Early-Life Nutrition, Growth Trajectories, and Long-Term Outcome

Ferdinand Haschke, Christoph Binder, Mercedes Huber-Dangl, and Nadja Haiden

Introduction

It is well established that nutrition during the first 1,000 days can have a long-term effect on growth, metabolic outcome, and long-term health [1, 2]. We review long-term anthropometric follow-up of children with risk of later morbidity: (a) very-low-birthweight (VLBW) infants who have birthweights <10% percentile of weight and receive fortified breast milk, (b) infants from developing countries who are breastfed according to the present recommendations but have low birthweight and birth length, and (c) children from developed countries who were enrolled in randomized controlled trials (RCTs) to test if breastfeeding and low-protein formulas can prevent from rapid weight gain and childhood obesity.

VLBW Infants

Following international recommendations for nutrition of VLBW infants [3] (birthweight <1,500 g; <32 weeks of gestation) now contributes to better postnatal growth which should be parallel to a percentile line of intrauterine growth charts. The segment of VLBW infants which have a birthweight below the 10th percentile for gestational age (“born too small”) includes growth-restricted VLBW infants who are born constitutionally small (SGA) and VLBW infants with intrauterine growth restriction (IUGR) which is caused by a complex antenatal pathology [4]. For VLBW infants who are “born too small” ESPGHAN recommends an “enhanced nutrients strategy” which provides extra nutrients up to 52 weeks [3]. Actually, reliable data are lacking to guarantee that the recommended “enhanced nutrients strategy” is safe and effective for both SGA and IUGR infants in terms of long-term growth, i.e. no increased risk of persisting postnatal malnutrition as well as of later obesity, diabetes type 2, and cardiovascular events. We investigated the impact of the “enhanced
nutrients strategy” up to 52 weeks of postconceptional age on growth of VLBW infants (SGA with no genetic defects, malformations, intrauterine infections, \( n = 31 \); IUGR with pathological ultrasound measurements [4], \( n = 127 \)). Mean birthweights of SGA and IUGR infants were 600 and 688 g (ns), and mean gestational ages were 25 and 29 weeks (<0.001), respectively. Enteral feeding of all infants started with breast milk that was then fortified with a human milk fortifier. At discharge, 68% of the infants still received breast milk. IUGR infants showed low weight with downwards crossing of weight percentiles between discharge and 3 months (corrected for GA). Mean weight of the SGA infants crossed the 10th percentile of the WHO standards of weight already at 6 months corrected for GA. A longitudinal analysis indicated higher weight of the SGA group between 3 and 24 months corrected for GA \( (p < 0.05) \). BMI of both groups was similar during the observation period. Our data question the ESPGHAN approach [3] that there is no need to develop separate nutrition guidelines for VLBW who are SGA or IUGR, but randomized controlled studies which include body composition and metabolic outcome measurements are necessary to prove the preliminary findings.

**Breastfed Infants from Developing Countries – Stunting**

The associations of breastfeeding with growth and health in developing countries can be studied by repeatedly analyzing DHS (demographic health surveys; US) datasets that provide information on nutrition, growth, and health. We reviewed data of more than 130,000 infants and small children (0–6, 6–12, 12–24 months) from 20 developing countries that were collected at least twice at intervals of 5–10 years during the last 2 decades [5, and unpubl. data]. Exclusive breastfeeding was associated with significantly higher weight, length, and lower probability of stunting, wasting, and infections. DHS data of infants between 6 and 24 months also reflect the influence of low-quality complementary feedings and poor environmental conditions in developing countries, which contribute to the high stunting and wasting rates. Growth trajectories from 2 well-controlled African cohorts [6, 7] with strong breastfeeding support showed the importance of maternal stature, nutrition, and health as well as maternal nutrition before conception and during pregnancy: growth trajectories of infants who were in the top 10th percentile segment of length at birth grew almost according to the WHO standards until 2 years. However, those infants in the bottom 10th percentile segment at birth (i.e., newborns with disturbed intrauterine growth) showed poor growth and had mean length at 2 years that was below the \(-2\) z-score of the WHO standards. In addition to breastfeeding support, future key targets should be to improve nutrition.
of adolescent girls, young women, and during pregnancy. Height catch-up in young children, even in the absence of external nutritional interventions, clearly contradicts the widely held impression that a window of opportunity closes at 24 months of age. The extent of catch-up after 24 months is highly context specific and presumably reflects the availability of foods, food-consumption patterns, the composition of diets, and the prevailing burden of infections (especially those affecting gastrointestinal function).

**Is Low-Protein Intake during the Breastfeeding Period and Beyond a Factor That Contributes to Prevention of Obesity?**

Infants fed traditional high-protein formulas have higher weight than breastfed infants at least until 24 months. RCTs indicate that infants receiving new low-protein follow-up formulas have lower weight gain during the first 12 months than infants receiving high-protein formulas [8–11]. Follow-up of clinical trials until 5–6 years indicates that children who were on low-protein formulas during the first year have BMIs similar to children who were breastfed [12, 13]. During longitudinal body composition follow-up, we found that percentage of body fat is more rapidly decreasing between 6 and 60 months, if children had been exclusively breastfed for 4–6 months or had been fed low-protein formulas until 12 months [13]. Children who received higher protein formulas during infancy showed only marginal decrease in percentage body fat until 60 months ($p < 0.05$). An RCT indicates that higher protein intake during infancy results in significantly higher BMI at 72 months and a higher percentage of childhood obesity [12]. A longitudinal cohort study that reflects the French childhood population [14] indicates that higher protein intake (>15% of calories) is associated with higher BMI during school age, adolescence, and young adulthood.

**Conclusions**

VLBW infants who are IUGR show low weight gain after discharge from hospital when they receive fortified breast milk. RCTs are necessary to confirm the results of our cohort study and to test new fortification strategies of breast milk. Exclusive breastfeeding is important to prevent infants from stunting in developing countries. Further preventive measures include nutritional supplementation of young women before and during pregnancy, promotion of breastfeeding and improvement of quality of complementary foods. RCTs which include follow-up of growth and
body composition during childhood indicate that breastfeeding and the use of low-protein formulas can contribute to prevention of rapid weight gain during infancy and childhood obesity.

References