

# The Diagnostic Accuracy of In-Hospital Weight Gain for Differentiating Neglect From Other Failure to Thrive Etiologies

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**OBJECTIVES:** To investigate the association of in-hospital weight gain with failure to thrive (FTT) etiologies.

## ABSTRACT

**METHODS:** With this retrospective cross-sectional study, we included children <2 years of age hospitalized for FTT between 2009 and 2012 at a tertiary care children's hospital. We excluded children with a gestational age <37 weeks, intrauterine growth restriction, acute illness, or preexisting complex chronic conditions. Average daily in-hospital weight gain was categorized as (1) below average or (2) average or greater for age.  $\chi^2$ , Fisher's exact test, and 1-way analysis of variance tests were used to compare patient demographics, therapies, and FTT etiologies with categorical weight gain; multivariable logistic regression models tested for associations.

**RESULTS:** There were 331 children included. The primary etiologies of FTT were neglect (30.5%), gastroesophageal reflux disease (GERD) (28.1%), child-centered feeding difficulties (22.4%), and organic pathology (19.0%). Average or greater weight gain for age had a specificity of 22.2% and positive predictive value of 33.9% for differentiating neglect from other FTT etiologies. However, sensitivity and negative predictive value were 91.1% and 85.0%, respectively. After adjusting for demographics and therapies received, neglect ( $P = .02$ ) and child-centered feeding difficulties ( $P = .01$ ) were more likely to have average or greater weight gain for age compared with organic pathology. Children with GERD gained similarly ( $P = .11$ ) to children with organic pathology.

**CONCLUSIONS:** In-hospital weight gain was nonspecific for differentiating neglect from other FTT etiologies. Clinicians should exercise caution when using weight gain alone to confirm neglect. Conversely, below average weight gain may be more useful in supporting GERD or organic pathologies but cannot fully rule out neglect.

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Failure to thrive (FTT) describes inadequate growth and/or undernourishment, most often in infants and young children, and serves as a physical sign for a heterogeneous group of underlying conditions.<sup>1,2</sup> Neglect is one of the underlying etiologies of FTT that clinicians specifically seek to identify given its association with poor child well-being.<sup>3,4</sup> Hospitalization with observation of weight gain has been used to differentiate neglected from non-neglected children.<sup>1,2</sup> This practice is supported by a 2005 American Academy of Pediatrics clinical report by Block and Krebs<sup>5</sup> stating, "Liberal intake and above-average weight gain observed in the hospital support a diagnosis of neglect as an underlying cause of the FTT."

Contrary to this practice, data from over 30 years before (when weeks long hospital courses were common) were used to conclude that in-hospital weight gain was not a reliable indicator in differentiating between FTT etiologies.<sup>6</sup> Additionally, nearly all FTT children cared for in outpatient clinics gain weight well long-term<sup>7-9</sup> regardless of the underlying cause of their FTT.<sup>10,11</sup> Also, short-term observation of in-hospital weight gain may be complicated by other factors, such as fluid shifts, timing of oral intake, urination, and/or defecation,<sup>1</sup> and malnourished infants may require 2 to 3 days of adequate nutrition before gaining weight.<sup>12</sup>

Although the observation of weight gain may serve other purposes (eg, ensuring that a child's nutritional regimen is adequate or for medicolegal considerations), the diagnostic value of observing in-hospital weight gain to differentiate between FTT etiologies remains unclear. If the diagnostic value of in-hospital weight gain in FTT is overestimated or misinterpreted, it may lead to diagnostic errors, unnecessarily prolonged hospital length of stay, or contribute to biases leading to inappropriate reporting to child protective services. Therefore, our objectives with this study were to (1) describe the frequencies of FTT etiologies (neglect or primary medical etiologies) among children hospitalized with FTT and (2) investigate the association of in-hospital weight gain with the underlying etiologies of children's FTT. We hypothesized that children whose FTT was due to neglect would more frequently demonstrate

average or greater weight gain for age compared with other FTT etiologies, particularly after in-hospital therapies were controlled for.

## METHODS

### Study Setting and Population

We conducted a retrospective cross-sectional chart review of children <2 years of age with a first-time FTT hospitalization between 2009 and 2012 at a tertiary care children's hospital with over 14 000 admissions per year. Candidate FTT hospitalizations were first identified as those having any (primary or secondary) *International Classification of Diseases, Ninth Revision* discharge diagnosis of FTT or inadequate growth, consistent with previous work (779.34: FTT in newborns; 783.41: FTT in children; 783.21: abnormal loss of weight; 783.22: underweight; and 781.91: loss of height).<sup>13</sup> Exclusions and data collection were then achieved through individual chart review (Fig 1). Children with the following diagnoses were excluded because they may not follow normal growth patterns: preexisting complex chronic conditions (eg, trisomy 21),<sup>14</sup> history of gestational age <37 weeks or intrauterine growth restriction, or an active acute illness (eg, gastroenteritis). Children were also excluded if FTT, undernourishment, or inadequate growth were not explicitly identified and clinically addressed by the medical team during the hospitalization (ie, not an FTT hospitalization), if a discharge weight was unavailable, or if there was inadequate information to identify a primary FTT etiology.

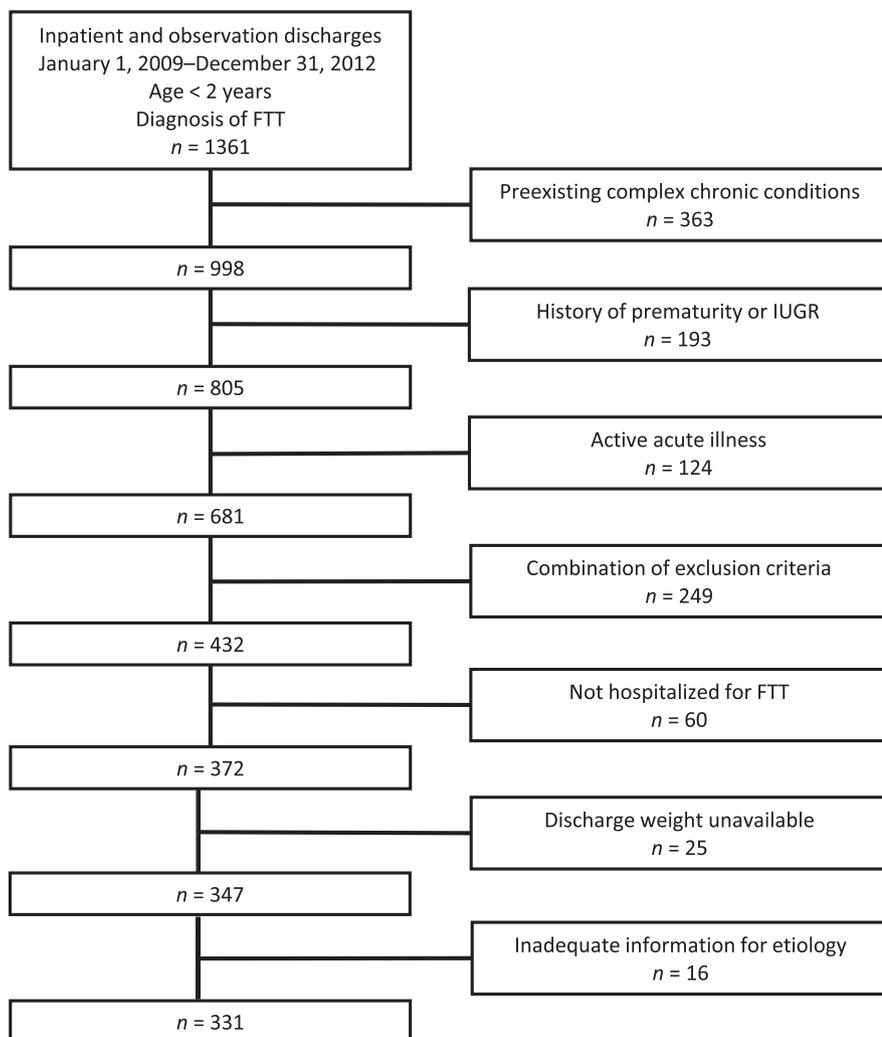
### FTT Etiologies and Operational Definitions

The etiology of FTT was the primary independent variable, and each child was categorized as having 1 of the following: neglect, child-centered feeding difficulties (eg, dysphagia), gastroesophageal reflux disease (GERD), or new organic pathology (ie, not diagnosed before admission). Authors of previous reports have been inconsistent in their taxonomy for FTT etiologies.<sup>1,2,6,15,16</sup> Therefore, operational definitions for the above FTT etiologies were developed by using conditions prevalent

among children with FTT from previous work<sup>6,13,15</sup> and an a priori consensus among 4 pediatric hospitalists (H.T.P., L.P., M.K., and J.L.B.) and 1 child abuse pediatrician (T.F.). A detailed listing of these operational definitions is in Table 1. Neglect was defined as a child's needs not adequately being met, resulting in actual or potential harm and independent of parental intent.<sup>17-19</sup> Because some conditions may seem problematic categorized as neglect under this inclusive definition, and varied clinical and/or legal actions may be required for different forms of neglect,<sup>20,21</sup> we subcategorized neglect further into (1) parent-centered feeding deficits or (2) omissions in basic care. We chose a priori to aggregate the 2 subcategories of neglect for weight gain analyses for 2 principle reasons. First, children's physiologic response to nutrition and their subsequent weight gain should be independent of parental intent, which is essentially the distinction between the 2 types of neglect. Second, determining parental intent can be problematic, and misclassification between the subtypes of neglect may exist. All cases were independently reviewed by 2 attending pediatric hospitalists (H.T.P., L.P., M.K., and J.L.B.) in a blinded fashion, and a primary FTT etiology was assigned. Interrater agreement on a 20% sampling of cases was high ( $\kappa = 0.83$ ). Any disagreements regarding the primary FTT etiology were resolved by simple majority of 5 authors (H.T.P., L.P., M.K., T.N.F., and J.L.B.). Children with a primary medical etiology in whom neglect was also present or suspected were grouped by their primary medical etiology but designated as mixed cases and accounted for in a sensitivity analysis.

### Primary Outcome

The primary dependent variable was average daily in-hospital weight gain, which was calculated as the difference between discharge and admission weights divided by the total number of days between the measurements (not necessarily length of stay). Per protocol, children were weighed on admission and then daily at a prescribed time on the same scale. To account for age-based differences in expected weight gain,<sup>22,23</sup> these grams-per-day values were then dichotomized into (1) below average or



**FIGURE 1** Consort diagram of children hospitalized with FTT included in our study. IUGR, intrauterine growth restriction.

(2) average or greater weight gain for age. Because the argument can be made that catch-up weight gain should be the goal for children hospitalized with FTT, we alternatively dichotomized weight gain as (1) meeting, or (2) not meeting catch-up weight gain for age (defined as 2.5 times the lower range of expected weight gain for age).<sup>23</sup>

### Independent Variables

Patient characteristics were collected on chart reviews and included gender, age, race and/or ethnicity, anthropometrics at admission, and length of stay. In-hospital therapies, including acid suppression medications, thickener use, escalation in diet (eg, initiation of formula

supplementation in a breastfed-only infant), change in breast and/or formula caloric density, type of formula at discharge, initiation of enteral tube feedings, and consultations (nutrition, social work, occupational therapy, and lactation) were also collected.

### Statistical Analysis

$\chi^2$ , Fisher's exact test, and 1-way analysis of variance tests were used to compare patient characteristics, therapies, and FTT primary etiologies across categorical in-hospital weight gain. They were also used to test for differences in independent variables between FTT etiologies to inform covariates for regression modeling.  $\chi^2$  tests

were also used to test for differences in FTT etiologies between age categories. Multivariable logistic regression models tested for associations between independent variables and categorical in-hospital weight gain. Only covariates with near significance ( $P$  values  $<.1$ ) in bivariate analyses were used in multivariable models. To account for the multifactorial nature of FTT, a sensitivity analysis excluding children with mixed FTT etiologies (ie, cases in which a non-neglect etiology was complicated by concurrent neglect) was performed. All statistical analyses were performed by using IBM SPSS version 23.0 (IBM SPSS Statistics, IBM Corporation).  $P$  values  $<.05$  were considered statistically significant. The institutional review board at Children's Mercy Kansas City approved this study.

## RESULTS

### Patient Characteristics and In-Hospital Therapies

A total of 331 children were included. Children were most commonly boys (53.2%), non-Hispanic white (69.8%) with public insurance (69.8%) and a median age of 2 months (interquartile range: 1, 6) (Table 2). Overall, the caloric density of children's feeds was increased in 123 children (37.2%), and 46 (13.9%) children received enteral tube feeds. Thickeners and acid suppression medications were provided to 36 (10.9%) and 171 (51.7%) children, respectively. Children with below average weight gain for age were more likely to have the caloric density of their feeds increased ( $P = .045$ ) and receive acid suppression medications ( $P = .002$ ) compared with children with average or greater weight gain for age (Supplemental Table 4). Otherwise, the weight gain groups did not differ in the in-hospital therapies that they received. All but 1 child (99.7%) received nutrition consultation, and 311 (94.0%) received social work consultation.

### FTT Etiologies

Neglect was the most common primary etiology of FTT, present in 101 children (30.5%). Of these, 74 (73.3% of children diagnosed with neglect and 22.4% of children overall) were due to parent-

**TABLE 1** Operational Definitions of FTT Etiologies

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Neglect; a child's needs were not adequately met resulting in actual or potential harm independent of parental intent
Omissions in parental care
Parent observed to not adequately feed child per documented recommendations
Parent fails to adequately feed children during in-hospital observation
Parent-directed restricted diet was not altered after anticipatory guidance
Observation or documentation of parent's altered mental status or parent being under the influence affecting his or her ability to adequately feed and/or care for child
In-hospital observations of child feeding was inconsistent with home diet history
Parent-centered feeding difficulties (successfully corrected during hospitalization)
Improper formula mixing
Parent unaware of "normal" feeding (eg, not feeding at night)
Impaired feeding techniques
Impaired recognition of feeding cues
Parent-directed restricted diet was altered after anticipatory guidance
Disordered parent-child interaction
Insufficient breast milk supply and/or caloric density
Child-centered feeding difficulties
Dysphagia
Oral aversion
Ankyloglossia
Low appetite
Avoidant eating behavior
Behavioral rigidity and/or sensory aversions interfering with feeding
Developmental delay interfering with feeding
Food preference and/or avoidance
GERD, vomiting, and/or overfeeding
Organic pathology defined as new diagnosis of condition contributing to weight faltering made during hospitalization

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attaining average or greater weight gain for age more frequently had feeding difficulties or neglect, lower weight-for-age z scores at admission, and shorter lengths of stay (1.4 days shorter compared with children with below average weight gain). Conversely, children with below average daily weight gain for age more frequently had organic pathology or GERD. Children in the 2 subcategories of neglect (ie, omissions in basic care and parent-centered feeding difficulties) did not gain weight differently ( $P = .74$ ), supporting our decision to combine them for weight gain analyses.

### Adjusted Odds Ratios of Average or Greater Weight-for-Age by FTT Etiology

After controlling for patient demographics, age-based differences in expected daily weight gain, and in-hospital therapies, neglect and child-centered feeding difficulties had >3 times the odds of having average or greater weight gain for age compared with organic pathology (Table 3). Children hospitalized with FTT caused by GERD gained similarly to children with organic pathology ( $P = .11$ ). The odds of average or greater weight gain for age were greater for children with lower weight-for-age z score at admission and lower for children receiving acid suppression medication.

To account for the multifactorial nature of FTT, a separate sensitivity analysis excluded the 60 children with mixed FTT etiologies (cases with medical etiologies possibly complicated by neglect, either parent-centered feeding difficulties, or omissions in basic care). In this analysis, the associations of FTT etiologies and weight gain remained largely unchanged except that the adjusted odds of neglected children having average or greater weight gain increased to 5.1 (95% confidence interval (CI): 2.12–12.31).

### Accuracy of In-Hospital Weight Gain to Differentiate Neglect From Other FTT Etiologies

In differentiating neglect from other FTT etiologies, average or greater weight gain for age in the hospitalized setting had

centered feeding deficits (eg, improper mixing of formula and inadequate nighttime feeds), and 27 (26.7% of children diagnosed with neglect and 8.2% of children overall) were due to omissions in basic care. Neglect was suspected as a secondary etiology in an additional 60 children (18.1% with primary medical FTT etiologies). Thirty-nine children (11.8%) were referred to child protective services by the referring providers or by the inpatient team, of which 20 had omissions in basic care, 15 had parent-centered feeding difficulties, and 4 were not neglected. GERD (28.1%) was the second most common primary etiology for FTT followed by child-centered feeding difficulties (22.4%) and organic pathology (19.0%). The 63 children with new organic pathology were diagnosed with 29 unique diagnoses (Supplemental Table 5).

Primary FTT etiologies varied by age at admission ( $P < .001$ ; Fig 2). GERD was the most common cause of FTT in young infants (2–5 months; 44.8%) but decreased with age and was rare in toddlers (2.9%). The highest number of cases of organic pathology occurred in neonates ( $n = 25$ ; 20.0%; the majority of which were pyloric stenosis). The likelihood of organic pathology increased with age and accounted for the largest proportion of FTT in toddlers ( $n = 14$ ; 41.2%), particularly if cases of pyloric stenosis were excluded. The percent of FTT cases due to neglect (regardless of subtype) was similar across age groups.

### Average Daily Weight Gain

Overall, 271 (81.9%) children had average or greater weight gain for age, and 60 (18.1%) had below average weight gain for age (Table 2). In bivariate analysis, children

**TABLE 2** Patient Characteristics for the 331 Children Hospitalized With FTT

Patient Characteristics	Average Daily Wt Gain for Age			P
	Overall (N = 331), n (%)	Below Average (60 [18.1]), n (%)	Average or Greater (271 [81.9]), n (%)	
Sex				.24
Male	176 (53.2)	36 (60.0)	140 (51.7)	
Race				.73
Non-Hispanic white	231 (69.8)	45 (75.0)	186 (68.6)	
Non-Hispanic African American	46 (13.9)	6 (10.0)	40 (14.8)	
Hispanic	15 (4.5)	2 (3.3)	13 (4.8)	
Other or unknown	39 (11.8)	7 (11.7)	32 (11.8)	
Age, mo				.26
Neonates, 0–1	125 (37.8)	29 (48.3)	96 (35.4)	
Young infants, 2–5	116 (35.0)	17 (28.3)	99 (36.5)	
Older infants, 6–11	56 (16.9)	10 (16.7)	46 (17.0)	
Toddlers, 12–23	34 (10.3)	4 (6.7)	30 (11.1)	
Anthropometrics at admission, mean ± 2 SDs				
Wt-for-age z score	−2.5 ± 1.1	−2.2 ± 1.0	−2.6 ± 1.1	.006
Length-for-age z score	−1.7 ± 1.7	−1.7 ± 2.7	−1.6 ± 1.4	.89
Head circumference-for-age z score	−0.8 ± 1.6	−1.1 ± 2.6	−0.8 ± 1.3	.22
Wt-for-length z score	−2.0 ± 1.5	−1.8 ± 1.3	−2.1 ± 1.5	.30
Etiology of FTT				<.001
Neglect	101 (30.5)	9 (15.0)	92 (33.9)	
Feeding difficulties (child centered)	74 (22.4)	8 (13.3)	66 (24.4)	
GERD	93 (28.1)	23 (38.3)	70 (25.8)	
Organic pathology	63 (19.0)	20 (33.3)	43 (15.9)	
Length of stay, d				<.001
<3	129 (39.0)	15 (25.0)	114 (42.1)	
3–4	118 (35.6)	16 (26.7)	102 (37.6)	
5–7	35 (10.6)	14 (23.3)	21 (7.7)	
>7	49 (14.8)	15 (25.0)	34 (12.5)	

sensitivity, specificity, positive predictive, and negative predictive values of 91.1%, 22.2%, 33.9%, and 85.0%, respectively. Alternatively, dichotomizing children as meeting or not meeting catch-up weight gain for age provided only marginal improvement in specificity (44.8%) and positive predictive value (38.0%) for neglect.

## DISCUSSION

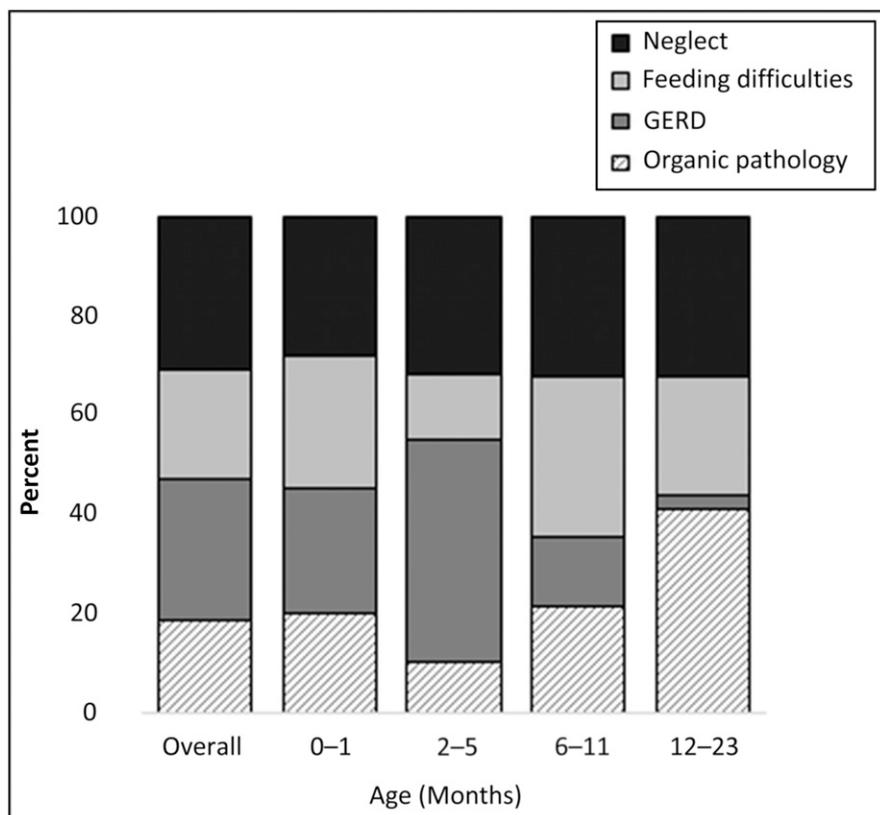
In this study of 331 children hospitalized with FTT, neglect was the most common primary etiology, but <1 in 10 cases overall were due to frank omissions in basic care. Children with neglect or child-centered feeding difficulties were more likely than children with GERD or organic pathologies to have average or greater weight gain for

age. However, most children hospitalized with FTT met or exceeded expected weight gain for age regardless of etiology, making in-hospital weight gain nonspecific for differentiating neglect from other etiologies of FTT. Our results raise concern that although in-hospital weight gain has some value for differentiating between FTT etiologies, its value in confirming neglect may be clinically overestimated.

Under a broad definition, we identified neglect as the sole cause of FTT in 30% of children and in another 18% who had a primary medical FTT etiology. This appears similar to data from nearly 30 years before, when 32% to 50% of FTT in the hospitalized setting was caused by “social-environmental deprivation.”<sup>6,15</sup> Concern has been raised

that the prevalence of neglect among children with FTT may be overestimated.<sup>24</sup> In support of this, we found that neglect due to omissions in basic care was the primary cause of FTT for only 8% of children, and 12% of children were referred to child protective services, similar to previous reports (5%–10%).<sup>4,24,25</sup> However, the second form of neglect, potentially inadvertent parent-centered feeding difficulties, was the cause of FTT in about 1 in 4 children. Given their nature, some of these hospitalizations may have been preventable with careful histories and simple outpatient interventions.<sup>26</sup>

Children with neglect or child-centered feeding difficulties were more likely to have average or greater weight gain for age



**FIGURE 2** The proportion of FTT etiologies for each age group.

compared with children with organic pathology and GERD, in contrast to previous reports.<sup>6,10</sup> Owing to the high sensitivity in our sample, our results are in apparent support of Block and Krebs<sup>5</sup> statement that above average in-hospital weight gain supports neglect as an underlying cause of the FTT. However, similar to previous findings,<sup>6,10,11,15</sup> our results also reveal that

most children hospitalized for FTT met or exceeded expected weight gain for age regardless of their underlying FTT etiology, leading to low specificity (22%) and positive predictive value (33.9%). With our results, we indicate that average or greater weight gain for age has minimal value in confirming neglect but below average weight gain for age may have greater clinical value by

**TABLE 3** Adjusted Odds Ratio (95% CI) of Average or Greater Wt Gain for Age Compared With Below Average for 331 Children Hospitalized for FTT

	Average or Greater aOR (95% CI)	P <sup>a</sup>
Etiology of FTT		.02
Neglect	3.1 (1.2–7.7)	.02
Feeding difficulties	3.6 (1.4–9.0)	.007
GERD	1.9 (0.9–4.2)	.11
Organic pathology	—	—
Wt-for-age z-score on admission	0.7 (0.5–0.9)	.01
Acid suppression medication use during admission	0.4 (0.2–0.9)	.02

Regression model adjusted for etiology of FTT, wt-for-age z score, length of stay, acid suppression medication use during admission, change in caloric density, escalation in diet, thickener use, occupational therapy consult, and lactation consult. aOR, adjusted odds ratio; —, not applicable.

<sup>a</sup> P values calculated by multiple logistic regression.

supporting a non-neglectful etiology (eg, organic pathology). Clinically overestimating the association between weight gain and neglect may lead to confirmation bias, diagnostic errors, and contribute to disparities in the diagnosis and/or reporting of neglect, particularly among minority or low socioeconomic children.<sup>27,28</sup> Greater emphasis should be given toward obtaining a thorough history and physical examination, objective assessments of a child's feeding practices, identification of psychosocial risk factors, and observation of parental behaviors and parent-child interactions.<sup>1</sup> Also, it should be noted that we do not view our results as invalidating the medicolegal paradigm that adequate weight gain for age in the hospitalized setting can support neglect as a cause (evidenced by the high sensitivity found), only that other clinical factors and observed parental behaviors need to be taken into consideration.

Children with GERD or new organic pathology were less likely to have average or greater weight gain for age, but most still attained expected weight gain for age. The lower likelihood of weight gain seen in children with GERD-related FTT may be because of the general lack of or only marginally efficacious therapies for GERD.<sup>29–31</sup> New organic pathology was identified in 19% of children hospitalized for FTT in our study, similar to that previously reported in the hospitalized setting over 30 years ago (10%–18%)<sup>6,15</sup> but more than has been reported in gastroenterology clinic (7%)<sup>32</sup> and population-based cohorts (3%–8%).<sup>25,33,34</sup> The likelihood of new organic pathology (other than pyloric stenosis) increased with age and was the most common cause of FTT in toddlers (41.2%). With our findings, we suggest that although routine diagnostics are not recommended for FTT evaluations given their low yield (about 1%), even in hospitalized settings,<sup>1,6,15</sup> considerations of a child's age may inform more selective testing.

Our results should be interpreted in the context of the following limitations. First, there are limitations inherent to retrospective studies. Second, although we were able to account for changes in feeding regimens, we were unable to account for

the timing of their introductions or other variables that may have impacted children's total average daily weight gain, such as interruptions in oral intake for diagnostics, tiered introduction of feeding therapies, or weight changes from intravenous fluids. For example, if a child gained poorly on standard calorie formula for 2 days but then gained well for 2 days on 26-kcal formula, we accounted for the increase in their caloric density but not the duration of each nutritional regimen. Third, we could not account for practice variability in clinicians' demands for in-hospital weight gain before discharge. Fourth, the diagnosis of some FTT etiologies are dependent on clinical assessments (eg, GERD) and, although our methods were rigorous, our assignment of etiologies may have been inaccurate in some cases. In addition, assigning primary etiologies for each case may not fully capture the multifactorial nature of FTT. However, aiming to capture the complex feeding and/or psychosocial issues that can confound FTT cases, a sensitivity analysis accounting for mixed cases did not meaningfully alter this study's conclusions. Fifth, although our methods were specifically structured to identify a large number of candidate cases, there remains the possibility that some cases of FTT may have been missed. Finally, as a single-center investigation, our results may not be generalizable to all other hospitalized settings.

## CONCLUSIONS

There were differences in weight gain between FTT etiologies even after accounting for confounding variables. However, average or greater weight gain for age was nonspecific for neglect among children hospitalized for FTT. With our results, we suggest that clinicians should exercise caution when using in-hospital weight gain to confirm neglect, and, ultimately, assessments should be more heavily reliant on history and physical examinations, observations of child and parental behavior, and, as suggested by our results, a child's age at admission. Conversely, greater clinical value may be derived from observations of below average weight gain for age, which appears to lend

support for GERD or organic pathologies but cannot rule out neglect. Further study is needed to determine if some children hospitalized with FTT can be safely discharged from the hospital without strict weight gain requirements.

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