



Serum Ferritin Threshold to Diagnose Iron Deficiency in Children 9 to 13-Month-Old

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BACKGROUND

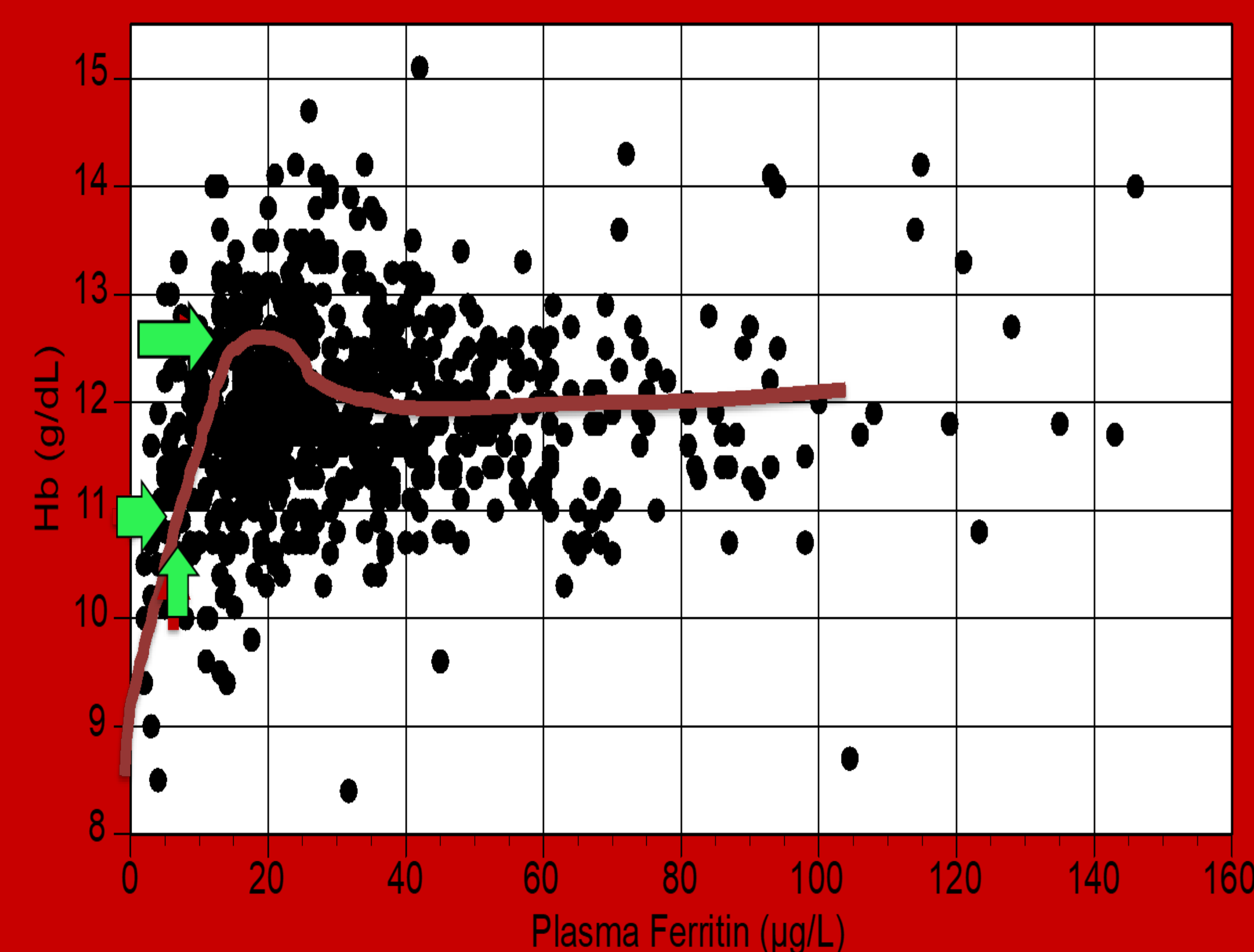
- In the US, American Academia of Pediatrics recommends universal screening for iron deficiency anemia (IDA) with hemoglobin (Hb) near 1 year of age.
- Diagnosing pre-anemic iron deficiencies (ID) is important as timely iron supplementation may lead to better neurocognitive outcomes.¹
- Recent work supports a nonlinear relationship between Hb and ferritin and that a ferritin level between 18-24 µg/L may be a better threshold for diagnosing iron deficiency than currently recommended level of 10-12 µg/L.²

METHODS

- A cross-sectional study
- **Inclusion criteria:**
 - Healthy children
 - Age 9 to 13 months
 - Urban and rural UW-Health clinics pediatrics and family medicine primary care visits
- **Exclusion criteria:**
 - Children seen inpatient or at pediatric specialty clinics
- Data were collected from January 2013 to April 2015.
- Serum ferritin was measured with the Abbott Architect immunoassay analyzer (Abbott, Abbott Park, Illinois, USA).
- Serum Hb was measured using clinical Beckman Coulter (Brea, CA, USA) or Sysmex platforms (Sysmex Canada, Mississauga, ON, Canada).
- Ferritin threshold was determined through the restricted cubic spline regression modeling while controlling for age.

- The relationship between Hb and ferritin was nonlinear and demonstrated a slightly curved ferritin plateau of at least 20 µg/L (Figure 1).
- Based on our cohort results, Hb<11 g/dL and serum ferritin <10-12 µg/L are not sufficient tests for the diagnosis of ID in children age 9-13 months.
- Increasing ferritin threshold would reveal more pre-anemic IDs making the problem even more common than according to the traditional thresholds (15% of infants with ID+IDA).

Figure 1. Plot of the restricted cubic spline regression model.



RESULTS

- Of 4172 blood samples analyzed, 721 had values for Hb and ferritin. The mean (SD) age of the children was 11.7 (1.1) months. Mean (SD) serum ferritin and Hb were 28.9 (17.1) µg/L and 11.9 (0.9) g/dL.
- In our cohort, 8.2% had Hb<11 g/dL, but normal serum ferritin (anemia, but not IDA), 3.5% had low Hb and ferritin values (IDA), and 11.4% had only low ferritin value (only ID), lower normal rates than NHANES national survey (Figure 2).

Figure 2. Anemia and IDA rates.³

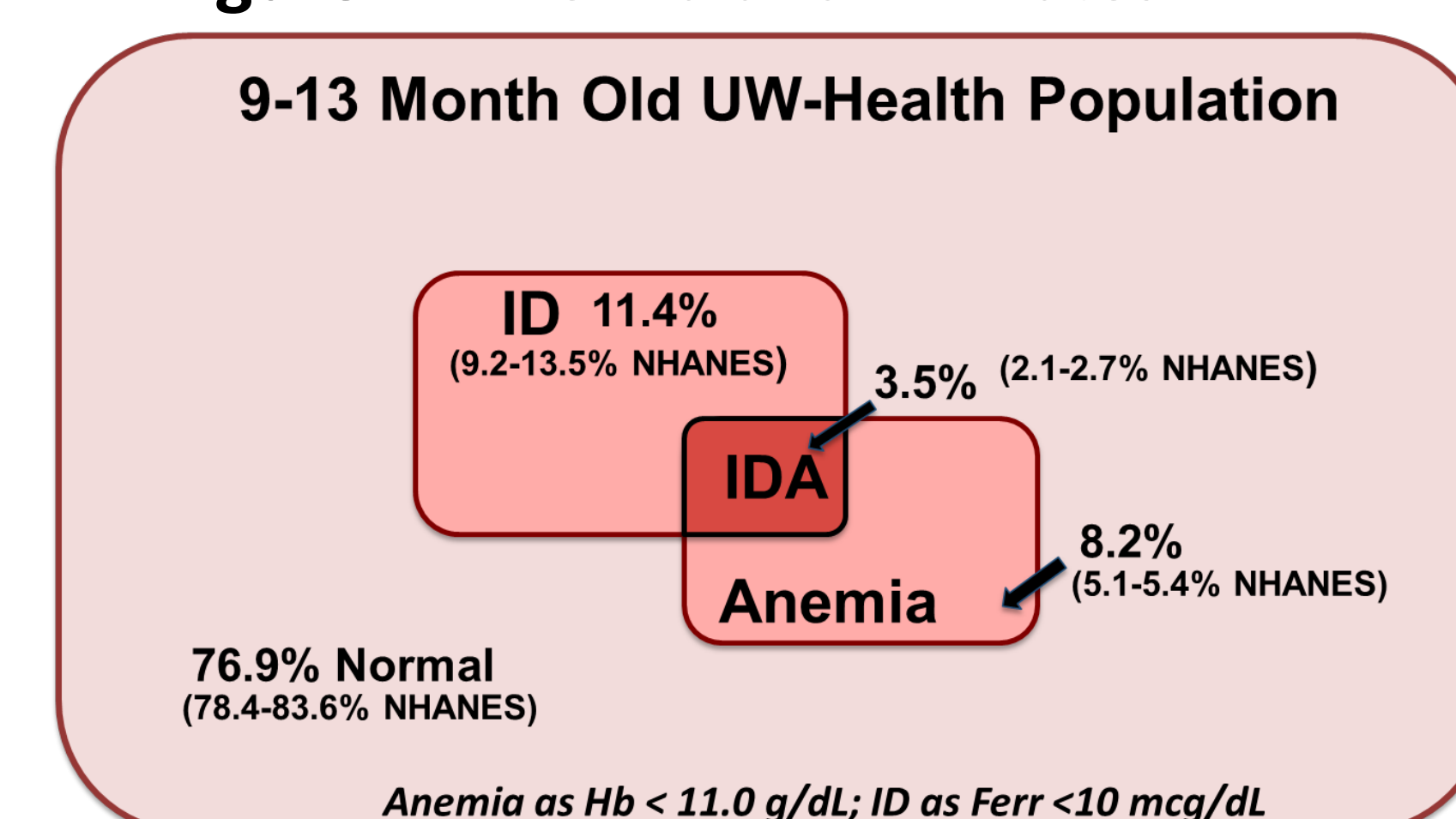


Table. Diagnostic properties for three different threshold values (10, 12, and 15 µg/L) of serum ferritin in diagnosis of IDA, defined as Hb<11 g/L, in children aged 9-13 months.

Ferritin threshold, µg/L	Sensitivity, %	Specificity, %	PPV, %	NPV, %
Ferritin <10	100*	90	29.9	100*
Ferritin <12	100*	91.1	34.5	100*
Ferritin <15	100*	92.9	47.6	100*

* Hb is a part of the definition of IDA, thus defines this 100%.

Ferritin threshold of 15 µg/L is used for other age groups. When studying the efficacy, the prediction ability of Hb as a sole marker of IDA was poor but improved with the inclusion of ferritin. Using a ferritin threshold of 15 µg/L showed a better PPV than lower thresholds.

CONCLUSIONS

- Our goal was to evaluate higher serum ferritin thresholds that could improve our ability to measure iron status at the pediatric ages, especially in the first 1000 days of life, when iron needs are highest for brain development.
- Higher (18-24 µg/L) serum ferritin ID thresholds is consistent with recent work, and may be worthwhile, even with more false positives. Treatment is cost-effective, has limited side effects, and prevents irreversible negative health sequelae that have been associated with ID, particularly those related to neurocognitive and behavioral outcomes.⁴

ADDITIONAL KEY INFORMATION

FUTURE WORK:

Further analysis of a bigger and diverse study population with a measurement of reticulocyte hemoglobin iron might help define a more accurate serum ferritin threshold for ID diagnosis.⁵

ACKNOWLEDGEMENT:

We are thankful to the UW-Health data quality and safety group, Jeff Pier, Amy M. Topel, Stacey C.L. Moyer RN, MSN, CCRC and the UW-Health ambulatory care clinics and specifically GPAM group, including Gail S. Allen MD, Sandy Jacobson.

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