# The impact of preoperative anemia on postoperative anemia and related nutritional abnormalities after bariatric surgery

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## CONFLICT OF INTEREST DISCLOSURE

**I have no potential conflict of interest to report.**

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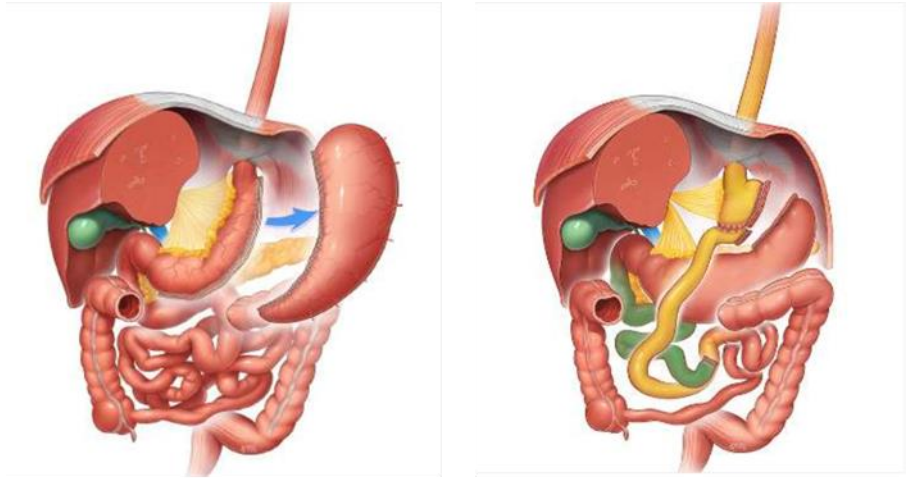
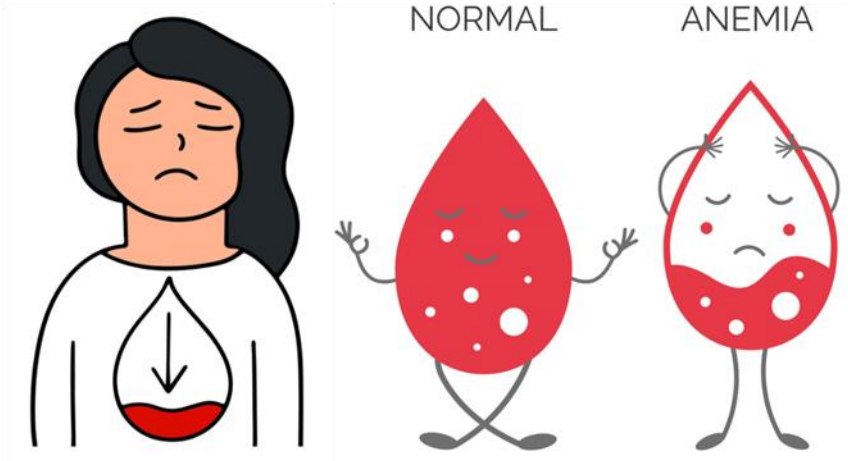
# Background

- Anemia is a one of the most common nutritional complications after bariatric surgery, with an incidence rate of 10% to 40%.
- Postoperative anemia after bariatric surgery is often difficult to manage with oral supplementation alone, frequently progressing to refractory anemia.
- Due to obesity-induced inflammation and the deficiencies in micronutrients and vitamins, up to 30% of patients are anemic before surgery.
- Current guidelines for perioperative management in bariatric surgery do not provide specific recommendations for the treatment of preoperative anemia.





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# The aim of this study

- To explore the impact of **preoperative anemia** on **postoperative anemia** and **related nutritional abnormalities** in bariatric surgery patients.

# Study Design

- **Study type:** Retrospective cohort study
- **Multicenter:** China-Japan Friendship Hospital & Beijing Fuxing Hospital
- **Study Period:** Sep 2017 – Dec 2021
- **Surgical type:** Sleeve gastrectomy (SG) or Roux-en-Y gastric bypass (RYGB)
- **Obesity:** BMI > 27.5 $kg/m^2$
- **Prophylactic nutrient supplement:** ASMBS guideline
- **Exclusion:** (1) baseline renal failure; (2) vegetarian diet; (3) postoperative bleeding (drop in hemoglobin > 30 g/L or confirmed blood loss requiring treatment); and (4) lack of 1-year follow-up data

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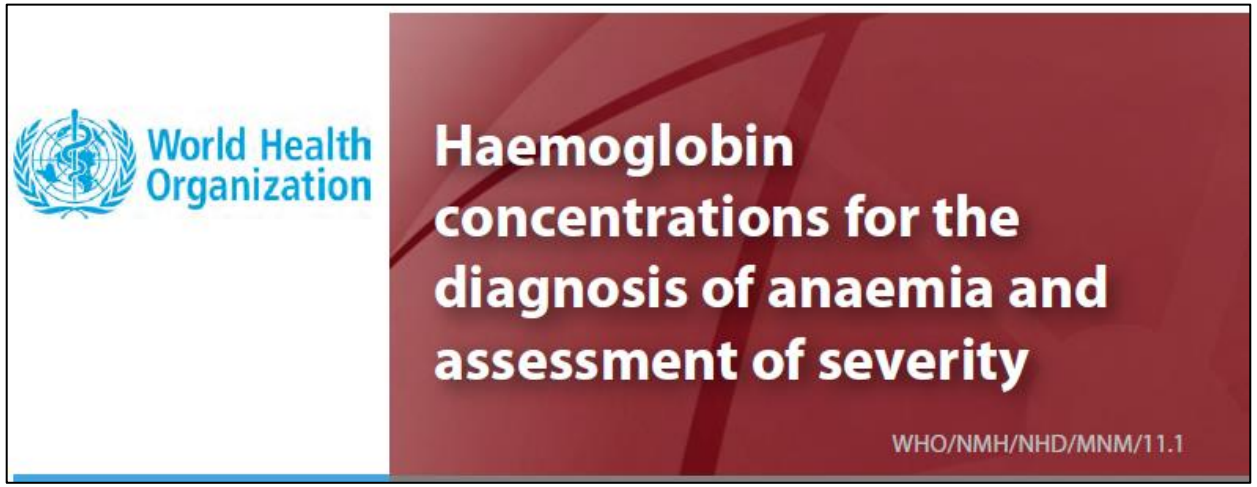
## Definition of anemia (WHO criteria)

- Male: Hb < 130 g/L
- Female: Hb < 120 g/L

## Severity of anemia (WHO criteria)

- Mild anemia: Hb > 110 g/L
- Moderate anemia: 80 g/L < Hb < 110 g/L
- Severe anemia: Hb < 80 g/L




## Definition of anemia related nutritional abnormalities

- Folate deficiency: Folate < 10 nmol/L
- Vitamin B12 deficiency: Vitamin B12 < 150 pmol/L
- Ferritin deficiency: Ferritin < 30 ng/mL
- Low  transferrin saturation (TS) level: TS < 20%

https://www.who.int/publications/i/item/WHO-NMH-NHD-MNM-11.1
Food Nutr Bull. 2008 Jun;29(2 Suppl):S238-44.

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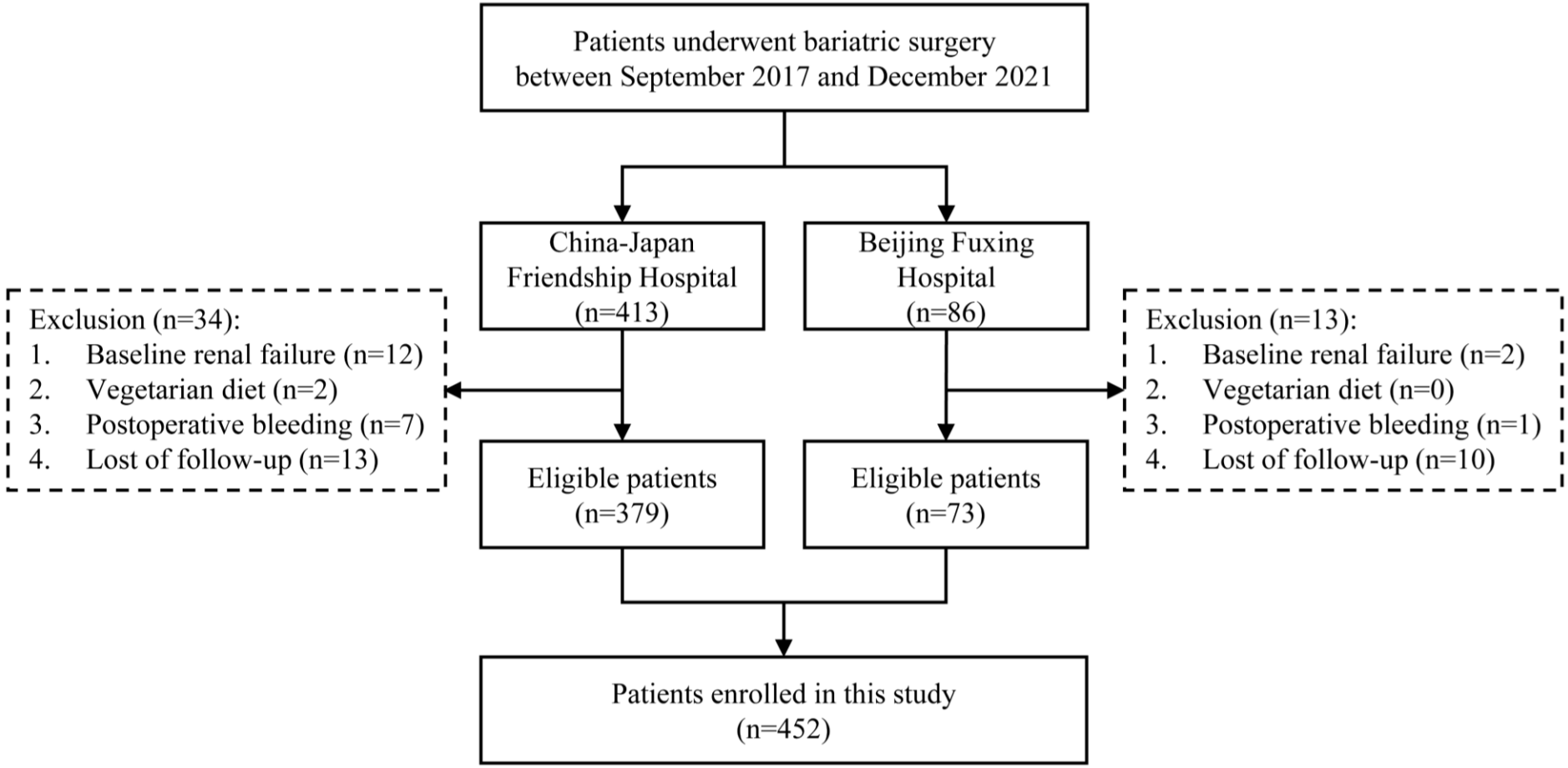
# Results—Study flow



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# Results—Study characteristics

| Variable | Overall (N = 452) | Normal (N = 399) | Preoperative anemia (N = 53) | P |
|---|---|---|---|---|
| Male, % | 138 (30.5) | 134 (33.6) | 4 (7.5) | <0.001 |
| Age, years | 37.1 ± 10.7 | 36.9 ± 10.7 | 38.7 ± 10.1 | 0.242 |
| Height, cm | 168.0 ± 8.4 | 168.3 ± 8.6 | 165.7 ± 6.4 | 0.036 |
| Weight, kg | 103.0 (90.0, 120.0) | 104.0 (90.0, 120.5) | 100.0 (91.0, 112.0) | 0.319 |
| BMI, kg/m$^2$ | 37.1 (32.8, 41.4) | 37.2 (32.9, 41.5) | 36.73 (32.6, 41.0) | 0.894 |
| WC, cm | 117.1 ± 15.6 | 117.1 ± 15.8 | 117.1 ± 14.3 | 0.989 |
| HC, cm | 121.0 ± 14.2 | 120.9 ± 14.3 | 121.4 ± 14.1 | 0.797 |
| WHR | 1.0 ± 0.1 | 1.0 ± 0.1 | 1.0 ± 0.1 | 0.651 |
| Surgical procedure, % | | | | |
| SG | 361 (79.9) | 318 (79.7) | 43 (81.1) | 0.950 |
| RYGB | 91 (20.1) | 81 (20.3) | 10 (18.9) | |
| Smoking history, % | 79 (17.5) | 76 (19.0) | 3 (5.7) | 0.027 |
| Alcohol consumption, % | 67 (14.8) | 60 (15.0) | 7 (13.2) | 0.883 |
| Hypertension, % | 212 (46.9) | 187 (46.9) | 25 (47.2) | 1.00 |
| SBP, mmHg | 137.0 ± 18.9 | 137.4 ± 19.4 | 134.1 ± 14.7 | 0.237 |
| DBP, mmHg | 86.4 ± 14.6 | 86.8 ± 15.0 | 83.0 ± 10.6 | 0.080 |
| T2DM, % | 268 (59.3) | 240 (60.2) | 28 (52.8) | 0.384 |
| Hyperuricemia, % | 281 (62.2) | 261 (65.4) | 20 (37.7) | <0.001 |
| Hypercholesterolemia, % | 156 (34.5) | 143 (35.8) | 13 (24.5) | 0.141 |
| Hypertriglyceridemia, % | 111 (24.6) | 101 (25.3) | 10 (18.9) | 0.393 |
| BMI at 1 year | 26.4 (24.0, 29.4) | 26.3 (23.9, 29.3) | 27.4 (25.0, 29.5) | 0.127 |
| ΔBMI at 1 year | 10.2 (7.3, 13.5) | 10.3 (7.3, 13.6) | 9.1 (6.7, 12.1) | 0.108 |
| %EWL at 1 year | 94.2 ± 37.8 | 95.1 ± 38.4 | 87.4 ± 32.8 | 0.163 |

- **Male:** 30.5%
- **Age:** 37.1 years
- **BMI:** 37.1 kg/m$^2$
- **SG:** 79.9%
- **RYGB:** 20.1%
- **BMI at 1 year:** 26.4 kg/m$^2$
- **ΔBMI at 1 year:** 10.2 kg/m$^2$
- **%EWL at 1 year:** 94.2%

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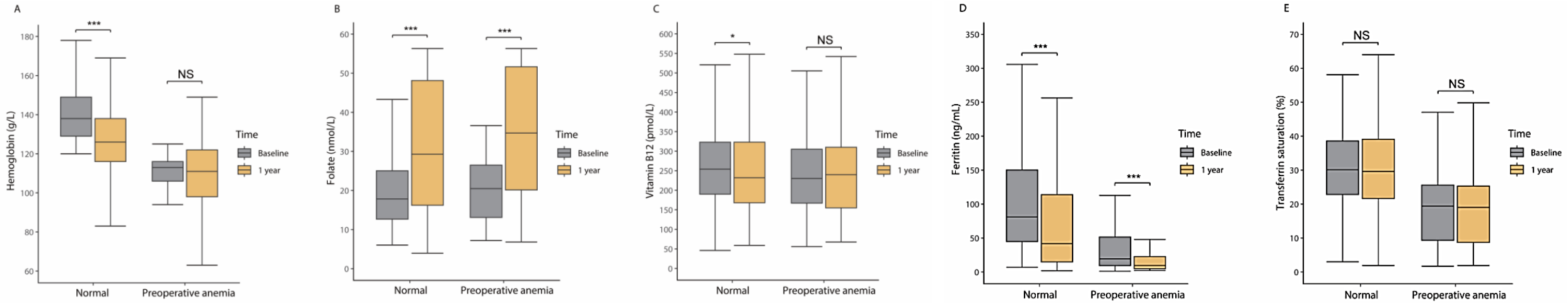
# Results—Hematological and nutrient parameters

- ✓ Non-anemic preoperative patients showed significant decreases in **hemoglobin, vitamin B12, and ferritin levels**, and a significant increase in folate levels at one year
- ✓ Among preoperative anemic patients, **ferritin levels** significantly decreased, folate levels significantly increased, but there were no significant changes in hemoglobin, vitamin B12, and TS levels.



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# Results—Hematological and nutrient parameters

| Variable | Normal (N = 399) | Preoperative anemia (N = 53) | P |
|---|---|---|---|
| **Hemoglobin, g/L** | | | |
| **At baseline** | 139.8 ± 12.9 | 110.9 ± 7.3 | <0.001 |
| **At 1 year** | 126.5 ± 18.4 | 108.7 ± 19.9 | <0.001 |
| **Change from baseline** | -13.3 ± 15.2 | -2.2 ± 20.0 | 0.747 |
| **Folate, nmol/L** | | | |
| **At baseline** | 17.8 (12.7, 25.0) | 20.5 (13.1, 26.5) | 0.449 |
| **At 1 year** | 29.3 (16.2, 48.1) | 34.7 (20.1, 51.7) | 0.076 |
| **Change from baseline** | 8.2 (-1.0, 19.8) | 14.1 (3.4, 26.7) | 0.411 |
| **Vitamin B12, pmol/L** | | | |
| **At baseline** | 259.0 (191.5, 338.5) | 235.0 (174.5, 314.0) | 0.260 |
| **At 1 year** | 235.0 (170.3, 337.1) | 269.7 (162.0, 333.0) | 0.497 |
| **Change from baseline** | -11.0 (-89.9, 60.0) | 14.0 (-67.1, 93.0) | 0.309 |
| **Ferritin, ng/mL** | | | |
| **At baseline** | 85.4 (47.3, 170.2) | 19.3 (9.3, 51.5) | <0.001 |
| **At 1 year** | 43.6 (15.2, 118.4) | 9.5 (4.7, 22.8) | <0.001 |
| **Change from baseline** | -59.2 (-139.0, -15.0) | 3.2 (-10.1, 27.8) | 0.271 |
| **Transferrin saturation, %** | | | |
| **At baseline** | 31.4 ± 11.9 | 18.8 ± 12.2 | <0.001 |
| **At 1 year** | 30.6 ± 14.3 | 18.5 ± 11.4 | <0.001 |
| **Change from baseline** | -0.8 ± 14.8 | -0.3 ± 16.4 | 0.003 |

Change from baseline between two groups were compared by analysis of covariance, adjusting for baseline levels, sex, age, BMI, waist circumference, hip circumference, surgical procedure, smoking history, alcohol consumption, hypertension, T2DM, hyperuricemia, hypercholesterolemia, and hypertriglyceridemia.

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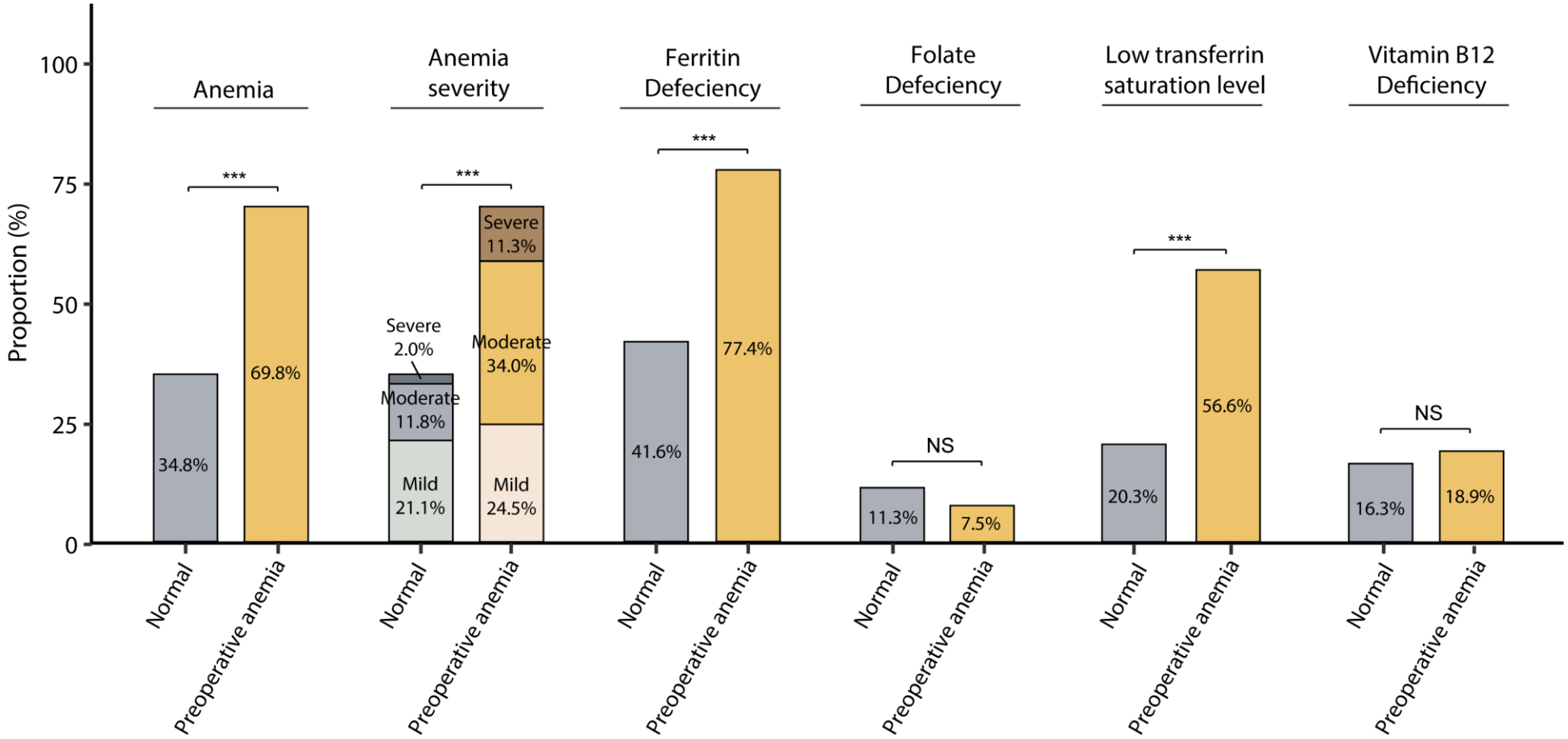
# Results—Anemia and related nutritional abnormalities



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# Results—Association of preoperative anemia with postoperative anemia

| Abnormality | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | OR (95% CI) | P | OR (95% CI) | P | OR (95% CI) | P |
| **Anemia** | | | | | | |
| Normal | 1.00 (reference) | | 1.00 (reference) | | 1.00 (reference) | |
| Preoperative anemia | 4.33 (2.36-8.25) | <0.001 | 3.38 (1.82-6.53) | <0.001 | 3.52 (1.83-7.06) | <0.001 |
| **Moderate to severe anemia** | | | | | | |
| Normal | 1.00 (reference) | | 1.00 (reference) | | 1.00 (reference) | |
| Preoperative anemia | 5.18 (2.81-9.54) | <0.001 | 4.22 (2.24-7.95) | <0.001 | 5.03 (2.48-10.20) | <0.001 |
| **Folate deficiency** | | | | | | |
| Normal | 1.00 (reference) | | 1.00 (reference) | | 1.00 (reference) | |
| Preoperative anemia | 0.64 (0.19-1.67) | 0.415 | 1.00 (0.29-3.39) | 0.997 | 1.08 (0.29-3.95) | 0.909 |
| **Vitamin B12 deficiency** | | | | | | |
| Normal | 1.00 (reference) | | 1.00 (reference) | | 1.00 (reference) | |
| Preoperative anemia | 1.19 (0.57-2.50) | 0.636 | 1.51 (0.70-3.24) | 0.294 | 1.40 (0.60-3.28) | 0.439 |
| **Ferritin deficiency** | | | | | | |
| Normal | 1.00 (reference) | | 1.00 (reference) | | 1.00 (reference) | |
| Preoperative anemia | 4.80 (2.45-9.40) | <0.001 | 3.43 (1.64-7.17) | 0.001 | 3.77 (1.74-8.17) | 0.001 |
| **Low transferrin saturation level** | | | | | | |
| Normal | 1.00 (reference) | | 1.00 (reference) | | 1.00 (reference) | |
| Preoperative anemia | 5.12 (2.82-9.29) | <0.001 | 4.03 (2.19-7.44) | <0.001 | 4.12 (2.16-7.84) | <0.001 |

Model 1: unadjusted. Model 2: adjusted for sex, age, and BMI. Model 3: adjusted for sex, age, BMI, waist circumference, hip circumference, surgical procedure, smoking history, alcohol consumption, hypertension, T2DM, hyperuricemia, hypercholesterolemia, and hypertriglyceridemia.

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# Conclusion

- Preoperative anemia significantly increases the incidence of postoperative anemia after bariatric surgery, particularly the incidence of moderate to severe anemia.
- Iron deficiency is the primary cause of postoperative anemia and is exacerbated by preoperative anemia.
- This study highlights the critical need for screening and managing preoperative anemia to mitigate the risk of refractory postoperative anemia.

# Acknowledgement

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