest that optimizing dietary iron sources, using vitamin C as an absorption enhancer, and modulating gut microbiota via probiotics/ prebiotics may mitigate these effects. Additionally, slow-release iron supplements and real-time hepcidin monitoring show promise in personalizing iron interventions.

These findings not only have significant implications for astronaut health but also offer translational benefits for managing iron-related disorders on Earth.