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Short Communication

Breastfeeding attenuates the effect of low birthweight on abdominal adiposity in adolescents: the HELENA study

Idoia Labayen*, Francisco B Ortega†‡, Jonatan R Ruiz†‡, Gerardo Rodriguez§, David Jiménez-Pavón¶,, Vanesa España-Romero††, Kurt Widhalm‡‡, Frédéric Gottrand§§ and Luis A Moreno¶,¶¶**

*Department of Nutrition and Food Science, University of the Basque Country, UPV/EHU, Vitoria, Spain, †Department of Physical Education and Sport, School of Sport Sciences, University of Granada, Granada, Spain, ‡Department of Biosciences and Nutrition at NOVUM, Unit for Preventive Nutrition, Karolinska Institutet, Huddinge, Sweden, §Department of Pediatrics, Faculty of Medicine, University of Zaragoza, HCU Lozano Blesa, Zaragoza, Spain, ¶Department of Physiotherapy and Nursing, School of Health Sciences, University of Zaragoza, Zaragoza, Spain, **Department of Physical Education, School of Education, University of Cadiz, Puerto Real, Spain, ††MRC Epidemiology Unit, Cambridge, UK, ‡‡Division of Nutrition and Metabolism, Department of Pediatrics, Medical University of Vienna, Vienna, Austria, §§EA 2694, Nutrition Department, University Lille Nord de France, Lille, France, and ¶¶Department of Preventive Medicine, Faculty of Medicine, University of Sao Paulo, Sao Paulo, Brazil

Abstract

The aim of this study was to examine whether breastfeeding may reduce the programming effect of birthweight on abdominal adiposity. Abdominal (in three regions: R1, R2 and R3) adiposity was measured by dual energy x-ray absorptiometry in 314 adolescents. Breastfeeding duration, birthweight, duration of gestation and maternal educational level were obtained from questionnaire. Physical activity was objectively measured. We detected significant interactions between breastfeeding and birthweight on abdominal adiposity (Ps = 0.02–0.07). We observed that birthweight was associated with abdominal adiposity in the group who had never been breastfed ($\beta = -0.19$ to -0.23; $P\text{s} < 0.05$), while no association was found in adolescents who had breastfeeding for ≥3 months ($\beta = -0.03$ to -0.07). The results were independent of duration of gestation, age, sex, maternal educational level and physical activity. Breastfeeding may reduce the adverse influence conferred by low birthweight on abdominal adiposity in adolescents.

Keywords: breastfeeding, abdominal adiposity, birthweight, programming, infant feeding.

Correspondence: Idoia Labayen, Department of Nutrition and Food Science, University of the Basque Country, Paseo de la Universidad, 7, 01006 Vitoria-Gasteiz, Spain. E-mail: idoia.labayen@ehu.es

Introduction

Body weight at birth is negatively associated with abdominal adiposity in adolescents (Labayen *et al*. 2009). Although previous studies on the topic have provided mixed results, it seems that breastfeeding can reduce the risk of becoming obese (Owen *et al*. 2005). Therefore, we hypothesized that breastfeeding could interact with birthweight attenuating the adverse effect of a low birthweight on key adiposity markers. The interaction between pre- and post-natal nutritional environments has been little examined. A greater in-depth knowledge of the post-natal nutritional factors affecting abdominal adiposity and related diseases in youth will contribute to the development of effective prevention programs, counselling and public health policy. The purpose of the present study was to test whether breastfeeding in infancy may reduce the risk of the prenatal programming of abdominal adiposity.

Materials and methods

The present study comprises 314 Spanish adolescents participating in the Healthy Lifestyle in Europe by Nutrition in Adolescence (Moreno *et al*. 2008). The study was approved by the Human Research Ethics Committee of Aragón. Written informed consent to participate was obtained from both parents and adolescent.

Data on breastfeeding (in months), body weight at birth, duration of gestation and socioeconomic status were collected by means of parental recall using a questionnaire. The duration of gestation was stratified into three categories: <37 weeks, between 37 and 42 weeks, and >42 weeks of amenorrhea. The duration of breastfeeding was classified into four categories: never, <3 months, from 3 to 6 months and >6 months of breastfeeding. Because there can be a recall bias about the exact duration of breastfeeding and, as the beneficial influence on cardiovascular disease (CVD) risks have been reported for ≥3 months of breastfeeding, we decided to use only two categories in the analysis, never breastfed and breastfed for ≥3 months, restricting the analyses to 229 adolescents. Socioeconomic status was defined by maternal educational level (university or non-university degree).

We measured abdominal adiposity at three different regions (R1, R2 and R3) with dual energy x-ray absorptiometry (DXA) (QDRExplorer, Hologic Corp., Software version 12.4, Waltham, MA, USA; Labayen *et al*. 2009). A rectangle was drawn on the digital scan image to establish every region. All of them have the lower horizontal border on the top of iliac crest. For R1, the upper border was established parallel to the end of the lowest rib. The upper border of the R2 was parallel to the junction of the T12 and L1 vertebrae, and for the R3 was parallel to the middle of the costovertebrae articulation of the last rib. The lateral sides were adjusted to include the maximal amount of abdominal tissue within each region. The age- and sex-specific body mass index (BMI) cut-off values proposed by the International Obesity Task Force, based on international data and linked to the widely accepted adult cut-off points of a BMI of 25 and 30 kg m^{-2} were used to categorize the adolescents as non-overweight, overweight and obese. Physical activity was assessed by accelerometry (Actigraph™ GT1M, Actigraph LLC, Pensacola, FL, USA).

Differences in categorical and continuous variables between breastfeeding categories were examined by chi-squared and *t*-test, respectively. Regression analysis was used to examine the association between birthweight and the dependent variables adjusting for sex and whole body mass (Model 1), and additionally for duration of gestation, age and maternal educational level (Model 2). Breastfeeding × birthweight interaction term was entered into the models and when significant interactions were found ($P < 0.1$), the association between birthweight and the study outcomes was analysed stratifying by breastfeeding categories (never vs. ≥3 months). The analyses were repeated after further adjustment for physical activity.

Results

Sample characteristics are reported in Table 1. We detected significant interactions between breastfeeding and birthweight on truncal and abdominal adiposity (Table 2). Analyses stratified by breastfeeding categories showed statistically significant and negative associations between birthweight and truncal and abdominal adiposity in the three regions in the group who had never been breastfed after adjusting for confounders (*P*s = 0.02–0.04; Table 2 and Fig. 1), while no evidence of association was found in adolescents who had breastfeeding for ≥3 months (Table 2 and Fig. 1). Further adjustment for physical activity did not substantially change the results ($\beta = -0.18$ to -0.24 and *P*s = from 0.01 to 0.04 in never breastfed and $\beta = -0.005$ to -0.01 and Ps = from 0.46 to 0.93 in adolescents breastfed for ≥3 months).

Discussion

The major finding of the current study was that breastfeeding attenuates the programming effect of

Key messages

- Pre- and postnatal programming of abdominal adiposity in adolescents.
- Breastfeeding, birthweight and abdominal adiposity in adolescents.
- Protective effect of breastfeeding on prenatal programming of adiposity in adolescents.
- Protective influence of breastfeeding on cardiovascular disease risk factors in adolescents.

Table 1. Descriptive characteristics of adolescents according to breastfeeding duration categories (never breastfed vs. breastfed for at least 3 months)

	Never (N = 47)	At least 3 months of breastfeeding (N = 182)	*P*
Age (years)	15.2 (1.1)	14.9 (1.2)	0.06
Girls (%)	53.2	52.7	0.96
Pubertal status (%)			
I–II	2.2	2.3	0.57
III–IV	13.3	17.6	
V	84.5	80.1	
Body weight at birth (kg)	3.1 (0.5)	3.3 (0.5)	0.002
Duration of gestation (weeks)			
<37	13.3	1.7	0.003
37–42	66.7	64.9	
>42	20.0	33.4	
Maternal educational level (%)			
University	39.1	64.4	0.002
Non-university	60.9	35.6	
Physical activity (counts per min)†	446 (147)	419 (150)	0.29
Body weight (kg)	58.4 (11.2)	57.7 (10.5)	0.67
Body mass index (kg m^{-2})	21.6 (3.9)	21.1 (3.0)	0.40
Overweight (%)	23.4	18.7	0.89
Truncal fat mass (g)*	6116 (3517)	5445 (2673)	0.33
Abdominal fat mass R1 (g)*	966 (722)	835 (520)	0.24
Abdominal fat mass R2 (g)*	1370 (1010)	1158 (685)	0.23
Abdominal fat mass R3 (g)*	1495 (1110)	1281 (775)	0.34

Data are means (standard deviations), unless otherwise stated. *Analyses were performed with logarithmically transformed data, but non-transformed data are presented. †Physical activity data were measured in 92.7% of the participants (94.1% of men, 91.3% of women).

low birthweight on abdominal adiposity in adolescents. Indeed, this attenuation was consistent and robust across all measures of central adiposity including truncal adiposity and the three measured abdominal regions. Moreover, the associations were independent of potential confounding factors including maternal educational level and physical activity.

Fetal and early post-natal life are considered critical periods in the development of obesity and CVD later in life. We have previously shown that birthweight is negatively associated with abdominal adiposity in youths (Labayen *et al*. 2009). The influence of breastfeeding on abdominal adiposity in childhood has been previously examined. Crume *et al*.

Table 2. Unstandardized regression coefficients (*β*) and confidence intervals (CI) between body weight at birth and truncal and abdominal adiposity in the three regions in adolescents according to breastfeeding duration

	Body weight at birth (g)												
	P_{int}	Never breastfed						At least 3 months of breastfeeding					
		Model 1			Model 2			Model 1			Model 2		
		β	95% CI	*P*	*β*	95% CI	*P*	*β*	95% CI	*P*	*β*	95% CI	*P*
Truncal fat mass (g)	0.06	−0.14	−0.28, −0.02	0.02	−0.19	−0.36, −0.03	0.04	−0.02	−0.11, 0.07	0.64	−0.03	−0.12, 0.06	0.61
Abdominal FM R1 (g)	0.07	−0.15	−0.38, 0.02	0.07	−0.23	−0.51, −0.04	0.02	−0.03	−0.17, 0.09	0.51	−0.04	−0.20, 0.06	0.40
Abdominal FM R2 (g)	0.02	−0.16	−0.37, 0.00	0.05	−0.21	−0.47, −0.04	0.02	−0.06	−0.19, 0.05	0.23	−0.07	−0.21, 0.03	0.21
Abdominal FM R3 (g)	0.03	−0.17	−0.39, −0.01	0.04	−0.22	−0.48, −0.03	0.02	−0.06	−0.20, 0.06	0.28	−0.06	−0.23, 0.04	0.26

R1, region 1; R2, region 2; R3, region 3; P_{int}, P for interaction between body weight at birth and breastfeeding. Model 1: Analyses were adjusted for sex and whole body mass. Model 2: Model 1 was additionally adjusted for age, duration of gestation and maternal educational level. All the analyses were performed with logarithmically transformed data.

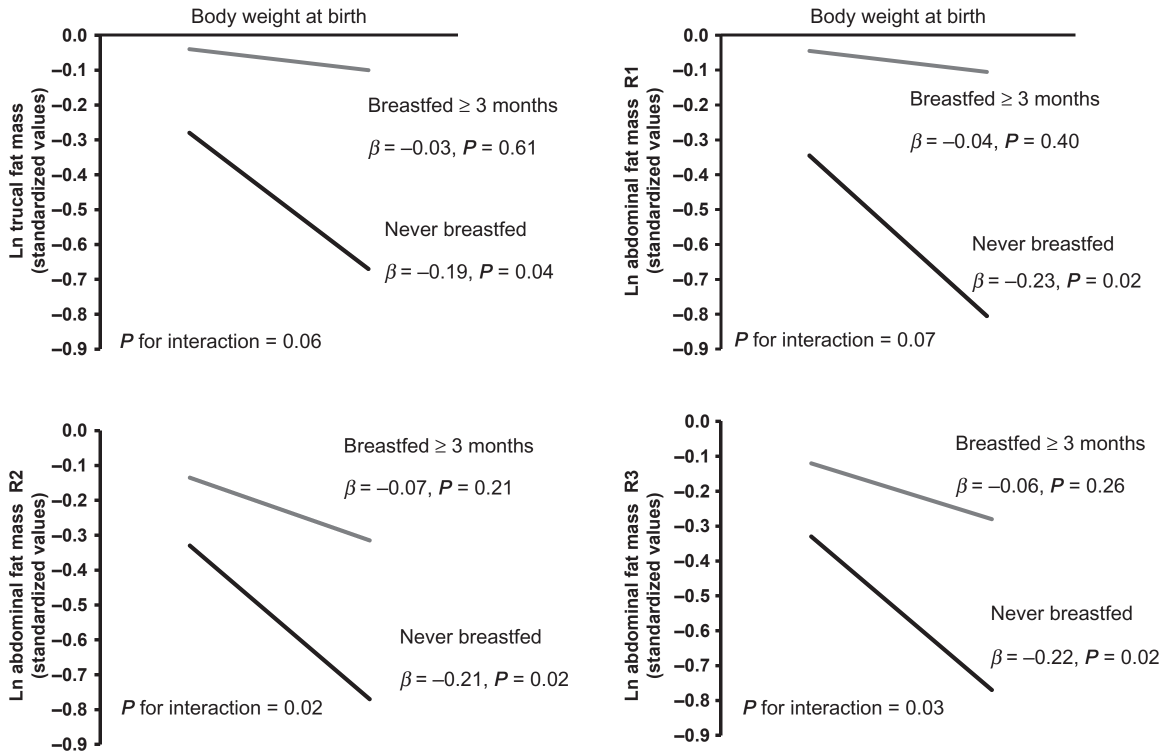

Fig. 1. Associations of body weight at birth with truncal and abdominal fat mass in the three regions (R1, R2 and R3) in adolescents who had breastfeeding for at least three months (N = 182) or who had never been breastfed (N = 47). Data are standardized coefficients (β) examining the relationship between birthweight and truncal and abdominal fat mass (logarithmically transformed) adjusted with age, sex, duration of gestation, maternal educational level and whole body mass.

showed that breastfeeding for at least 6 months was associated with lower abdominal adiposity in youths (Crume *et al*. 2011). In contrast, Davis *et al*. did not find any significant protective effect of breastfeeding on abdominal adiposity in a sample of overweight youth (Davis *et al*. 2007).

The interaction between fetal and post-natal nutritional environment on adiposity has been little examined. A previous study performed with children born small for gestational age (SGA) observed that faster early growth by a nutrient-enriched diet was associated with adiposity at 5–8 years of age as compared with either standard formula or breastfeeding (Singhal *et al*. 2010). However, they did not examine fat distribution. Crume *et al*. observed that breastfeeding for ≥6 months reduced the adverse effect of exposure to diabetes *in utero* on abdominal adiposity in children (Crume *et al*. 2011). Findings of the current study support the concept that early nutrition influences abdominal adiposity later in life. Moreover, our data could contribute to explain the adverse effect of 'overnutrition' or faster weight gain in infancy on later CVD in children born SGA.

Our study had some limitations and strengths. First, our sample size was not comparable with that of larger epidemiological studies, but a major strength of our report was the use of DXA. Second, the exposure variables used in the present study were obtained retrospectively some years post-partum. Ideally, breastfeeding patterns would be assessed prospectively in the child from birth to weaning (Kark *et al*. 1984; Vobecky *et al*. 1988).

In conclusion, our findings suggest that breastfeeding may be used as a primary prevention nutritional factor of abdominal adiposity and later metabolic disorders in individuals at increased risk due to fetal programming.

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Conflict of interest

The authors declare that they have no conflicts of interest.

Contributions

IL conceived the hypothesis, conducted the statistical analyses and drafted the manuscript. FO, JR, and LM critically revised the drafted manuscript. GR, DJP, VER, KW and FG collected the data and critically revised the manuscript.

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