

ORIGINAL PAPERS

# Can Complementary Feeding Patterns Influence Rapid Weight Gain in Infancy?

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## Abstract

**Objectives:** Rapid weight gain during infancy is one of the traditional factors associated with later obesity. This paper examines early dietary factors that influence rapid weight gain at the age of 12 months in a group of subjects enrolled at 6 months of age and followed-up in terms of dietary patterns and weight evolution. **Methodology:** Subjects were enrolled at their 6 months check-up visit and the admission procedure included demographic questionnaire, data about birth anthropometry extracted from birth medical documents, growths patterns assessment along with feeding type. We determined changeable variables associated with rapid weight gain. **Conclusions:** This analysis supports the concept that timing of complementary feeding and some particular patterns are associated with rapid weight gain.

**Keywords:** rapid weight gain, complementary feeding, early nutrition

## Rezumat

**Obiective:** Creșterea rapidă în greutate în primii ani de viață reprezintă unul dintre factorii de risc pentru instalarea obezității ulterior. Acest studiu evaluează factorii determinanți ai creșterii rapide în greutate într-un lot de sugari înrolați la vârsta de 6 luni și urmăriți periodic prin determinări antropometrice și evaluarea aspectelor legate de nutriție. **Metodologie:** Subiecții au fost evaluați inițial la vârsta de 6 luni prin determinări antropometrice, înregistrarea datelor legate de aspectele demografice, chestionar cu privire la dietă și notarea dimensiunilor de la naștere din registrele medicale. Am analizat ulterior factorii cauzatori ai creșterii rapide în greutate la această vârstă. **Concluzii:** Rezultatele au indicat asocieri pozitive între momentul inițierii alimentației complementare și evoluția ponderală, pe lângă o serie de alți factori.

**Cuvinte cheie:** creștere rapidă în greutate, alimentație complementară, alimentație precoce

## INTRODUCTION

Current knowledge based on large randomized controlled trials documented so far that early protein intake from milk products, in the first six months of life, is associated with various changes in later outcomes regarding body weight or body composition<sup>1,2</sup>. Beyond the exclusive milk nutrition period, complementary feeding practices are less investigated in terms of obesity appearance<sup>3</sup>. Macronutrients supply in early life, such

as carbohydrates and fats, do not seem to be implicated in later childhood obesity<sup>4</sup>, whereas protein supply is much more studied in the present<sup>5</sup>. Due to rapid weight gain and body size evolution in first 3 years of life, nutritional requirements are high, but exceeding some normal ranges leads to future disturbances. Metabolic disturbances and non-communicable diseases such as obesity could be triggered by early excess of energy, inappropriate macronutrients supply or deficiency

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encies<sup>6,7</sup>. Rapid weight gain during infancy is one of the traditional factors associated with later obesity<sup>8,9</sup>. Several determinants for rapid weight gain were investigated, such as birth weight, genetic factors or early nutrition patterns<sup>10</sup>.

### Aim of the study

This paper examines early dietary factors that influence rapid weight gain at the age of 12 months in a group of subjects enrolled at 6 months of age and followed-up in terms of dietary patterns and weight evolution.

## MATERIAL AND METHODS

### Population

This was an observational study involving healthy infants enrolled at their check-up visit at 6 months of age. Parents, mainly mothers, received a brief information about the study protocol and purposes, and in the end, they all gave their written consent in order to enroll the infants and accomplish the ongoing follow-up procedure. We decided to include only healthy term infants, with a gestational age over 37 weeks, having birth weight above 2700g. Subjects known with congenital abnormalities, chronic disease or belonging to neglected families were not included in the study. Mothers' level of education was assessed as follows: high: faculty diploma; secondary/ college: high-school, 8 classes; none/primary: none or 4 classes. Their economic levels was indicated based on the declaration that they belong to either "low", "medium" or "high" income social class.

### Data collection and study procedures

For the beginning, subjects were enrolled at their 6 months check-up visit and the admission procedure included demographic questionnaire, data about birth anthropometry extracted from birth medical documents, along with feeding type, as detailed bellow.

Weight and length were assessed periodically by trained staff, starting with this age until 12 months. We used digital baby scale (Miniland Scaly Up 89041) in order to weigh the infants and length was measured on recumbent position using Infantometer HM80 P digital board. Anthropometry was then appreciated using WHO Standards specific for age and sex, in terms of Z-scores for weight-for-age, length-for-age and weight-for-length, as a measure of standard deviation of the distance from the median value, adjusted for age and sex<sup>11</sup>. According to some previous studies, we defined rapid weight gain as a greater than 0.67 change in

weight-for-age from birth until the final assessment<sup>12</sup>. This was our main variable.

### Dietary records

For each visit, mothers were asked to answer a face-to-face interview consisting in a questionnaire about feeding type: breastfeeding exclusively (breastmilk only with no other food or fluids), combination feeding (breast and formula feeding), and formula feeding only. For the analysis, the first and the last category were compared as a risk factor for rapid weight gain. We were interested about the feeding schedule and mother could either choose between feeding their infants "on demand" or respecting a certain "schedule". The feeding pattern was assessed based on answers to the following yes/no questions: Do you use homemade food? Do you use store-bought baby food? Also, mothers provided yes/no answers to indicate the origin of food products: organic agriculture, supermarket or home grown.

### Ethics consideration

All mothers gave their informed consent prior to enrollment in the study. Ethical approval to conduct the study was obtained from "Grigore Alexandrescu" Emergency Children's Hospital Committee of Ethics.

### Statistics analyze

We used multivariate logistic regression models for the following variables, in association with rapid weight gain: mother's age, BMI, birthweight, age, gender. Main results were interpreted as odds of rapid weight gain with 95% confidence interval for each categorical variable. SPSS version 18 was used for statistical analysis.

## RESULTS

### Population

Initially, 154 families agreed to participate to the survey. During the follow-up procedure, 148 infants managed to accomplish the study. The ages of the subjects ranged from 5.4 months to 5.8 months at starting point. All demographic characterization is revealed in Table 1.

### Dietary records

For the first six months of life, a total of 31 (20.9%) were exclusively breastfed, 68 (45.9%) received combination feeding, and the remaining 49 (33.2) were formula feed for the same period. By the enrollment visit, 24% of infants were already introduced to solid food in their diet. Infants receiving formula were more likely

Table 1. Demographic characterization of the study population

Topics	N=148
Mother	
Mean age (years ± SD)	28.6±5.7
Education, n (%)	
High	24 (16.2%)
Secondary/ college	48 (32.5%)
None/ primary	76 (51.3%)
Economic level	
High	35 (23.6%)
Medium	78 (52.7%)
Low	35 (23.6%)
BMI kg/m <sup>2</sup> , n (%)	
Underweight (<18.5)	27 (18.2%)
Normal weight (18.5-24.9)	43 (29.2%)
Overweight (25.0-29.9)	49 (33.1%)
Obese (≥30)	29 (19.5%)
Infant	
Mean birthweight (kg ± SD)	3.4 ± 0.5
Mean age at enrollment (months ± SD)	6.1 ± 0.3
Gender	
Male	83 (56%)
Female	65 (44%)

to be weaned earlier [OR = 2.67 (95%CI 1.29, 5.33), P <0.005]. Mothers attending only medium levels of education offered more frequently formula feed to their infants [OR = 1.75 (95%CI 1.19-2.613, P<0.05] and the subjects being weaned before 4 months belong to the same category [OR = 3.38 (95%CI 1.52-7.85), P < 0.005]. Feeding according to daily schedule was performed for 33.1% (N=49) of subjects and the others 66.9% (N=99) were fed on demand.

### Growth patterns and determinants

Tables 2 shows mean Z-scores at birth and at the consecutive time-points assessments.

Regarding nutritional status at baseline, according to WHO criteria, 15 (10.1%) were classified with a weight-for-length Z-score above 1, but the mean weight-for-length Z-score was -0.18. In the meantime, breastfed infants had lower mean change in weight-for-age Z-score between enrollment and 12 months assessment [mean change (±SD) = -0.45 (± 1.0)] than formula fed infants [mean change (±SD) = -0.2 (±1.1)], P <0.005. A rapid weight gain defined as above was identified in 15.5% (N=23) of the infants.

Table 3 is able to identify the investigated factors associated with rapid weight gain. This could be speculated more frequently in former newborns with lower

Table 2. Anthropometric characterization (mean ± SD) in the N = 148 final group (Z-scores calculated using WHO standards)<sup>11</sup>

	Anthropometry	Mean±SD
Birth	Weight (kg)	3.3±0.6
	Weight Z-score	0.38±0.7
	Length Z-score	0.41±0.8
Determination	Age (months)	11.3±1.8
	Weight (kg)	10.3±3.3
	Length	77.2±9.2
	Weight-for-age Z-score	-0.03 ± 0.82
	Length-for-age Z-score	0.31 ±0.85
	Weight-for-length Z-score	-0.29 ±1.2
	Weight gain from previous 6 months	4.3 ± 1.5

Table 3. Determinants of infancy rapid weight gain

Determinants	OR 95%CI	P-value
Birth weight: under 3100g vs. over 3100g	7.9 (3.7-14.7)	<0.001
Male vs. female	1.97 (1.34-2.97)	<0.05
Feeding to schedule vs. feeding on demand	3.52 (2.39-5.11)	0.005
Formula feeding only vs. breastfed	2.20 (1.37-3.93)	<0.005
Weaned <4 months vs. >4 mo	1.99 (1.44-2.87)	<0.05
Supermarket vs. organic agriculture/ home grown	1.44 (0.89-2.33)	0.16
Homemade food vs. baby food	1.51 (0.98-2.17)	0.15

birthweight and in infants heavier at baseline, meaning 6 months of age.

Formula feeding, feeding to schedule and earlier weaning were the modifiable factors associated with rapid weight gain from 6 to 12 months, [OR = 2.20 (95%CI 1.37-3.93), P <0.005], [OR =3.52 (95%CI 2.39-5.11), P <0.05 0.020] and [OR = 1.99 (95%CI 1.44-2.87), P <0.05], respectively.

## DISCUSSION

The infancy transient period of nutrition from milk only diet to solid food diet is a critical phase of development, when child's diet changes and gradually accept various flavors and textures until family adult diet is well introduced. A focus on influencing some bad ancient dietary habits in this period might improve future generation wellbeing.

In a multi-ethnic cohort study, authors demonstrated that rapid weight gain in infants was associated with increased risk of being overweight at 4 years of age, independently of potential confounders<sup>9</sup>. In our research, infants being born under 3100g were more likely to be rapid growers than the ones born over this

weight and also males put on weight more rapidly than girls. This is similar to some previous study performed on larger cohorts, although their result refer mainly to the first 6 months of life<sup>13</sup>. Also, eating formula from the first months of life is considered as a risk factor for obesity and overweight at later ages<sup>14,15</sup>. What infants eat and the way we administrate either formula or human milk might also influence growth velocity, and this could be further influenced and changed in order to prevent excessive weight gain. Human milk, due to its many bioactive molecules, some of them yet unknown, may elicit endocrine long and short term effects and induce regulation of infant appetite and weight gain<sup>16</sup>.

The introduction of semisolid or solid foods to an infant, regardless his previous nutrition manner, is an important dietary transition process, known as weaning period and actual evidence support the theory that this

age changes also influence future dietary habits and growth patterns. In Cambridge Baby Growth Study authors focused on timing of complementary feeding in relationship with weight gain and they concluded that age at weaning of 3.0-7.0 months was inversely associated with weight and length (but not with body mass index) at 12 months (both  $P \leq .01$ , adjusted for maternal and demographic factors)<sup>17</sup>.

## CONCLUSIONS

Supporting the existing evidence in the literature about breastfeeding being a protective factor against rapid weight gain, our research bring data about influencing factors of complementary feeding patterns that can be modify in order to lower growth rates in the first year of life.

## References

1. Koletzko B, Broekaert I, Demmelmair H, Franke J, Hannibal I, Oberle D, Schiess S, Baumann BT, Verwied-Jorky S. Protein intake in the first year of life: a risk factor for later obesity? The E.U. Childhood Obesity Project. *Adv Exp Med Biol.* 2005;569:69-79.
2. Koletzko B, von Kries R, Closa R, Escribano J, Scaglioni S, Giovannini M, Beyer J, Demmelmair H, Gruszfeld D, Dobrzanska A, et al. Lower protein in infant formula is associated with lower weight up to age 2 y: a randomized clinical trial. *Am J Clin Nutr* 2009; 89: 1836-45.
3. Association between timing of introducing solid foods and obesity in infancy and childhood: A systematic review Kate E. Morcroft, Joyce L. Marshall Felicia M. McCormick Volume 7, Issue 1, pages 3-26, January 2011
4. Summerbell CD, Douthwaite W, Whittaker V, ELLS LJ, Hillier F, Smith S, Kelly S, Edmunds LD, Macdonald I. The association between diet and physical activity and subsequent excess weight gain and obesity assessed at 5 years of age or older: a systematic review of the epidemiological evidence. *Int J Obes.* 2009;33(Suppl 3): S1-92.
5. Michaelsen KF, Greer FR. Protein needs early in life and long-term health. *Am J Clin Nutr.* 2014;99:718S-722S.
6. Singhal A. et al: Nutrition in infancy and longterm risk of obesity: evidence from 2 randomized controlled trials. *Am J Clin Nutr.* 2010;92: 1133-1144.
7. Velkoska E, Cole TJ, Morris MJ: Early dietary intervention: long-term effects on blood pressure, brain neuropeptide Y, and adiposity markers. *Am J Physiol Endocrinol Metab.* 2005;288:E1236-E1243.
8. Monteiro PO, Victora CG: Rapid growth in infancy and childhood and obesity in later life—a systematic review. *Obes Rev.* 2005;6(2):143-154.
9. Ong KK, Loos RJ: Rapid infancy weight gain and subsequent obesity: systematic reviews and hopeful suggestions. *Acta Paediatr.* 2006;95(8):904-908.
10. Baird J, Fisher D, Lucas P, Kleijnen J, Roberts H, Law C: Being big or growing fast: systematic review of size and growth in infancy and later obesity. *BMJ.* 2005; 331(7522):929.
11. WHO Multicentre Growth Reference Study Group: WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development. Geneva World Health Organization; 2006.
12. Beyerlein A, Ness AR, Streuling I, Hadders-Algra M, von Kries R: Early rapid growth: no association with later cognitive functions in children born not small for gestational age. *Am J Clin Nutr.* 2010;92(3):585-593.
13. Mhrshahi S, Battistutta D, Magarey A, Lynne A, Mhrshahi D. et al. Determinants of rapid weight gain during infancy: baseline results from the NOURISH randomised controlled trial. *BMC Pediatrics.* 2011;11:99.
14. Kramer MS, Guo T, Platt RW, Sevkovskaya Z, Dzikovich I, Collet JP, Shapiro S,
15. Chalmers B, Hodnett E, Vanilovich I, et al: Infant growth and health outcomes associated with 3 compared with 6 mo of exclusive breastfeeding. *Am J Clin Nutr* 2003, 78(2):291-295.
16. Koletzko B, von Kries R, Monasterolo RC, Subias JE, Scaglioni S, Giovannini M, Beyer J, Demmelmair H, Anton B, Gruszfeld D, et al: Infant feeding and later obesity risk. *Adv Exp Med Biol.* 2009; 646:615.
17. Savino F, Liguori SA. Update on breast milk hormones: leptin, ghrelin and adiponectin. *Clin Nutr.* 2008;27:42-47.
18. Vail B, Prentice P, Dunger DB, Hughes IA, Acerini CL, Ong KK. Age at Weaning and Infant Growth: Primary Analysis and Systematic Review. *The Journal of Pediatrics.* 2015;167(2):317-324.