# Pediatric Malnutrition Is Associated With Increased Five-Year Risk of Fracture and Mortality

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INTRODUCTION:

Pediatric malnutrition is a major global health concern with known associations to growth impairment, immune dysfunction, and skeletal fragility. However, the long-term impact of malnutrition on fracture incidence and mortality in children remains poorly defined. This study aims to quantify the five-year risk of fracture and all-cause mortality in pediatric patients with laboratory evidence of malnutrition compared to matched controls.

METHODS:

We conducted a retrospective cohort study of pediatric patients aged 0–18 years who underwent clinical evaluation between January 1, 2018, and July 1, 2018, with five years of follow-up. Malnutrition was defined as serum transferrin ≤204 mg/dL, albumin ≤3.5 g/dL, or leukocyte count ≤1.5 × $10^3$/μL. Patients with a history of malnutrition were compared to those with no laboratory evidence of malnutrition. Propensity score matching (1:1) was performed on 22 demographic and clinical variables, including comorbidities such as cerebral palsy, osteogenesis imperfecta, leukemia subtypes, and noninfective enteritis. The primary outcome was five-year fracture risk; secondary outcomes included site-specific fracture patterns and all-cause mortality. Cox proportional hazards models were used to compute hazard ratios (HRs) with 95% confidence intervals (CIs).

RESULTS: After matching, 15,753 malnourished patients and 15,753 controls were analyzed. Malnourished patients exhibited a significantly higher risk of overall fracture (7.3% vs. 6.0%, HR: 1.26, 95% CI: 1.15–1.37, p<0.001), femur fracture (1.4% vs. 0.4%, HR: 4.02, 95% CI: 3.00–5.39, p<0.001), and lower leg fracture (1.5% vs. 1.1%, HR: 1.39, 95% CI: 1.14–1.69, p<0.001). All-cause mortality was markedly elevated in the malnourished group (5.5% vs. 0.7%, HR: 7.84, 95% CI: 6.44–9.55, p<0.001). Fracture risk was also significantly elevated at the one-year mark, particularly for femur and pathologic fractures (HRs: 4.57 and 14.58, respectively).

DISCUSSION AND CONCLUSION:

Pediatric malnutrition is associated with a significantly increased risk of both short- and long-term fracture and mortality. The disproportionate elevation in femur, fragility, and pathologic fracture risk highlights the skeletal vulnerability of this population. These findings support the need for early nutritional screening and bone health surveillance in children with biochemical evidence of malnutrition.

**Table 1**: Demographic and Clinical Characteristics of Pediatric Patients With and Without Malnutrition Before and After Propensity Score Matching

| Variable | Pre-Match Malnutrition (n = 15,792) | Pre-Match Control (n = 2,765,386) | Pre-Match P | Post-Match Malnutrition (n = 15,753) | Post-Match Control (n = 15,753) | Post-Match P |
|---|---|---|---|---|---|---|
| Age at Index (mean ± SD) | 3.8 ± 3.6 | 4.8 ± 3.5 | <0.001 | 3.8 ± 3.6 | 3.8 ± 3.7 | 0.786 |
| Female | 7,045 (44.6%) | 1,299,873 (47.0%) | <0.001 | 7,029 (44.6%) | 7,015 (44.5%) | 0.874 |
| Male | 8,719 (55.2%) | 1,462,493 (52.9%) | <0.001 | 8,697 (55.2%) | 8,716 (55.3%) | 0.83 |
| Black or African American | 3,100 (19.6%) | 503,299 (18.2%) | <0.001 | 3,091 (19.6%) | 3,110 (19.7%) | 0.788 |
| Hispanic or Latino | 3,109 (19.7%) | 527,378 (19.1%) | 0.049 | 3,107 (19.7%) | 3,117 (19.8%) | 0.887 |
| Hypertensive Diseases | 1,246 (7.9%) | 6,287 (0.2%) | <0.001 | 1,219 (7.7%) | 1,239 (7.9%) | 0.674 |
| Diabetes Mellitus | 166 (1.1%) | 8,284 (0.3%) | <0.001 | 164 (1.0%) | 158 (1.0%) | 0.737 |
| Chronic Kidney Disease | 570 (3.6%) | 3,044 (0.1%) | <0.001 | 561 (3.6%) | 632 (4.0%) | 0.036 |
| Liver Disease | 597 (3.8%) | 2,525 (0.1%) | <0.001 | 577 (3.7%) | 635 (4.0%) | 0.089 |
| Nicotine Dependence | 10 (0.1%) | 144 (0.0%) | <0.001 | 10 (0.1%) | 10 (0.1%) | 1 |
| Cystic Fibrosis | 131 (0.8%) | 2,105 (0.1%) | <0.001 | 130 (0.8%) | 158 (1.0%) | 0.097 |
| Type 1 Diabetes Mellitus | 109 (0.7%) | 7,733 (0.3%) | <0.001 | 108 (0.7%) | 106 (0.7%) | 0.891 |
| Celiac Disease | 30 (0.2%) | 1,900 (0.1%) | <0.001 | 30 (0.2%) | 24 (0.2%) | 0.414 |
| Cerebral Palsy | 433 (2.7%) | 8,785 (0.3%) | <0.001 | 432 (2.7%) | 491 (3.1%) | 0.049 |
| Muscular Dystrophy | 22 (0.1%) | 988 (0.0%) | <0.001 | 22 (0.1%) | 26 (0.2%) | 0.563 |
| Osteogenesis Imperfecta | 11 (0.1%) | 418 (0.0%) | <0.001 | 11 (0.1%) | 10 (0.1%) | 0.827 |
| Lymphoid Leukemia | 741 (4.7%) | 1,958 (0.1%) | <0.001 | 712 (4.5%) | 619 (3.9%) | 0.009 |
| Myeloid Leukemia | 121 (0.8%) | 336 (0.0%) | <0.001 | 114 (0.7%) | 85 (0.5%) | 0.039 |
| Monocytic Leukemia | 19 (0.1%) | 40 (0.0%) | <0.001 | 16 (0.1%) | 10 (0.1%) | 0.239 |
| Other Leukemias | 35 (0.2%) | 87 (0.0%) | <0.001 | 33 (0.2%) | 23 (0.1%) | 0.181 |
| Unspecified Leukemia | 394 (2.5%) | 470 (0.0%) | <0.001 | 373 (2.4%) | 275 (1.7%) | <0.001 |
| Noninfective Enteritis and Colitis | 970 (6.1%) | 36,715 (1.3%) | <0.001 | 960 (6.1%) | 958 (6.1%) | 0.962 |

**Table 2**: One-Year Risk of Fracture and Mortality in Pediatric Patients With Versus Without Malnutrition

| Outcome | Malnutrition n (%) | No Malnutrition n (%) | Hazard Ratio (95% CI) |
|---|---|---|---|
| Overall Fracture | 521 (3.1%) | 320 (1.9%) | 1.625 (1.414–1.867) |
| Hand or Wrist Fracture | 29 (0.2%) | 44 (0.3%) | 0.626 (0.407–0.961) |
| Forearm Fracture | 85 (0.5%) | 109 (0.7%) | 0.772 (0.582–1.026) |
| Upper Limb Fracture | 121 (0.7%) | 75 (0.4%) | 1.603 (1.202–2.138) |
| Femur Fracture | 138 (0.8%) | 30 (0.2%) | 4.572 (3.081–6.786) |
| Lower Leg Fracture | 99 (0.6%) | 51 (0.3%) | 1.928 (1.375–2.702) |
| All-Cause Mortality | 521 (3.1%) | 35 (0.2%) | 14.793 (10.505–20.830) |

**Table 3**: Five-Year Risk of Fracture and Mortality in Pediatric Patients With Versus Without Malnutrition

| Outcome | Malnutrition n (%) | No Malnutrition n (%) | Hazard Ratio (95% CI) |
|---|---|---|---|
| Overall Fracture | 1,156 (7.3%) | 945 (6.0%) | 1.257 (1.153–1.370) |
| Hand or Wrist Fracture | 150 (1.0%) | 200 (1.3%) | 0.730 (0.595–0.896) |
| Forearm Fracture | 265 (1.7%) | 314 (2.0%) | 0.857 (0.728–1.009) |
| Upper Limb Fracture | 241 (1.5%) | 207 (1.3%) | 1.184 (0.984–1.426) |
| Femur Fracture | 222 (1.4%) | 56 (0.4%) | 4.019 (2.998–5.388) |
| Lower Leg Fracture | 240 (1.5%) | 176 (1.1%) | 1.388 (1.143–1.687) |
| All-Cause Mortality | 867 (5.5%) | 112 (0.7%) | 7.841 (6.440–9.546) |