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Weight gain velocity in infants with achondroplasia

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Abstract

There are virtually no data regarding appropriate oral intake in infants with dwarfing disorders such as achondroplasia, nor is there clear information regarding appropriate weight gain velocity in this population. Yet, these individuals are at increased risk for both early failure to thrive and, later in life, for obesity. Having appropriate expectations regarding weight gain and reasonable goals in management is imperative. We sought to clarify the rate of weight gain in infants with achondroplasia during the first year of life through analysis of data from 60 infants with achondroplasia seen at least twice during the first year of life in the Midwest Regional Bone Dysplasia Clinic, University of Wisconsin-Madison between 1998 and 2018. The mean weight gain velocity during the first 3 months was 23 g/day which contrasts with 30 g/day in average statured infants. Mean weight gain from 0 to 12 months of age was 13 g/day. The 3% of weight gain velocity during the first year of life was 8 g/day, and this rate did not differ between 0–3 months and 0–12 months of age. Infants with achondroplasia slightly more than doubled their birth weights by 1 year of age in contrast to averaged statured infants who typically triple birth weights by 1 year. Infants with achondroplasia can be thriving but erroneously assessed as failing to thrive if the incorrect reference values are used. This article describes infant weight gain velocity reference data for this population.

KEYWORDS

achondroplasia, dwarfism, failure to thrive, weight gain velocity

1 | INTRODUCTION

Achondroplasia is the most common type of dwarfism, occurring in ~1:26,000 to 1:28,000 live births (Pauli & Legare, 2018). Weight gain velocity data do not exist for infants with achondroplasia in the first year of life. Although growth curves for patients with achondroplasia have been published and further explicated over the years (del Pino, Fano, & Adamo, 2019; Hoover-Fong, McGready, Schulze, Alade, & Scott, 2017; Hoover-Fong, McGready, Schulze, Barnes, & Scott, 2007; Horton, Rotter, Rimoin, Scott, & Hall, 1978; Merker et al., 2018; Tofts, Das, Collins, & Burton, 2017), weight for length curves of patients with achondroplasia are infrequently utilized outside specialty clinics. In our experience concerns regarding overfeeding and underfeeding are both raised as issues when there are none and overlooked when concerns should be present in this population.

Some characteristics of infants with achondroplasia may affect their caloric intake and energy expenditure and increase their risk to fail to thrive. Ribs of individuals with achondroplasia are shorter, creating a narrower rib cage and thus smaller lungs. Further, the ribs are more flexible which can result in paradoxical movement with inspiration and decreased effective inspiratory volume. Smaller lungs and more compliant ribs result in increased work of breathing and additional energy expenditure while breathing (Reid, 1992). Hypotonia associated with achondroplasia can also cause a poor suck and decreased ability to drink adequate volumes. Babies with achondroplasia have an increased incidence of gastroesophageal reflux

disease (GERD) seen in clinical care which can further impair feeding (J. M. Legare, personal observation).

Adequate weight gain is important to development. In a study conducted by Ireland et al. (2013), patients with achondroplasia were evaluated to see if weight, height, and/or head circumference played a key role in gross motor developmental achievements. In their study, they found that children who were heavier at the age of 12 months were likely to achieve certain motor milestones earlier (Ireland et al., 2013). Ireland et al. (2013) postulated that this may be due to increased truncal strength and muscle mass resulting from increased weight.

While optimal weight gain is beneficial, there are risks associated with overfeeding. Overfeeding increases work of breathing, GERD, and risk of aspiration pneumonia. In addition, published studies in the general population have shown that rapid weight gain during the first year of life is associated with childhood obesity (Druet et al., 2011; Weng, Sam, Swift, Yang, & Glazebrook, 2012). Obesity is already a significant issue in older children and adults with achondroplasia.

Average weight gain for an average statured infant early in infancy is ~1 ounce (30 g) per day (Danner, Joeckel, Michalak, Phillips, & Goday, 2009). Anecdotally, we have observed that children with achondroplasia gain only ~1/2–2/3 of an ounce per day during infancy (J. M. Legare & R. M. Pauli, personal experience), but parents and physicians often are unaware that infants with achondroplasia should only gain a portion of an ounce per day. We are aware of many instances when infants with achondroplasia were given supplemental feeds via nasogastric tube or gastrostomy tube because of misinterpretation of their oral needs, only to suffer consequences of overfeeding.

2 | METHODS

After approval of IRB, a retrospective study was conducted in which patient records at the Midwest Regional Bone Dysplasia Clinic from the years 1998 through 2018 were examined. Two hundred files were assessed and patients were selected based on the following criteria: The patient had to have been unambiguously diagnosed with achondroplasia, have birth weight (BW) available in the medical record, and have at least two visits within the first year of life in the Midwest Regional Bone Dysplasia Clinic (MRBDC), University of Wisconsin-Madison. Diapered weights were obtained on all children. Any child over the age of 1 year without two or more visits in the first year of life was excluded. Patients born prior to 35 weeks of gestation or individuals in whom a nasogastric tube or gastrostomy tube was used in the first year of life were excluded from the study. Weight velocity from birth through 1 year of age was analyzed using linear regression analysis of weight on months of age. Weight gain per month was calculated from the slope parameter of the regression model. A histogram was generated to evaluate the distribution of weight gain. Data analysis was conducted using SAS software (SAS Institute Inc., Cary, NC), version 9.4.

3 | RESULTS

A total of 60 patients met the criteria for the study. De-identified data were recorded on each individual, including BW and age in months at each visit in the MRBDC with correlating weights in kilograms (Figure S1). A growth curve was generated using the slope parameter of the linear regression model of weight on age,

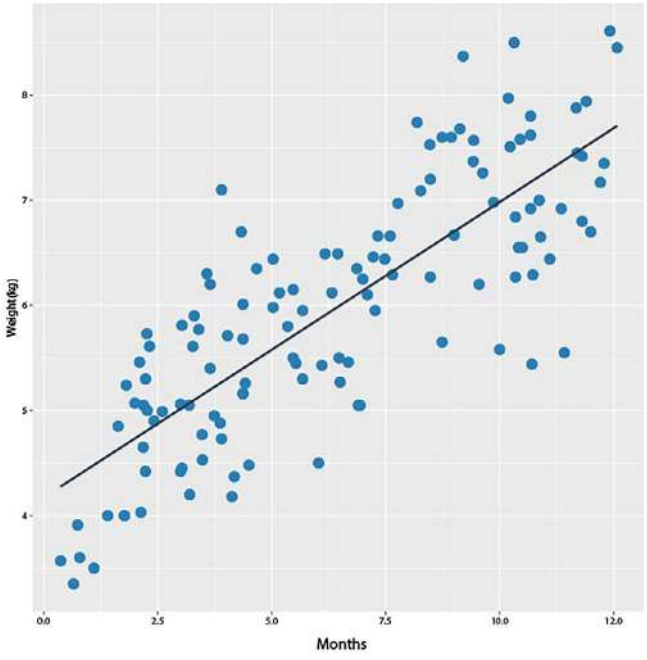

FIGURE 1 Weight growth curve: line shows slope parameter of the linear regression model [Color figure can be viewed at wileyonlinelibrary.com]

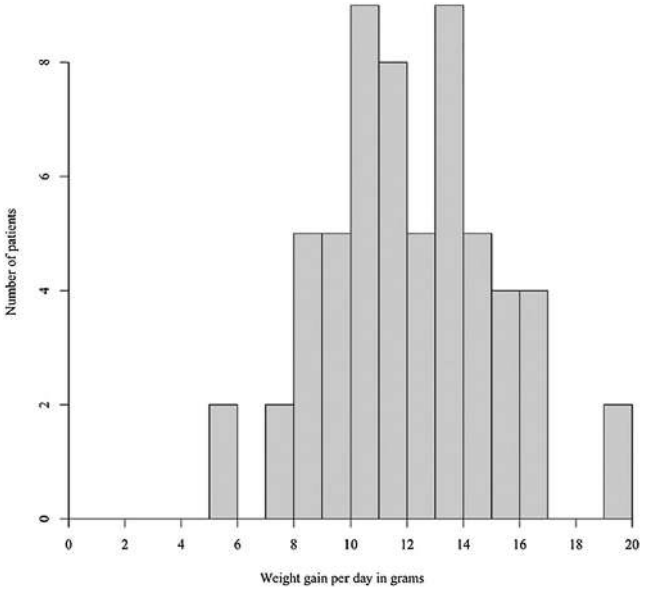

FIGURE 2 Distribution of overall weight gain velocity in grams/day from birth to 12 months of age

Age in months	Mean weight gain (g/day)	95% CI	3%	25%	75%	97%
0–12	12.5	12.0–13.67	8	11	14.5	18
0–6	19.33	17.33–21.33	7	14	23	31
6–12	9.0	6.67–11.0	1	6	12	17
0–3	23.33	20.0–26.67	7	18	30	39
3–9	11.33	8.33–14.33	7	9	12	15

TABLE 1 Weight gain velocity in infants with achondroplasia from birth to 12 months in grams/day

(Figure 1). The overall distribution of the weight velocity graph in Figure 2 is clustered around 10–15 g/day from birth to 12 months of age. Mean weight gain in infants with achondroplasia ages 0–12 months was 12.5 g/day (95% CI: 11.8–13.5 g/day) with the 3% at 8 g/day and 97% at 18 g/day. Mean weight gain for infants between ages 0 and 3 with achondroplasia was 23.0 g/day (95% CI: 19.7–26.3 g/day) with 3% at 7 g/day and 97% at 39 g/day. Table 1 lists the weight gain in grams/day of infants with achondroplasia at varying intervals and percentiles of that weight gain velocity.

4 | DISCUSSION

The mean weight gain velocity for infants with achondroplasia included in this study was 12.5 g/day over the entire first year and 23.0 g/day over the first 3 months. These numbers confirmed our clinical impression that appropriate weight gain in achondroplasia is considerably slower than in individuals with average stature. Average statured infants' weights typically double by around 4 months and triple by 12 months of age (Kuczmarski et al., 2000, 2002). However, based on the slope parameter for the linear regression model depicted in Figure 1, infants with achondroplasia just over double, not triple, their BWs by 12 months of age. Unfortunately, the number of patients in our study precluded us from separating males and females. It is anticipated that males gain weight slightly faster than females.

The average weight gain velocity over the first 3 months of life of 23.0 g/day in babies with achondroplasia is approximately equivalent to the 3%ile for average statured babies (Danner et al., 2009). Thus, based on average statured expectations, about ½ of all infants with achondroplasia could be misinterpreted as failing to thrive.

Dieticians involved with clinical care should be cognizant of lower weight gain velocities in order to prevent overfeeding in the hospital setting. Primary care practitioners should optimally use achondroplasia specific growth charts. Both can use the data presented here to both limit overfeeding and identify true failure to thrive when it exists. This study confirms estimates of infant weight gain in previous growth charts (Hoover-Fong et al., 2007), but also gives a more detailed account of infant weight gain during the first year of life. Having early standards may help prevent underfeeding and overfeeding, which will help with optimal weight maintenance throughout life.

DATA AVAILABILITY STATEMENT

Non identified data is available from the Midwest Regional Bone Dysplasia clinic.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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