

# Toenail and serum measures as biomarkers of iron levels

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## Introduction

Iron – an essential metal – is toxic at high levels. Studies of health effects of iron typically use serum, but toenails offer a convenient alternate because they are easy to collect and store. No study has compared serum and toenail measures for iron.

## Aim

To compare serum and toenail iron measures both cross-sectionally and longitudinally.

## Study population

- Women in the US-wide prospective Sister Study cohort, ages 35-74 years at enrollment (2003-2009)
- We studied the participants who donated serum and toenails at baseline (n=281) and a subsample (59%, n=165) that provided specimens again about 8 (IQR: 7,9) years later

## Methods

**Cross-sectional analyses:** Spearman’s correlation coefficients, coefficient of variation, fitted regression lines

**Longitudinal analyses:** Spearman’s correlation coefficients, mixed effects models

**Serum measures:** Continuous iron (mg/dL), ferritin (mg/dL), and transferrin saturation (%)

- Transferrin Saturation =  $\frac{Iron}{Iron+UIBC} \cdot 100$ , UIBC=unsaturated iron-binding capacity

**Nails:** Self-collected toenail clippings (mcg/g)

Comparisons of iron levels between toenail and serum samples indicate little evidence supporting the use of toenails as a proxy for serum measures.



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## Results

Figure 1. Scatter plots of serum and nail iron values at baseline.

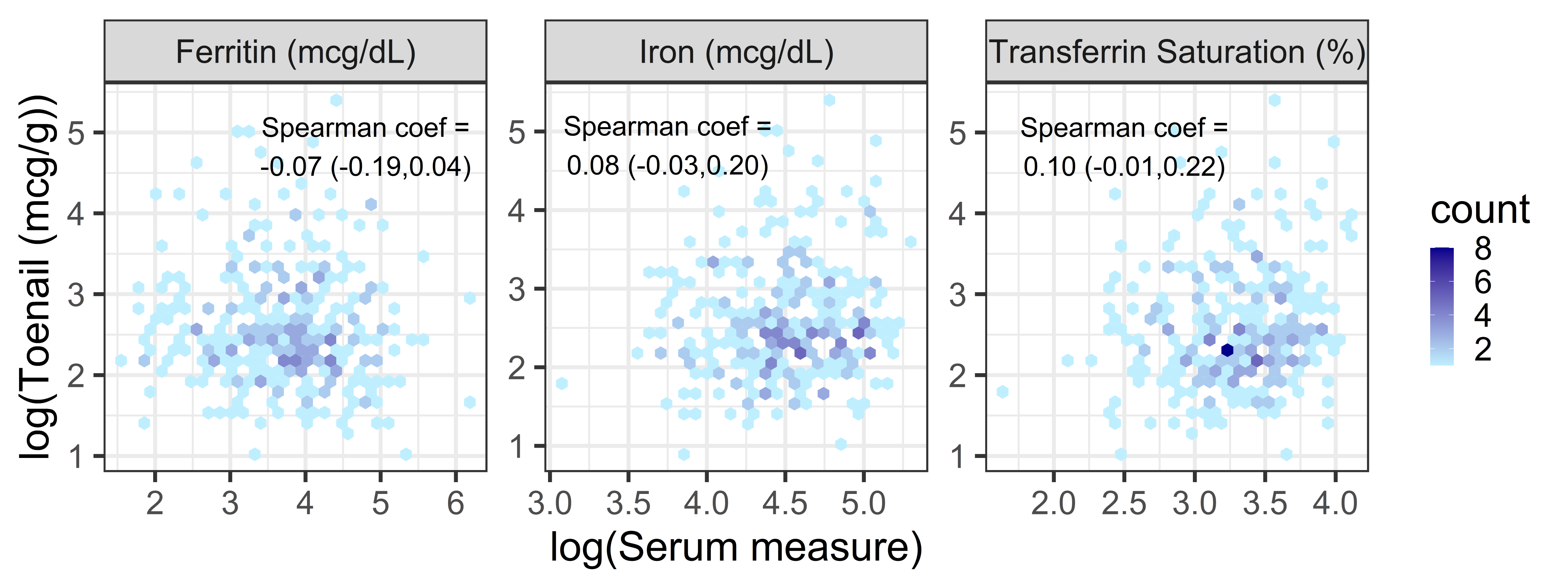
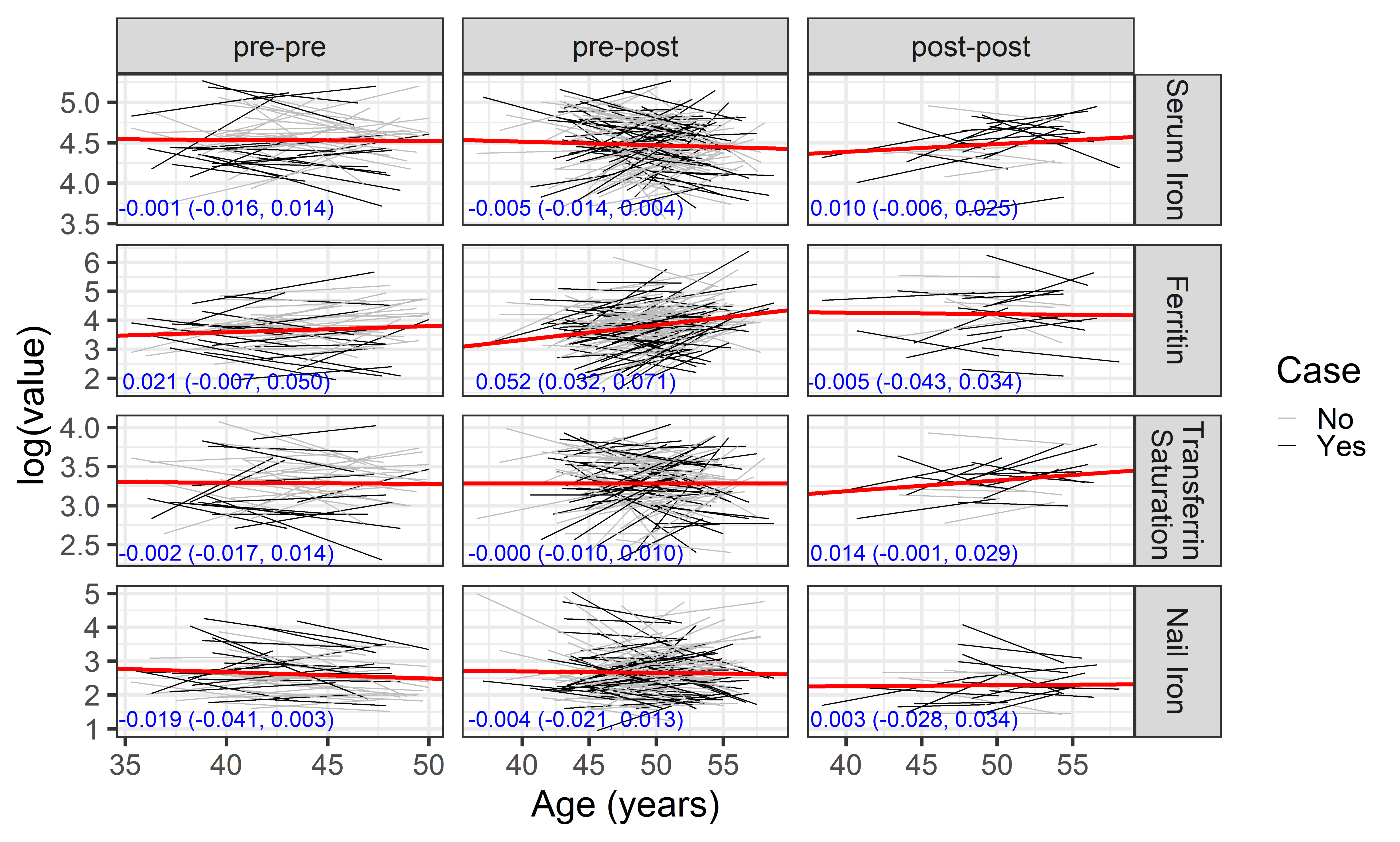


Table 1. Spearman correlation coefficients between two time points by nail and type of serum measure.

| Measure                    | Estimate (95% CI) |
|----------------------------|-------------------|
| Nail iron (mcg/g)          | 0.47 (0.37, 0.60) |
| Serum Iron (mg/dL)         | 0.25 (0.11, 0.39) |
| Ferritin (mg/dL)           | 0.45 (0.33, 0.58) |
| Transferrin Saturation (%) | 0.33 (0.18, 0.47) |

Similar to ferritin measures over time, toenail iron measures are correlated over time.

Figure 2. Repeated iron values by age, type of measure, and menopause status (time 1 to time 2)



Note: Red lines represent the mixed-effects fitted regression line and slope of fitted line (95% CI) in blue text. Other lines represent individuals.

We found little evidence of systematic change in iron measures over time. Serum ferritin was one exception, capturing the expected increase in iron stores for women who transition into menopause and cease menstruation.

## Discussion

We did not find evidence to support similarities in serum and nail iron measures in this sample, and each type of measure may represent different mechanisms of iron storage.