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Anthropometry and body composition of 18 year old men according to duration of breast feeding: birth cohort study from Brazil

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Abstract

Objective To assess the association between duration of breast feeding and measures of adiposity in adolescence.

Design Population based birth cohort study.

Setting Pelotas, a city of 320 000 inhabitants in a relatively developed area in southern Brazil.

Participants All newborn infants in the city's hospitals were enrolled in 1982; 78.8% (2250) of all male participants were located at age 18 years when enrolling in the national army.

Main outcome measures Weight, height, sitting height, subscapular and triceps skinfolds, and body composition (body fat, lean mass).

Results Neither the duration of total breast feeding nor that of predominant breast feeding (breast milk plus non-nutritive fluids) showed consistent associations with anthropometric or body composition indices. After adjustment for confounding factors, the only significant associations were a greater than 50% reduction in obesity among participants breast fed for three to five months compared with all other breastfeeding categories ($P=0.007$) and a linear decreasing trend in obesity with increasing duration of predominant breast feeding ($P=0.03$). Similar significant effects were not observed for other measures of adiposity. Borderline direct associations also occurred between total duration of breast feeding and adult height ($P=0.06$).

Conclusions The significant reduction in obesity among children breast fed for three to five months is difficult to interpret, as no a priori hypothesis existed regarding a protective effect of intermediate duration of breast feeding. The findings indicate that, in this population, breast feeding has no marked protective effect against adolescent adiposity.

Introduction

Whether breast feeding protects against obesity is still hotly debated despite recent work suggesting that breast feeding may protect against overweight and obesity in adolescence¹⁻⁵ We report on a birth cohort of over 2000 male Brazilians followed for 18 years, for whom detailed breastfeeding information was collected in early childhood. In addition to several anthropometric measures of adiposity, we ascertained body composition through bio-impedance.

Methods

Pelotas (population 320 000) is a relatively affluent city in southern Brazil. The population is mostly of European background. The mean annual gross domestic product per capita is about US\$2700 (£1690; €2398), and infant mortality in 1982 was 38 per thousand.

The study recruited all 5914 infants born alive during 1982 in the three maternity hospitals in Pelotas (over 99% of all city births).^{6,7} The infants were examined, and their mothers were interviewed. In early 1983 children born in January-April 1982 were sought at home. In 1984 and 1986 all households in the city were visited in search of cohort children; 87% and 84% of the original cohort were located. Duration of breast feeding and age at introduction of fluids and foods were recorded. In 2000 we invited men in the cohort who were registering at the local army base to join the study.

We used standard definitions of breast feeding.⁸ Total duration in months and days was collected at the 1983, 1984, and 1986 follow ups. Exclusive breast feeding was of short duration, because virtually all children also received herbal teas or water from the first week of life and were thus classified as predominantly breast fed. Duration of predominant breast feeding recorded the age when foods other than breast milk or teas or water were introduced. We used the earliest available information in order to minimise recall bias.

Confounding variables were measured in 1982: monthly family income, maternal education, pre-pregnancy body mass index (in kg/m^2), smoking during pregnancy (non-smokers, 0-14, or ≥ 15 cigarettes a day), birth weight, and gestational age (estimated by the date of the last menstrual period and recorded as less than 37, 37-38, 39-41, or ≥ 42 weeks or unknown). We also collected information on confounders in 2000: skin colour (self reported, classified as white or other), physical activity (minutes per week spent on physical exercise), type of diet (Block classification⁹: best low fat food, low fat food, eating American diet, diet is quite high in fat, diet is high in fat), daily smoking, and alcohol intake in the preceding week.

We measured several outcomes in 2000. We measured standing and sitting height and obtained leg length by subtraction. We weighed participants and measured subscapular and triceps skinfolds. We used standard World Health Organization definitions and reference curves.¹⁰ We defined overweight as body mass index at or above the 85th centile of the sex and age specific value and obesity as body mass index at or above the 85th centile plus subscapular and triceps skinfolds at or above the 90th centile. We repeated all analyses with body mass index cut-offs of $25 \text{ kg}/\text{m}^2$ and $30 \text{ kg}/\text{m}^2$. We estimated fat mass and fat-free mass in kg by using bio-impedance. See bmj.com for more details.

We analysed dichotomous outcomes by using χ^2 tests for heterogeneity and for linear trends in proportions. We used logistic regression to adjust for confounding. We compared means by using analysis of variance (crude analyses) and general linear models (adjusted analyses).

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Table 1 Distribution of sample according to key indicators (n=2250)

| Sample characteristic | No | % |
|---------------------------------|------|------|
| Overweight | 392 | 17.4 |
| Obese | 182 | 8.1 |
| Daily smokers | 356 | 15.8 |
| Physical activity <90 min/week | 403 | 17.9 |
| High fat diet | 1085 | 48.2 |
| Alcohol intake in previous week | 1352 | 60.1 |

Results

Of the 3037 liveborn boys in the cohort, we examined 2250 (74.1%) in 2000, and 143 (4.7%) are known to have died. We therefore traced 78.8% of the original cohort. Another 37 cohort members were identified but refused to participate. Middle class participants were more often traced than either poor or wealthy ones. Regarding maternal education, follow up rates were highest for the 5-8 years and ≥ 12 years groups. No significant differences in follow up occurred according to birth weight or duration of breast feeding.

Both short (less than one month) and long (12 months or more) durations of breast feeding were more prevalent in poor families with less educated mothers (data available on request). Non-white infants tended to be breast fed for longer than white ones, and birth weight was inversely associated with duration of breast feeding. Similar patterns occurred for predominant breast feeding. Income, maternal education, smoking, skin colour, maternal body mass index, gestational age, and birth weight were treated as potential confounders in the multivariable analyses. Table 1 shows characteristics of the sample in 2000.

In crude analyses, no significant associations occurred between total duration of breast feeding and prevalence of overweight or mean body mass index, fat, or fat-free mass, but obesity was about three times less prevalent in participants who were breast fed for three to five months than in the other categories (P=0.004).

Height increased steadily with duration of breast feeding until 11 months, with a significant overall linear trend. A significant linear association also occurred with percentage leg length, but the differences were small.

Table 2 shows adjusted analyses of overweight and obesity. Total duration of breast feeding remained unassociated with overweight, but the lower risk of obesity for participants breast fed for three to five months persisted, with an adjusted odds ratio of 0.41 compared with those breast fed for 12 months or longer (P=0.006). Table 3 shows adjusted analyses of continuous outcomes. No association occurred between total duration of breast feeding and mean body mass index, fat, or fat-free mass. The association with height was almost significant (P=0.06), but differences were small. No association with leg length occurred.

We repeated all analyses for predominant breast feeding (see bmj.com). Adjustment for confounding confirmed the lack of association with overweight (table 4). However, we found evidence of a protective effect against obesity (P=0.03), although children who were predominantly breast fed for at least four months showed a slight increase compared with those breast fed for three months. After adjustment for confounders, no significant associations occurred between duration of predominant breast feeding and body mass index, fat, fat-free mass, height, or percentage leg length. We repeated all analyses with the adult cut-offs for body mass index of 25 kg/m² and 30 kg/m²; results were virtually unchanged.

Discussion

Our results were mostly negative. Neither the duration of total breast feeding nor that of predominant breast feeding had marked effects on the anthropometric or body composition indices. Two significant associations remained after adjustment. The first was a greater than

Table 2 Logistic regression analyses for prevalence of overweight and obesity among 18 year old men according to duration of total breast feeding (n=2082)

| Outcomes | Model | Odds ratio (95% CI) according to duration of total breast feeding (months) | | | | | | | P value* |
|----------------|-----------|--|---------------------|---------------------|---------------------|---------------------|-----|-------|----------|
| | | <1 | 1-2 | 3-5 | 6-8 | 9-11 | ≥12 | | |
| Overweight (%) | Crude | 1.04 (0.69 to 1.56) | 0.98 (0.66 to 1.47) | 0.78 (0.51 to 1.19) | 1.21 (0.74 to 1.98) | 1.51 (0.81 to 2.78) | 1.0 | 0.27 | |
| | Adjusted† | 1.14 (0.77 to 1.68) | 0.91 (0.61 to 1.35) | 0.85 (0.57 to 1.27) | 0.86 (0.53 to 1.40) | 1.34 (0.74 to 2.44) | 1.0 | 0.41 | |
| Obese (%) | Crude | 1.16 (0.71 to 1.91) | 1.08 (0.66 to 1.76) | 0.43 (0.24 to 0.79) | 1.32 (0.73 to 2.38) | 1.24 (0.56 to 2.74) | 1.0 | 0.007 | |
| | Adjusted† | 1.08 (0.63 to 1.84) | 1.09 (0.64 to 1.84) | 0.38 (0.20 to 0.72) | 1.20 (0.64 to 2.24) | 1.05 (0.46 to 2.42) | 1.0 | 0.006 | |

*Likelihood ratio test.

†Adjusted for family income and maternal education at birth, maternal body mass index, skin colour, birth weight, gestational age, maternal smoking during pregnancy, and current behavioural variables (smoking, alcohol drinking, type of diet, and physical exercise).

Table 3 Anthropometry and body composition of 18 year old men according to duration of total breast feeding: adjusted analyses*. Values are means (SEs)

| Outcomes | Duration of total breast feeding (months) | | | | | | P value |
|-------------------------------|---|-------------|-------------|-------------|-------------|-------------|---------|
| | <1 | 1-2 | 3-5 | 6-8 | 9-11 | ≥12 | |
| Body mass index | 23.0 (0.2) | 22.9 (0.2) | 22.6 (0.2) | 22.9 (0.3) | 23.3 (0.4) | 23.0 (0.2) | 0.35 |
| Fat mass percentage | 17.5 (0.2) | 17.7 (0.2) | 17.6 (0.2) | 17.8 (0.2) | 18.2 (0.3) | 17.8 (0.2) | 0.24 |
| Fat mass/height ² | 4.1 (0.1) | 4.1 (0.1) | 4.0 (0.1) | 4.2 (0.1) | 4.3 (0.1) | 4.2 (0.1) | 0.28 |
| Lean mass/height ² | 18.9 (0.2) | 18.8 (0.2) | 18.6 (0.2) | 18.8 (0.2) | 19.1 (0.3) | 18.9 (0.2) | 0.45 |
| Height in cm | 173.9 (0.4) | 174.1 (0.4) | 174.4 (0.4) | 174.5 (0.5) | 174.8 (0.7) | 174.8 (0.4) | 0.49 |
| Percentage leg/total height | 44.6 (0.1) | 44.6 (0.1) | 44.7 (0.1) | 44.8 (0.1) | 44.7 (0.2) | 44.6 (0.1) | 0.52 |

*General linear model (general factorial); estimates adjusted for family income and maternal education at birth, maternal body mass index, skin colour, birth weight and gestational age, maternal smoking during pregnancy, and current behavioural variables (smoking, alcohol drinking, type of diet, and physical exercise). The number of participants ranged from 2106 to 2133, depending on the outcome.

Table 4 Logistic regression analyses for prevalence of overweight and obesity among 18 year old men according to duration of predominant breast feeding (n=1993)

| Outcomes | Model | Odds ratio (95% CI) according to duration of predominant breast feeding (months) | | | | | P value* |
|----------------|-----------|--|---------------------|---------------------|---------------------|-----|----------|
| | | <1 | 1-1.9 | 2-2.9 | 3-3.9 | ≥4 | |
| Overweight (%) | Crude | 1.03 (0.67 to 1.58) | 0.96 (0.60 to 1.56) | 0.76 (0.47 to 1.23) | 0.89 (0.58 to 1.38) | 1.0 | 0.62 |
| | Adjusted† | 1.05 (0.69 to 1.58) | 0.82 (0.51 to 1.32) | 0.86 (0.55 to 1.34) | 0.82 (0.54 to 1.25) | 1.0 | 0.56 |
| Obese (%) | Crude | 1.43 (0.82 to 2.49) | 1.12 (0.60 to 2.10) | 0.94 (0.50 to 1.74) | 0.87 (0.49 to 1.56) | 1.0 | 0.03‡ |
| | Adjusted† | 1.42 (0.79 to 2.56) | 1.14 (0.59 to 2.22) | 1.02 (0.53 to 1.94) | 0.80 (0.43 to 1.48) | 1.0 | 0.03‡ |

*Likelihood ratio test.

†Adjusted for family income and maternal education at birth, maternal body mass index, skin colour, birth weight, gestational age, maternal smoking during pregnancy, and current behavioural variables (smoking, alcohol drinking, type of diet, and physical exercise).

‡Test for linear trend.

50% reduction in obesity in participants breast fed for three to five months. Although it is tempting to relate this finding to the “critical window” theory of development, it has to be interpreted with caution, because we did not find significant reductions in this group for any of the other measures of adiposity, and because we had no a priori hypothesis regarding a protective effect of intermediate duration of breast feeding.

The second significant finding was a linear trend for a reduction in obesity with increasing duration of predominant breast feeding. We found no associations between predominant breast feeding and any of the other measures of adiposity studied, however. We also observed a possible positive effect of total duration of breast feeding on adult height ($P = 0.06$), a finding that was not reported in the available literature.

This study has some limitations. About 21% of the participants were lost to follow up over the 18 year period; losses were higher at both extremes of the socioeconomic scale and were not associated with duration of breast feeding. Another limitation is that results are not available for women.

A review of the English language literature on breast feeding and adolescent adiposity found four studies. A US study found that children aged 9-14 years who had been mostly breast fed for the first six months of life had a 20% lower risk of being overweight than those who had not been breast fed.⁴ A Canadian case-control study compared obese, overweight, and non-obese 12-18 year olds.¹¹ Feeding history was ascertained retrospectively by telephone. A significant increasing trend in duration of breast feeding occurred among the three groups, but no additional benefit from delayed introduction of solids was seen, in either the crude or the adjusted analyses. Tulldahl et al studied the effect of duration of breast feeding on height, skinfolds, and body composition in 18 year olds.¹² Those who were breast fed for longer periods tended to be shorter and leaner, but not all associations were significant. In a study of 136 rural American teenagers, breast feeding for two months or less was positively associated with obesity.¹³

Our study differed from the four studies cited above, as it was a prospective cohort study assessing the association of duration and exclusivity of breast feeding with several measures of adolescent adiposity. The only other cohort study on the subject, the growing up today study, was a partly retrospective cohort in which information on breast feeding was obtained through maternal recall when participants were aged 9-14 years, with an overall response rate of less than 50%.⁴

What is already known on this topic

Although no consensus exists, some recent papers suggest that breast feeding may protect against overweight and obesity in adolescence

What this study adds

This is the largest birth cohort study reporting on the effect of breast feeding on several measures of adiposity, including body composition, in adolescence

Among 18 year old male Brazilians, duration of neither total nor predominant breast feeding was consistently protective against adolescent adiposity

Regardless of the role breast feeding may have in preventing obesity, it has been consistently associated with many advantages for the mother and child, ranging from decreased childhood mortality to a likely protection against breast cancer.^{14 15} The continued protection, promotion, and support of breast feeding remains a major public health priority.

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Breast feeding and obesity in childhood: cross sectional study

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The evidence that breast feeding protects against obesity is inconclusive: some studies show a protective effect¹ and others find no effect.^{2,3} Confounding factors may account for these inconsistencies. We used data from the offspring of the 1958 British birth cohort to assess whether breast feeding influences body mass index and obesity in childhood.

Methods and results

We used data from a randomly selected sample (n=2584) of the members of the 1958 British birth cohort who had children by 1991.⁴ Information was collected on their offspring. Of 3077 children aged 4-18 years, we included 2631 children (1293 girls and 1338 boys from 1768 families; average age 8 years) for whom data on duration of breast feeding, body mass index, and confounding factors were available.

Body mass index (weight (kg)/(height (m)²)) was standardised relative to the 1990 British growth reference,⁵ and obesity was defined as a standard deviation score > 1.64 (95th centile). Duration of breast feeding had been reported by the mother in 1991 (see table for categories).

Potential confounding factors, reported in 1991, were birth weight; mother's smoking during pregnancy (<1 cigarette/day, 1-9/day, or ≥10/day); and social class, based on the 1991 occupation of the male head of

household, classified as professional or managerial, skilled non-manual, skilled manual, or semiskilled or non-skilled. Parent's body mass index was derived from height and weight and standardised within the study by sex. The body mass index of the parent (only one parent was the cohort member) was available for each child.

The multilevel models that we used to estimate the relation between body mass index and duration of breast feeding (linear model) and between obesity and duration of breast feeding (logistic model) took into account the correlation between siblings. We used the iterative generalised least squares procedure (MLwiN statistical package) to calculate outcomes for ages 4-8 and 9-18 separately. We calculated odds ratios before and after adjusting for sex, parent's body mass index, maternal smoking during pregnancy, birth weight, and social class.

In our sample, 62.9% of children (1655) had been breast fed for ≥ 1 week. The mean score for body mass index in all children was higher than the growth reference sample by 0.18. A total of 207 children (7.9%) were obese. Mean body mass index and obesity were consistently lower in those breast fed for 2-3 months, though not significantly (table). We found no evidence that breast feeding influenced body mass index or obesity and no dose dependent trend in either age group; adjustment for confounding factors did not alter these findings. That there was no difference in the

Relation of duration of breast feeding to mean body mass index (BMI) and odds ratio for obesity* in children aged 4-18 years in 1991

| Duration of breastfeeding | No | Mean SD score for BMI (95% CI) | Odds ratio (95% CI) | |
|---------------------------|------|--------------------------------|---------------------|---------------------------|
| | | | Adjusted for sex | Adjusted for confounders† |
| Children aged 4-8: | 1541 | | | |
| <1 week | 505 | 0.21 (0.11 to 0.31) | 1.00 | 1.00 |
| 1 week to 1 month | 215 | 0.27 (0.10 to 0.44) | 1.19 (0.68 to 2.09) | 1.04 (0.57 to 1.90) |
| 2-3 months | 220 | 0.12 (-0.02 to 0.26) | 0.64 (0.33 to 1.25) | 0.68 (0.34 to 1.35) |
| 4-6 months | 210 | 0.22 (0.07 to 0.37) | 0.91 (0.49 to 1.68) | 0.94 (0.50 to 1.78) |
| 7-9 months | 197 | 0.24 (0.09 to 0.39) | 1.05 (0.58 to 1.92) | 1.14 (0.61 to 2.16) |
| >9 months | 194 | 0.19 (0.06 to 0.32) | 0.54 (0.26 to 1.15) | 0.61 (0.28 to 1.32) |
| Children aged 9-18: | 1090 | | | |
| <1 week | 471 | 0.18 (0.08 to 0.28) | 1.00 | 1.00 |
| 1 week to 1 month | 187 | 0.05 (-0.09 to 0.19) | 1.16 (0.62 to 2.18) | 1.25 (0.65 to 2.39) |
| 2-3 months | 171 | 0.04 (-0.12 to 0.20) | 0.70 (0.33 to 1.49) | 0.69 (0.32 to 1.52) |
| 4-6 months | 133 | 0.24 (0.06 to 0.42) | 1.27 (0.63 to 2.55) | 1.31 (0.62 to 2.74) |
| 7-9 months | 61 | 0.16 (-0.12 to 0.42) | 1.68 (0.70 to 4.05) | 2.02 (0.80 to 5.10) |
| >9 months | 67 | 0.20 (-0.04 to 0.44) | 0.73 (0.24 to 2.19) | 0.73 (0.23 to 2.27) |

*Standard deviation score for body mass index >1.64.

†Adjusted for sex, parent's BMI, maternal smoking during pregnancy, birth weight, and social class.