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Infantile Anorexia
Growth and Nutrient Intake in 62 Cases

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Abstract: Eating disorders among young children are not well characterized. Diet and growth data were collected from toddlers (1-3 years old) at the time of diagnosis of infantile anorexia (IA) and up to 1 year after family counseling. Children (n = 62) were underweight (≤ −2 z-score weight-for-age). Boys (n = 34) had a greater (P = .04) mean (standard error) weight-for-age percentile than girls (n = 28) and less evidence of wasting (z-score weight-for-length = −1.8 (0.14) vs −2.3 (0.17), respectively; P = .04). After counseling, girls demonstrated better linear growth than boys (4.14 (0.18) vs 3.47 (0.18) cm/6 months, respectively; P < .002). Significant catch-up in length-for-age was observed across genders and diagnoses of 1.4 (2.07) growth percentiles and 0.13 (0.05) z-scores on the normal curve in 6 months (P = .019). Head circumference correlated with dietary protein (r = .23, P = .03), calcium (r = .32, P = .004), and zinc (r = .36, P = .001). Girls met or exceeded dietary reference intakes for energy, protein, iron, zinc, vitamin A, and calcium, and boys improved intake of these nutrients (P < .05) but boys with IA fell short of recommended energy intake. Many children with IA reached tolerable upper intake levels for zinc and vitamin A, which warrants concern. These are the first data published on diet and growth among children with IA.

Keywords: eating disorders; feeding and swallowing problems; growth problems; supplementary nutrition; toddler anorexia (IA), whose deficiencies are attributed to their being “picky eaters” characterized by a tenacious refusal to eat adequate amounts of food over the course of 1 month or longer. The onset of IA food refusal behaviors often occurs during the transition to spoon- and self-feeding between 6 months and 3 years of age. The child with IA rarely communicates hunger. IA-related behaviors include food-related tantrums, strong refusal when offered food, attempts at climbing out of the high chair and/or leaving the table after minimal bites are eaten, and an enhanced interest in play and physical exploration during mealtimes. These behaviors result in inadequate food intake and growth failure.

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Some children exhibit both IA and sensory food aversions (IA + SFA). The SFA feeding disorder is characterized by consistent refusal, for 1 month or longer, to eat certain foods having specific tastes, textures, temperatures, or smells. Often the child with SFA develops a reluctance to try unfamiliar foods. Examples of SFA behavior include drinking one type of milk but refusing other milks or eating pureed food but refusing lumpy food. The children’s reactions to aversive foods can range from grimacing or spitting to gagging or vomiting. After having an aversive reaction, these children refuse to continue eating the associated food and frequently generalize and refuse other foods with a similar color, appearance, or smell. Consequently, some children refuse whole food groups, increasing risk for nutrient deficiencies. However, when offered their preferred food, the children eat without difficulty and usually do not show any growth failure; some even become overweight.

Research on IA has focused on behavioral, psychological, and social issues related to feeding and parent–child interactions and little data are available to describe nutritional status. The purpose of this nutrition study was to characterize the growth and nutrient intakes of children with IA and the IA + SFA feeding disorders and determine whether there were differences between these diagnostic groups before and during psychiatric care that included routine nutrition assessments by a registered dietitian.

Methods

Case Study Design and Diagnostic Categories

The growth and diet data collected for this case series were obtained prospectively during a psychiatric study of children (1-3 years old) diagnosed with IA or IA + SFA between November 1999 and May 2005. The hospital institutional review board approved the protocol and parents provided consent. A physical examination was conducted on all children by an experienced pediatric nurse practitioner under the supervision of a pediatric gastroenterologist. After a medical examination ruled out illness as a cause of food refusal, psychiatrists classified children as IA or IA + SFA according to published diagnostic criteria that included exhibiting a consistent pattern of food refusal. Children requiring hospitalization and/or tube feeding were excluded.

Clinical Management and Family Counseling

There are 3 cornerstones to recovery from IA: (a) increase the child’s reliance on internal cues of hunger and satiety; (b) increase consumption of a variety of whole foods; and (c) ensure adequate energy and nutrient intake, below the tolerable upper intake levels (UL). Nutrition care plans include a rehabilitation and refeeding program with consideration of energy requirements for healthy levels of physical activity and new tissue deposition; goals for age and developmentally appropriate food selection, self-feeding and other eating behaviors such as the transition to less reliance on liquid calories; other treatments, when indicated, including liquid food supplements; monitoring for symptoms and conditions associated with changes in diet (eg, diarrhea, constipation, abdominal pain); and expected rates of weight gain and height velocity.

Within 3 weeks of the diagnostic visit, parents returned to the clinic for 6 counseling sessions. The first 3 sessions were scheduled 1 week apart. During the first 2 sessions, the therapist discussed the child’s temperament, their absence of hunger cues, and their intense interest in numerous activities but lack of interest in food. The therapist explored the parents’ upbringing and any difficulties they had in setting limits with their child. In the third session, the therapist provided parents with feeding guidelines to help their child recognize hunger and eat until full. Parents were given instructions for setting limits and coaching their child in self-calming behavior. The subsequent 3 sessions were scheduled 2 to 3 weeks apart and focused on helping parents develop problem-solving skills to support setting limits and implement the feeding guidelines.

Anthropometry and Diet

Children were scheduled for follow-up visits at 1 month, 6 months, and 1 year after the last counseling session. During visits the research dietitians measured the children’s weight, recumbent length or height, and head circumference. The standing height was measured with a wall-mounted stadiometer (SECA model 216, Hanover, MD) if children were 36 months or older, otherwise recumbent length was measured (Holtain Limited, Crymych, Dyfed, UK). HC was measured with non-stretch tape (Seca 212, Seca Corp, Hanover, MD) positioned above the ears and eyebrows at the maximum circumference. Growth percentiles and z-scores were obtained from Centers for Disease Control and Prevention (CDC) clinical growth charts. Underweight was defined as ≤−2 z-score weight-for-age and wasing was defined as a weight-for-length z-score of −2 or less. The mean growth velocity after counseling was compared with median growth rate of healthy children.

Registered dietitians collected food records from parents who were asked to record all food and supplements consumed by the child for 3 consecutive days prior to each visit. If food records were incomplete, the dietitians administered a 24-hour recall, using food models and a multiple-pass method. Mean daily intake of energy, protein, calcium, iron, zinc, and vitamin A were calculated using food composition software (Nutritionist Pro v 3.0-4.2, Axxya Systems, Stafford, TX), which served as a representation of overall diet quality. For food brands not included in the software database, nutrient content was obtained using the product’s

References

Nutrition Facts label. Nutrient intakes from fruit juice, milk, infant formulas, and other fluids were recorded as a percentage of the daily total energy and protein consumed. Nutrient intake from supplements included intake from infant formulas, other nutritional fluids and vitamin tablets. Intake values were compared with dietary reference intakes (DRI), and for purposes of comparison with the estimated energy requirement, the values for 2- and 3-year-old children were used along with the Institute of Medicine (IOM) reference height and weight at low-active physical activity.

Intakes of participants were also compared with intakes of healthy toddlers who participated in the Feeding Infants and Toddlers Study (FITS). For energy and protein comparisons, the FITS values were converted to units per body weight (per kilogram) using median values were converted to units per body weight, length, and HC were tested for relation-
correlation coefficients. Trends in growth length, and HC were tested for relation-
correlation coefficients. Trends in growth length, and HC were significant for

Data Analyses
Anthropometric and nutrient intake variables were tested for normal distribution using the Shapiro–Wilk and/or Kolmogorov–Smirnov tests. Log transformations were performed on nonnormally distributed variables. Means, regression coefficients, and standard errors (SE) of transformed variables were back-transformed for reporting, but P values were presented as obtained in the analyses. Absolute measures of weight, length, and HC were tested for relationships with nutritional intake using Pearson correlation coefficients. Trends in growth and intake were analyzed beginning from the time of diagnosis (baseline) through the last follow-up visit using regression analysis (to compensate for attrition). All statistical analyses were performed using SAS Release 9.2 (SAS Institute Inc, Cary, NC) and statistical comparisons were made at the .05 α level.

Results and Discussion
Cases
The 62 (55% male) children who met the diagnostic criteria for IA were predomin-
antly non-Hispanic white (68%), mostly upper-middle class, and lived in the mid-Atlantic United States. The mean age (±SD) was 22.5 ± 7.4 months (19.9 ± 0.6 years) at diagnosis and 39.7 ± 10.6 months (3.0 ± 0.9 years) at the last measure. Age did not differ significantly between IA-only (n = 35) and IA + SFA groups (n = 27). The age at onset of the disorder and the duration of disordered eating prior to diagnosis was not determined.

In all, 40 (64.5%), 30 (48.4%), and 25 (40.3%) children returned for the 1-month, 6-month, and 1-year follow-up visits, respectively. Some of the reasons for reduced participation of the families in subsequent visits were as follows: relocation, lack of time, birth of another baby, deciding that a few visits resolved their child’s issues, and dissatisfaction with counseling.

Growth Status
At diagnosis, there were no significant differences in growth status between the diagnostic groups when gender and age were controlled (Table 1). Both groups were similarly and substantially underweight and wasted, having z-scores for weight-for-age and weight-for-length at 2 or more standard deviation units below the mean of the reference population (Table 1). However, HC was normal. It should be reiterated that this case series included only those children with SFA who also had IA; whereas, other children with SFA can have ample intake of preferred foods and exhibit no growth delays.

After counseling, positive changes in weight, length, and HC were significant for all children with IA (P < .0001). HC increased an average (SE) of 0.81 (0.11) cm/6 mo (< .0001), exceeding the median 0.54 and 0.61 cm/6 mo rate between ages of 22.5 and 36.0 months of healthy boys and girls, respectively.

Averaging 5.4 g/d of weight gain (Table 1), both diagnostic groups met or exceeded the median rate observed in healthy boys and girls between ages of 22.5 and 39.5 months of 4.7 and 5.1 g/d (0.85 and 0.92 kg/6 mo), respectively. However, weight-for-age and weight-for-length percentiles and z-scores did not change significantly from precounseling values, indicating that growth was insufficient to “catch up” to normal status. Based on these observational data, it appears that weight gains will have to surpass 5.4 g/d during the first year of treatment in order for IA and IA + SFA children to achieve improvement in relative weight as indicated on CDC growth charts with considerations for tailoring the growth velocity to the needs of the child to avoid overfeeding and excess fat accumulation. In contrast to weight gain, there was significant catch-up growth in length-for-age of 1.4 (2.1) percentiles (P = .0125) and 0.13 (0.05) z-scores on the normal curve (P = .019) over 6 months, across genders and diagnoses.

Girls had more extreme disparities in growth status than boys when age and diagnosis were controlled. Girls met criteria for wasting at diagnosis whereas boys did not, averaging −2.3 (0.2) versus −1.8 (0.1) in weight-for-length z-score, respectively (P = .04; Table 1). After counseling, girls demonstrated 0.67 cm/6 mo better linear growth than boys (P = .0016; Table 1). Linear velocity of growth was similar to the pattern observed in typical females between ages 22.5 of 39.5 months, where median growth is 4.05 cm/6 mo. Linear growth was sufficient to advance percentile standings on the CDC length-for-age growth chart. Despite positive growth, boys lagged 0.5 cm/6 mo behind the respective median reference rate of 3.94 cm/6 mo between ages of 22.5 and 39.5 months.

Seven months after family counseling, girls of both diagnoses were still classified as underweight-for-age and nutritionally wasted, whereas boys of both diagnoses were still classified as underweight-for-age. This disparity is due in part to girls having relatively greater deficits to recover from, starting for example with an average weight-for-age z-score of −2.7 (0.16) standard deviation units below the mean of the reference population (Table 1). These observations raise concerns of whether there is a gender bias on the part of parents who delayed seeking treatment for girls and/or whether primary care providers delayed referral to a feeding disorder specialist as it may be more socially acceptable for girls to be “picky eaters” and/or petite. Earlier
intervention for girls and for boys may improve prognosis of IA and IA + SFA because growth trajectory is established from 12 to 36 months of age and growth faltering during infancy has been shown to persist. Studies in developing countries indicate that children who were stunted in early childhood had little catch-up growth beyond age 7 years and remained shorter than their peers as teenagers and as adults. Stunting is associated with less skill in fine motor tasks, lower scores in arithmetic at 11 to 12 years, and more anxiety, depressive symptoms, and lower self-esteem in late adolescence. Pediatricians routinely monitor growth and recognize faltering but may need education to hasten referral of potential IA cases to specialists. Future investigations could consider factors contributing to the length of time that parents delay seeking medical consultation while they struggle in their attempts to experiment with food and food preparation techniques that might be acceptable to their children. Research shows that by 18 months of age, breast-fed infants are leaner and have lower weight-for-length z-scores than formula-fed infants, even after complimentary foods are introduced. Thus, studies of children with IA should control for confounding from birth weight and past breast-feeding duration on growth parameters. The CDC recently recommended that US clinicians use the 2006 World Health Organization (WHO) international growth charts rather than the CDC growth charts for children younger than 24 months to describe healthy growth in optimal conditions because all children included in the WHO data set were breast-fed for at least 12 months. The CDC growth charts should continue to be used as a growth reference for children 2 to 19 years old.

### Intake

Many pediatricians started children on fluid supplements prior to referring them to a feeding disorder specialist, so intakes at diagnosis may be more sufficient than the preceding diet that led to growth deficits. This may partly explain why children consumed 40% to 50% of their energy and protein in the form of fluids and consumed proportionally more vitamins and minerals from supplements than reported for healthy toddlers in FITS (Table 2). After counseling, boys significantly decreased the proportion of energy they derived from fluids, whereas girls made no significant change in the proportion of nutrients supplied by fluids or supplements (Table 2).

Girls met or exceeded the DRI for energy, protein, iron, zinc, vitamin A, and calcium at diagnosis, whereas boys with IA did not meet the recommended intake level for energy or calcium (Table 2).

### Table 1.

Growth Parameters of Toddlers (n = 62) at Diagnosis With Feeding Disorders and After Psychiatric Counseling

<table>
<thead>
<tr>
<th></th>
<th>IA (n = 35)</th>
<th>IA + SFA (n = 27)</th>
<th>Boys (n = 34)</th>
<th>Girls (n = 28)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Status at diagnosis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth percentile</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight-for-age</td>
<td>2.5 (1.0)</td>
<td>3.2 (1.3)</td>
<td>4.2 (1.0)*</td>
<td>1.6 (1.3)</td>
</tr>
<tr>
<td>Length-for-age</td>
<td>19.9 (3.0)</td>
<td>10.4 (3.5)</td>
<td>16.9 (2.8)</td>
<td>13.4 (3.4)</td>
</tr>
<tr>
<td>Weight-for-length</td>
<td>5.0 (1.3)</td>
<td>5.5 (1.6)</td>
<td>6.8 (1.3)*</td>
<td>3.8 (1.6)</td>
</tr>
<tr>
<td>Head circumference-for-age</td>
<td>46.4 (5.1)</td>
<td>29.4 (8.6)</td>
<td>39.1 (5.5)**</td>
<td>36.8 (8.4)</td>
</tr>
<tr>
<td><strong>z-score</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight-for-age</td>
<td>−2.5 (0.13)</td>
<td>−2.4 (0.16)</td>
<td>−2.2 (0.13)**</td>
<td>−2.7 (0.16)</td>
</tr>
<tr>
<td>Length-for-age</td>
<td>−1.1 (0.14)</td>
<td>−1.5 (0.17)</td>
<td>−1.2 (0.14)</td>
<td>−1.4 (0.17)</td>
</tr>
<tr>
<td>Weight-for-length</td>
<td>−2.1 (0.14)</td>
<td>−2.0 (0.17)</td>
<td>−1.8 (0.14)*</td>
<td>−2.3 (0.17)</td>
</tr>
<tr>
<td>Head circumference-for-age</td>
<td>−0.1 (0.19)</td>
<td>−0.7 (0.32)</td>
<td>−0.3 (0.20)*</td>
<td>−0.4 (0.31)</td>
</tr>
<tr>
<td><strong>Gains after counseling</strong></td>
<td>(89 measures)</td>
<td>(63 measures)</td>
<td>(80 measures)</td>
<td>(72 measures)</td>
</tr>
<tr>
<td>Weight (g/d)</td>
<td>5.38 (0.27)</td>
<td>5.48 (0.27)</td>
<td>5.22 (0.22)</td>
<td>5.65 (0.31)</td>
</tr>
<tr>
<td>Weight (kg/6 mo)</td>
<td>0.97 (0.05)</td>
<td>0.99 (0.05)</td>
<td>0.94 (0.04)</td>
<td>1.02 (0.06)</td>
</tr>
<tr>
<td>Length (cm/6 mo)</td>
<td>3.60 (0.18)</td>
<td>4.05 (0.18)</td>
<td>3.47 (0.18)*</td>
<td>4.14 (0.18)</td>
</tr>
<tr>
<td>Head circumference (cm/6 mo)</td>
<td>0.81 (0.11)</td>
<td>0.81 (0.11)</td>
<td>0.81 (0.11)</td>
<td>0.81 (0.11)</td>
</tr>
</tbody>
</table>

Abbreviations: IA, infantile anorexia; SFA, sensory food aversion.
*aSignificant difference between boys and girls (diagnosis and age were controlled): *P = .04, **P = .01, †P < .05, ‡P = .0016.

aData are presented as mean (standard error).
### Table 2.

Energy and Nutrient Intake for Toddlers (n = 62) at Diagnosis With Feeding Disorders and After Psychiatric Counseling

<table>
<thead>
<tr>
<th></th>
<th>Boys</th>
<th></th>
<th>Girls</th>
<th></th>
<th>Dietary Reference Intake (1-3 Years)</th>
<th>FITS Usual Intake</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IA (n = 18)</td>
<td>IA + SFA (n = 16)</td>
<td>All (n = 34)</td>
<td>IA (n = 17)</td>
<td>IA + SFA (n = 11)</td>
<td>All (n = 28)</td>
</tr>
<tr>
<td><strong>Total intake</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy (kcal/kg/d)</td>
<td>69.5 (8.90)</td>
<td>94.7 (8.29)</td>
<td>+5.0 (2.52)*</td>
<td>92.6 (9.29)</td>
<td>87.4 (9.94)</td>
<td>-2.9 (2.88)</td>
</tr>
<tr>
<td>Protein (g/kg/d)</td>
<td>2.4 (0.33)</td>
<td>3.0 (0.31)</td>
<td>+0.25 (0.11)*</td>
<td>2.7 (0.34)</td>
<td>2.6 (0.37)</td>
<td>-1.2 (0.79)</td>
</tr>
<tr>
<td>Iron (mg/d)</td>
<td>5.3 (2.34)</td>
<td>12.3 (2.18)</td>
<td>+2.2 (0.72)**</td>
<td>14.5 (2.44)</td>
<td>9.7 (2.62)</td>
<td>-1.2 (0.79)</td>
</tr>
<tr>
<td>Zinc (mg/d)</td>
<td>4.5 (1.56)</td>
<td>7.4 (1.45)</td>
<td>+1.8 (0.54)**</td>
<td>6.9 (1.63)</td>
<td>6.9 (1.74)</td>
<td>+0.1 (0.63)</td>
</tr>
<tr>
<td>Vitamin A (µg RAE/d)</td>
<td>451 (201.1)</td>
<td>974 (187.5)</td>
<td>+105 (60.1)*</td>
<td>699 (209.9)</td>
<td>763 (224.8)</td>
<td>+28 (67.3)</td>
</tr>
<tr>
<td>Calcium (mg/d)</td>
<td>405 (78.6)</td>
<td>498 (76.7)</td>
<td>+146 (32.2)**</td>
<td>693 (77.5)</td>
<td>638 (88.1)</td>
<td>+38 (35.4)</td>
</tr>
<tr>
<td><strong>Portion of daily amount from fluids (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>49</td>
<td>40</td>
<td>-4.4 (1.80)*</td>
<td>43</td>
<td>46</td>
<td>-3.4 (1.80)</td>
</tr>
<tr>
<td>Protein</td>
<td>44</td>
<td>37</td>
<td>+0.3 (0.05)</td>
<td>51</td>
<td>52</td>
<td>+0.01 (0.07)</td>
</tr>
<tr>
<td><strong>Portion of daily amount from supplements (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>43</td>
<td>58</td>
<td>+1.4 (0.60)</td>
<td>66</td>
<td>68</td>
<td>-1.5 (0.68)</td>
</tr>
<tr>
<td>Zinc</td>
<td>48</td>
<td>50</td>
<td>+1.2 (0.48)</td>
<td>67</td>
<td>71</td>
<td>-0.4 (0.53)</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>34</td>
<td>54</td>
<td>+81 (39.6)*</td>
<td>72</td>
<td>60</td>
<td>-36 (44.3)</td>
</tr>
<tr>
<td>Calcium</td>
<td>36</td>
<td>27</td>
<td>-15 (19.1)</td>
<td>50</td>
<td>35</td>
<td>-65 (21.2)</td>
</tr>
</tbody>
</table>

Abbreviations: AI, adequate intake; EAR, estimated average requirement; EER, estimated energy requirement; FITS, Feeding Infants and Toddlers Study; IA, infantile anorexia; IOM, Institute of Medicine; ND, not determined; RAE, retinol activity equivalents; SFA, sensory food aversion; UL, tolerable upper intake level.

aData are presented as mean (standard error).

bFor boys, significant change over the course of the study: *P < .05; **P < .01.

cSignificant difference in intake within a row (P < .05).
Boys consumed less calcium, values given as mean (SE), than girls when age and diagnosis were controlled, 451.3 (77.7) mg/d versus 665.8 (82.8) mg/d, respectively, \( P < .05 \). Boys with IA consumed significantly less iron than other groups (Table 2) but intake exceeded the estimated average requirement. It is possible that these children may have had prolonged deficiencies in other nutrients, not assessed in this study, that compromised growth. Furthermore, because of the magnitude of their deficits, their nutrient needs may be higher than the DRI. The DRI are not designed for catch-up growth and are not necessarily goals for IA, which should be tailored to the individual child with IA.

After counseling, boys improved intake (\( P < .05 \); Table 2). In particular, boys increased calcium intake by 146 (32.2) mg/d (\( P < .01 \)), closing the gap between baseline intake and the estimated average requirement (Table 2). Despite significantly increasing energy intake by 5.0 (±2.5) kcal/kg/d, boys with IA did not meet estimated energy requirements. It is known that energy deficits directly stymie length velocity in young mammals,\(^{30,31}\) but the exact toll of caloric deficit on length in children cannot be ascertained.

There was an interaction between gender and diagnosis for supplemental iron and vitamin A when age was controlled; girls with IA consumed significantly more supplemental iron than boys with IA, 9.6 (1.9) versus 2.3 (1.85) mg/d; \( P = .004 \), and significantly more supplemental vitamin A, 502 (140) versus 154 (134) µg retinol activity equivalents/d, respectively; \( P = .03 \); values given as mean (SE). Supplemental calcium and zinc did not differ significantly between diagnostic groups after controlling for age and gender.

Head circumference (but not weight or length) was correlated with intake of protein \( (r = .23, \ P = .03) \), calcium \( (r = .32, \ P = .004) \), and zinc (total zinc, \( r = .36, \ P = .001 \); supplemental, \( r = .24, \ P = .05 \)). Hoekema et al\(^{32}\) reported that protein, but not energy, had a significant positive association with head growth up to 3 years of age in children with phenylketonuria. However, correlations are not conclusive of causality and it is controversial whether supplementing nutrients can accelerate growth, especially in amounts that exceed the recommended dietary allowance (RDA).\(^{33,34}\) Bhandari et al\(^{35}\) reviewed the literature published on vitamin A supplementation and growth and concluded that in the absence of overt vitamin A deficiency (eg, subnormal blood concentration) supplementation had little benefit on linear velocity. Brown et al\(^{36}\) identified 25 placebo-controlled intervention trials of zinc supplementation that enrolled children with a mean age of 2.8 years. Those supplemented with zinc gained 0.72 ± 0.98 cm more in height than children not receiving supplements.\(^{36}\) Subsequently, a large clinical trial failed to find an effect of zinc supplementation on growth in children aged 6 to 30 months.\(^{37}\) In the case of iron, benefits were observed by supplementing anemic children but not other children, some of whom exhibited slower linear growth with supplementation.\(^{38}\)

The body can retain nutrients in excess of the amounts needed for healthy growth and can accumulate toxic levels in tissue, which is why the IOM established UL values (Table 2).\(^{13,34}\) It is concerning that most groups met or exceeded the UL for zinc. Adverse effects associated with increased supplemental zinc include suppression of the immune system and impaired copper absorption.\(^{15}\) In 2001, after the study was underway, the IOM reduced the RDA for zinc from 10 mg/d to 3 mg/d and the UL was set at 7 mg/d for children 1 to 3 years old.\(^{13}\) Some of the observed excess in zinc intake may have resulted from formulas and supplements in the market that were designed to meet the previous RDA. Most groups also met or exceeded the UL for vitamin A (Table 2). There are substantial data on the adverse effects of excessive vitamin A intake but the clinical presentation is varied and nonspecific. Chronic hypervitaminosis A is associated with liver abnormalities, headache, irritability, bone mineral loss, skeletal abnormalities, alopecia, and mouth fissures.\(^{13}\) It remains unclear whether nutrients in excess of the RDA promote accelerated growth. Clinicians should ensure that children’s micronutrient intakes meet the RDA but do not exceed UL.

One limitation of this study is that data on whether the mother breast-fed was not collected. However, Fox et al\(^{39}\) reported that breast milk represented only 1.6% of the energy intake of 12- to 24-month-old healthy children in the FITS study. Thus, it is likely that any contribution of breast milk to nutrient intake was minimal in our older IA data set.

**Clinical Applications**

Infantile anorexia is a feeding disorder that requires nutritional rehabilitation to be well integrated with the overall goals of family counseling. The specific nutritional goals need to be tailored to the child’s individual circumstances, including medical issues. Dietitians educate parents in methods to monitor the child’s growth and food intake and provide practical solutions to achieve diet-related goals developed during psychological counseling. Monitoring should include tracking weight-for-length and length-for-age z-scores when children are below the 5th percentile on the CDC clinical growth charts.\(^{40}\) Communication with the clinical team is especially important for the dietitian to determine how frequently to monitor the response to nutrition interventions and to reassess nutritional status in order to make necessary adjustments to the plan for nutritional care.

Underlying disorders that contribute to IA may not be apparent at the time of diagnosis. For example, at least 3 participants were later diagnosed with autism: 2 of these children were diagnosed in the clinic 1 year after completion of the study and the mother of the third mentioned this diagnosis in correspondence when the family did not return for follow-up to the clinic. Another child developed bipolar disorder. The reasons why IA develops in children have yet to be definitively explained.

There are little published data available to guide practitioners in planning goals for nutrition care, tailored to the individual child. The Food and Agriculture Organization of the United Nations suggests that energy and protein requirements of 18-month-old children may need to increase by 3.5% and 25%, respectively, above the normal requirement, to allow

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**Table 2**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Mean (SE)</th>
<th>Boys with IA</th>
<th>Girls with IA</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>146 (32.2)</td>
<td>451.3 (77.7)</td>
<td>665.8 (82.8)</td>
<td>&lt; .05</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>502 (140)</td>
<td>154 (134)</td>
<td>451.3 (77.7)</td>
<td>&lt; .05</td>
</tr>
<tr>
<td>Iron</td>
<td>9.6 (1.9)</td>
<td>2.3 (1.85)</td>
<td>2.3 (1.85)</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>UL for Zinc</td>
<td>7 mg/d</td>
<td>3 mg/d</td>
<td>3 mg/d</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>UL for Vitamin A</td>
<td>7 mg/d</td>
<td>3 mg/d</td>
<td>3 mg/d</td>
<td>&lt; .01</td>
</tr>
</tbody>
</table>

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\( ^{13} \) It remains unclear whether nutrients in excess of the RDA promote accelerated growth. Clinicians should ensure that children’s micronutrient intakes meet the RDA but do not exceed UL.

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for twice the “normal” growth rate. Limited data are available on which to base recommendations for catch-up growth past the age of 24 months. Although supplements help guard against nutrient deficiencies, the transition to improved intake of whole foods, which help develop oral/motor skills, is the primary goal in treating IA and IA + SFA. Further studies are needed to help elucidate the optimal levels of nutrient intake that promote healthy catch-up growth in the IA population. Future research should also address counseling strategies for helping young children with IA attain adequate nutrient intake within the behavioral goals of recognizing hunger, consuming a variety of foods, and eating to fullness.

**Conclusion**

This is the first published case series to describe malnutrition in IA, and distinguish growth and diet characteristics of toddlers with IA and IA + SFA. When data were examined by gender, girls had significantly worse anthropometric status than boys at the time of diagnosis, suggesting that parents and/or primary care physicians are not recognizing the severity of growth failure or are delaying referral of girls to specialists for other reasons. After clinical interventions, both diagnostic groups exceeded daily weight gain of normal weight children but fell short of achieving substantial catch-up growth in weight, whereas percentiles for length velocity improved, particularly for girls. Additional research is needed to inform the development of guidelines for dietary management of IA, including data on biomarkers of nutritional status, energy expenditure, types and dose of nutritional treatments, duration of follow-up periods, and long-term achievements in growth.

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