

## Citation:

Karaolis-Danckert N, Günther AL, Kroke A, Hornberg C, Buyken AE. How early dietary factors modify the effect of rapid weight gain in infancy on subsequent body-composition development in term children whose birth weight was appropriate for gestational age. *Am J Clin Nutr.* 2007 ;86(6):1700-8.

**PubMed ID:** [18065589](#)

## Study Design:

Longitudinally open-cohort study

## Class:

B - [Click here](#) for explanation of classification scheme.

## Research Design and Implementation Rating:



POSITIVE: See Research Design and Implementation Criteria Checklist below.

## Research Purpose:

To examine the interaction between rapid weight gain and nutrition in infancy and early childhood and their effect on body fat percentage (BF%) trajectories between 2 and 5 y of age.

## Inclusion Criteria:

AGA term singletons

Females

Infants and children (Early childhood)

All birth weights and lengths lay between the 10th and 90th percentiles of the German sex-specific birth weight-for-gestational age curves

All children had to have complete, plausible dietary records at ages 12 mo and 18 or 24 mo

## Exclusion Criteria:

NA

## Description of Study Protocol:

### Recruitment

- Recruitment began in 1985, detailed information on diet, growth, development, and metabolism between infancy and adulthood has been collected from >1100 children.

### Design

- Recruitment began in 1985, detailed information on diet, growth, development, and metabolism between infancy and adulthood has been collected from >1100 children. Every year, an average of 40–50 infants are newly recruited and first examined at the age of 3 mo. Each child returns for 3 more visits in the first year, 2 in the second, and then once annually until early adulthood.

- The study population comprised 249 (51.4% female) term appropriate for gestational age (AGA) participants of the Dortmund Nutritional and Anthropometric Longitudinally Designed Study, for whom repeated anthropometric measurements until 5 y of age and information on breastfeeding status and diet at 12 and 18–24 mo of age were recorded.
- Maternal characteristics (BMI and educational status) were recorded. Information on birth weight, length and head circumference at birth, gestational age, and maternal weight gain during pregnancy are abstracted. 3-d weighed dietary records were used to assess the intakes of energy, protein and fat.

#### Blinding used (if applicable)

NA

#### Intervention (if applicable)

NA

#### Statistical Analysis

- Unadjusted associations between the independent variables and rapid weight gain were tested by using chi-square, Student's *t* test, or Wilcoxon's rank-sum test as appropriate.
- Linear mixed-effects regression models (using PROC MIXED), including both fixed and random effects, were used to construct longitudinal models of BF% and BMI trajectories subsequent to the period of rapid weight gain (between 2 and 5 y of age) and to investigate the effect of rapid weight gain on baseline BMI or BF% status at age 2 and changes over time.
- A three-way interaction between time, rapid weight gain, and each of the other fixed variables was also included to consider differential effects of rapid weight gain on the BF% or BMI trajectories of children in various subgroups.
- A *P* value <0.05 was considered statistically significant.

## Data Collection Summary:

### Timing of Measurements

Infancy ( $\geq 4$  mo); 12 months, 18-24 mo; 5 years

### Dependent Variables

- BMI
- %BF and BF% slope between 2 and 5 y of age
- Rate of weight gain

### Independent Variables

Birth characteristics: Sex, birth at early (weeks 37 or 38) or late (weeks 41 or 42) gestation, parity (nulliparous, parous), and either BF% at 6 mo of age or BMI SDS at birth to adjust for baseline body composition.

Maternal characteristics: Maternal overweight status (BMI  $\geq 25$ ) and high educational status ( $\geq 12$  y of schooling).

Nutritional characteristics: Breastfeeding status ( $\geq 4$  mo), mean energy intake during the second year of life protein intake (high-high, other), and fat intake (high-high, other).

### Control Variables

Sex, birth at early (weeks 37 or 38) or late (weeks 41 or 42) gestation, parity (nulliparous, parous), and either BF% at 6 mo of age or BMI SDS at birth to adjust for baseline body composition, maternal overweight status (BMI  $\geq 25$ ) and high educational status ( $\geq 12$  y of schooling), breastfeeding status ( $\geq 4$  mo), mean energy intake during the second year of life protein intake (high-high, other), and fat intake (high-high, other), percent body fat.

## Description of Actual Data Sample:

**Initial N:** >1100 children

**Attrition (final N):** 249

**Age:** 3mo,  $\geq 4$  mo, 2 to 5 yr

**Ethnicity:** Germans

### Other relevant demographics:

Sex, birth at early (weeks 37 or 38) or late (weeks 41 or 42) gestation, parity (nulliparous, parous), maternal overweight status (BMI  $\geq 25$ ) and high educational status ( $\geq 12$  y of schooling), breastfeeding status ( $\geq 4$  mo), mean energy intake during the second year of life protein intake (high-high, other), and fat intake (high-high, other), percent body fat.

**Anthropometrics** BMI, body weight, Percent body fat, body composition, 4 skinfold-thickness measurements, triceps SDS, or subscapular SDS

**Location:** Dortmund, Germany

## Summary of Results:

### Key Findings

- Overall, 28.5% (71/249) of the children in this sample gained weight rapidly between birth and 24 mo. These children were both significantly lighter and shorter at birth, and a larger proportion were born relatively early compared with the normal growers.
- With respect to maternal anthropometry and educational status, no significant differences between the 2 growth groups were found. By the age of 5 y, those children who had gained weight rapidly were significantly heavier and taller and had a higher BMI SDS and BF% than did those children who had gained weight normally. Furthermore, a significantly larger proportion of these children were classified as overweight (17% compared with 7%;  $P = 0.02$ ) or overfat (27% compared with 15%;  $P = 0.03$ ).
- Neither in terms of breastfeeding status ( $P = 0.5$ ) nor in terms of macronutrient intake at either 12 or 18–24 mo did the differences in median intake between the 2 growth groups reach a statistical significance of  $< 0.05$ .
- There was no significant difference in the proportion of rapid or normal growers in each of the high-high macronutrient intake groups for any of the macronutrient variables: protein (35% compared with 33%;  $P = 0.8$ ), fat (30% compared with 31%;  $P = 0.8$ ), and carbohydrate (37% compared with 28%;  $P = 0.2$ ).
- Those rapid growers who were fully breastfed for  $\geq 4$  mo had a significantly lower fat mass at age 2 y than did those rapid growers who were not fully breastfed for  $\geq 4$  mo (adjusted difference between rapid growth groups:  $-1.53 \pm 0.59\%$ ;  $P = 0.009$ ).
- Breastfeeding status did not affect the rate of change in BF% between 2 and 5 y of age, ie, there was no three-way interaction between time, rapid weight gain, and breastfeeding status.
- There was no interaction between a consistently high fat intake at 12 and 18–24 mo and rapid weight gain at 2 y of age ( $0.28 \pm 0.67\%$ ;  $P = 0.7$ ).
- A higher mean energy intake during the second year of life tended to be associated with a lower BF% at age 2 y ( $P = 0.08$ ) but with a gain in BF% between 2 and 5 y ( $P = 0.005$ ).
- A consistently high protein intake, on the other hand, was associated with a higher BF% at age 2 y ( $P = 0.03$ ), but did not have any effect on change in BF% over time.
- Multilevel model analyses showed that, among rapid growers, those who had been fully breastfed for  $\geq 4$  mo had a lower BF% at 2 y of age than did those who had not been fully breastfed for  $\geq 4$  mo ( $P = 0.009$ ). This difference persisted until 5 y.
- Rapid growers who had a consistently high fat intake at both 12 and 18–24 mo did not show the expected physiologic decrease in BF% between 2 and 5 y seen in those rapid growers with an inconsistent or consistently low fat intake at these time points ( $P = 0.006$ ).

### Author Conclusion:

- The detrimental effect of rapid weight gain on fat mass development in healthy, term AGA children can be modified by dietary factors acting in infancy and early childhood. In particular, being breastfed for  $\geq 4$  mo attenuated the effect of rapid weight gain, resulting in a lower BF% at 2 y of age among rapid growers who had been fully breastfed than in

those who had not.

- A consistently high fat intake during the second year of life modified the subsequent effect of rapid weight gain on the longitudinal development of fat mass, thus inhibiting the normal physiologic decrease, thereby resulting in a larger BF% among exposed rapid growers.
- Data also suggest that the current recommendations in favor of a higher fat intake during the complementary feeding period may not necessarily be beneficial for all children.
- The influence of certain nutritional factors early in life on later body composition varies by growth pattern: among rapid growers, full breastfeeding for  $\geq 4$  mo exerts a protective effect against high BF%, whereas a consistently high fat intake during the second year of life inhibits the physiologic decrease in BF% between 2 and 5 y of age.
- Among rapid growers, full breastfeeding for 4 mo is protective against a high BF% at 2 y of age.
- High fat intake in the second year of life "inhibits" the physiologic decrease in %BF between 2 and 5 y.

### Reviewer Comments:

- *This is prospectively collected, longitudinal study with repeated assessments of breastfeeding status and diet in early childhood; the repeated anthropometric measurements from as early as 3 mo of age and detailed information on several possible covariates and confounders were reported. Appropriate statistical analysis were conducted.*
- *Full breastfeeding for  $\geq 4$  mo appears to directly influence the extent to which rapid weight gain adversely affects fat mass development in the first 2 y of life, after which the level of BF% reached tracks unchanged.*
- *The DONALD Study participants are characterized by a relatively high socioeconomic and educational status.*
- *The dietary data in general, and patterns in infancy, in particular in terms of rates of breastfeeding and choice of breast milk substitutes and commercial weaning foods may not be similar to other nations.*
- *The quality of fat intake is also important to focus in future studies and its effects on rate of body weight change, percent body fat and other metabolic parameters.*
- *Further studies are required to study the assessments in a large population with repeated anthropometric measurements in different ethnic groups, income and diversified population.*

### Research Design and Implementation Criteria Checklist: Primary Research

#### Relevance Questions

- |    |   |     |
|----|---|-----|
| 1. | Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies) | Yes |
| 2. | Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?   | Yes |
| 3. | Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?  | Yes |
| 4. | Is the intervention or procedure feasible? (NA for some epidemiological studies)  | Yes |

#### Validity Questions

- |      |   |     |
|------|---|-----|
| 1.   | <b>Was the research question clearly stated?</b>  | Yes |
| 1.1. | Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified? | Yes |

1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
<b>2.</b>	<b>Was the selection of study subjects/patients free from bias?</b>	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	???
<b>3.</b>	<b>Were study groups comparable?</b>	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	N/A
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
<b>4.</b>	<b>Was method of handling withdrawals described?</b>	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	N/A
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	???
4.4.	Were reasons for withdrawals similar across groups?	N/A

4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
<b>5.</b>	<b>Was blinding used to prevent introduction of bias?</b>	<b>Yes</b>
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	N/A
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
<b>6.</b>	<b>Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were intervening factors described?</b>	<b>Yes</b>
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
<b>7.</b>	<b>Were outcomes clearly defined and the measurements valid and reliable?</b>	<b>Yes</b>
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes

7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
<b>8.</b>	<b>Was the statistical analysis appropriate for the study design and type of outcome indicators?</b>	<b>Yes</b>
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
<b>9.</b>	<b>Are conclusions supported by results with biases and limitations taken into consideration?</b>	<b>Yes</b>
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
<b>10.</b>	<b>Is bias due to study's funding or sponsorship unlikely?</b>	<b>Yes</b>
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes

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