



Influence of maternal excess weight before pregnancy on breast-feeding and weaning: pooled analyses of four population-based cohorts born between 1982 and 2015

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Abstract

To investigate the associations of maternal excess weight before pregnancy with (1) weaning at 3 months of age, (2) duration of exclusive breast-feeding at 6 months of age, (3) duration of any breast-feeding at 12 months of age and (4) to compare the magnitude of these associations over four decades. Data were from participants in the Pelotas (Brazil) Birth Cohorts born in 1982 (*n* 5334), 1993 (*n* 1442), 2004 (*n* 4092) and 2015 (*n* 4102). Maternal pre-pregnancy weight was collected after the delivery and breast-feeding status was assessed when children were 3 and 12 months old. Only in the most recent cohort (2015), women with excess weight (BMI ≥ 25 kg/m²) before pregnancy had higher risk of discontinuing exclusive breast-feeding within the first 6 months postpartum than women with normal weight (hazard ratio = 1.22 (95% CI 1.15, 1.30)). Duration of any type of breast-feeding until 12 months of age was not affected by pre-pregnancy weight. Excess weight before pregnancy is associated with exclusive breast-feeding only in the most recent birth cohort coinciding with increases in excess weight and breast-feeding over time.

Key words: Breast-feeding; Weaning; Overweight; Obesity; Cohort studies

The prevalence of excess weight, defined as a BMI ≥ 25.0 kg/m²(¹), is increasing globally(¹), particularly in young women of reproductive age with low socio-economic position(^{2,3}). In low-middle-income countries, over 30% of women aged 20–49 years are overweight or obese(⁴). In Brazil, data from four population-based birth cohorts studies have shown that excess weight before pregnancy has increased from 22% in 1982 to 47% in 2015(⁵).

Excess weight before pregnancy increases the risk of still-birth, prematurity, macrosomia and hospital admissions(^{6,7}). It has been suggested that, compared to women with normal pre-pregnancy weight, those with excess weight are less likely to initiate and more likely to discontinue breast-feeding earlier(^{6–12}). Data from a Canadian study have shown that 20% of mothers with obesity did not initiate breast-feeding, compared with 12% of women with normal weight(¹²). In a Finnish cohort study, 71% of women with overweight

discontinued breast-feeding within the 4 months post-delivery, compared with 62% of women non-overweight(¹³). Data from the 2004 Pelotas (Brazil) Birth Cohort study have shown that children of mothers who were obese before pregnancy were more likely to be weaned within the first 3 months of life than children of women with normal weight(¹⁰).

A systematic review and meta-analysis of seventeen studies has shown that excess weight before pregnancy was associated with shorter exclusive breast-feeding duration(⁸). However, only three studies included in this systematic review were conducted in low-middle-income countries and bias in the reporting of negative results may have resulted in overestimation of the true magnitude of associations between excess weight before pregnancy and duration of breast-feeding(⁸).

Although there has been suggested that maternal excess weight before pregnancy is an important predictor of breast-feeding, the mechanisms underlying this association are still

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unclear. To date, it is accepted that excess weight may influence hormonal factors related to lactogenesis II⁽¹⁴⁾, and that psychological, behavioural, cultural and other factors^(15,16) may also influence breast-feeding behaviour.

The availability of four methodologically standardised population-based birth cohorts starting in 1982 and continuing with a new birth cohort every 11 years, in the city of Pelotas (Brazil), provides a unique opportunity to investigate these associations over time. This is important because over the last four decades substantial changes in the prevalence of excess weight before pregnancy and breast-feeding were observed⁽¹⁷⁾. Moreover, considerable changes in the distribution of socio-demographic characteristics that influence both excess weight and breast-feeding were also observed⁽¹⁷⁾. Lastly, the lack of evidence from low-middle-income countries, where over 80% of world's population resides, limits our understanding of the causal links between excess weight before pregnancy and breast-feeding. Therefore, the aims of this study were to investigate the associations of maternal excess weight before pregnancy with (1) weaning at 3 months of age, (2) duration of exclusive breast-feeding at 6 months of age, (3) duration of any breast-feeding at 12 months of age and (4) to compare the magnitude of these associations over four decades in Brazil.

Materials and methods

Sample

Pelotas is a city with approximately 342 000 residents (2019) in southern Brazil (<https://cidades.ibge.gov.br/brasil/rs/pelotas/panorama>). The Pelotas Birth Cohorts include all live births delivered by women living in Pelotas in 1982 (n 5914), 1993 (n 5249), 2004 (n 4231) and 2015 (n 4275). In these cohorts, women were interviewed shortly after delivery at the hospitals where the deliveries or immediate postnatal care took place, and the newborns have been followed up in household visits throughout their life (online Supplementary Table S1).

Due to funding availability, the follow-up schedules of the earliest cohorts were not identical. In the 1982 cohort, 1916 children (79.3% of the participants who were born between January and April 1982) were located and followed up when they were approximately 12 months old. The 1993 cohort followed up all low-birth-weight children (< 2500 g) in addition to a systematic sample of 1460 children, corresponding to 20% of the non-low birth weight births, that was followed up at 6 months (follow-up rate of 96.8%) and 12 months of age (follow-up rate of 93.4%)^(18,19). The 2004 and 2015 cohorts followed up all children at 3 and 12 months of age. The follow-up rates of the 2004 cohort at ages 3 and 12 months were 95.7 and 94.3%, respectively; for the 2015 cohort, the follow-up rates were 97.2 and 95.4%, respectively^(20,21).

In 1982 and 1993, verbal consent was obtained from mothers who agreed to participate in the studies, as written consent and ethical approvals for studies including human beings were not required by the Brazilian research Committees until 1996. All follow-up studies of these cohorts have been approved by the Federal University of Pelotas' Research

Ethics Committee after 1996 and written informed consent has been obtained, as has been the case for all data collection in the entirety of the 2004 and 2015 birth cohorts. Trained research interviewers collected the data and participants were interviewed using standardised, pre-coded questionnaires (in paper until 2004 and using electronic data collection systems after that). All questionnaires are available online (<http://www.epidemiologia.ufpel.br/site/content/estudos/index.php>). The methodologies adopted in these birth cohort studies have been described in detail in previous publications⁽¹⁸⁻²¹⁾, and detailed comparative description of the methodologies of these four birth cohorts has been published previously⁽¹⁷⁾.

Maternal excess weight before pregnancy

Maternal pre-pregnancy weight (in kg) and height (in cm) were self-reported in all four cohorts and were used to calculate the pre-pregnancy BMI (maternal weight (in kg) divided by the height squared (in m)). BMI was categorised as: underweight (< 18.5 kg/m²); normal weight (18.5–24.9 kg/m²); overweight (25.0–29.9 kg/m²) and obesity (\geq 30.0 kg/m²)⁽¹⁾. For the present study, excess weight before pregnancy was defined as BMI \geq 25.0 kg/m².

Breast-feeding

In all cohorts, mothers and/or caregivers were asked about infant feeding practices at each follow-up visit. Questions included: 'How long did the child breastfeed?'. In each assessment, breast-feeding status was categorised in one of the following categories: (1) *exclusive breast-feeding*: children who were not fed any other liquids or solids; (2) *predominant breast-feeding*: children who were breastfed but received any other fluids but no solid or semi-solid foods; (3) *partial breast-feeding*: children breastfed but receiving other types of milk, including cow's milk, formula or those receiving solid or semi-solid foods^(22,23); (4) *weaned*: children who were not being breastfed. Because questions about ingestion of water or tea were not included in the questionnaire in the 1982 cohort, the prevalence of exclusive breast-feeding was not assessed in this cohort.

Based on breast-feeding status and duration of breast-feeding, three outcomes were analysed in the present study: (i) the prevalence of weaning at 3 months of age (assessed at 12 months of age in the 1982 cohort, at 6 months of age in the 1993 cohort and at 3 months of age in the 2004 and 2015 cohorts); (ii) duration of exclusive breast-feeding at 6 months; and (iii) duration of any breast-feeding at 12 months of age.

Potential confounders

All analyses were adjusted for the following maternal covariates: age in completed years; skin colour ('non-white' or 'white') observed by the interviewer in the 1982 and 1993 cohorts, and self-reported in the 2004 and 2015 cohorts (reported as 'white', 'brown' or 'black'); marital status (with partner; single mother); maternal schooling (in complete years of education); family income (sum of reported earnings of all family members in the month before childbirth; categorised in tertiles

as low, middle and high income); and parity (number of previous children).

Statistical analyses

For the 1993 cohort, estimates were weighted to account for the oversampling of low-birth-weight children. Initially, maternal characteristics and breast-feeding status were summarised by cohort. The prevalence of excess weight before pregnancy, weaning and exclusive breast-feeding at 3 months of age was estimated according to tertiles of family income in each cohort. Crude and adjusted associations between excess weight before pregnancy and prevalence of weaning at 3 months were estimated using Poisson regression⁽²⁴⁾. Due to the presence of statistical interaction between the cohort (i.e. year of birth) and weaning at 3 months of age, exclusive breast-feeding and any breast-feeding, all analyses were stratified by cohort (pooled analyses are presented in online Supplementary Table S2). Adjusted survival probabilities of exclusive breast-feeding by age until 6 months and any breast-feeding by age until 12 months were estimated using Cox regression models. All analyses were adjusted for maternal skin colour, maternal age, maternal schooling, family income in tertiles, parity and marital status. Due to the similarity of the crude and adjusted associations between excess weight before pregnancy and prevalence of weaning at 3 months, the results of the crude analysis are presented in the appendix (online Supplementary Table S3). Associations with P -value < 0.05 were considered statistically significant. All analyses were conducted using Stata version 15.0.

Results

A total of 14 970 participants from the four cohorts were included in these analyses: 5334 from the 1982 cohort; 1442 from the 1993 cohort; 4092 from the 2004 cohort and 4102 from the 2015 cohort. The demographic and socio-economic characteristics of participants are presented in Table 1. Between 70 and 80 % of the mothers were white and lived with a partner. The mean maternal age increased from 25.8 years in the 1982 cohort to 27.1 in the 2015 cohort. Mean maternal education increased from 6.5 years to 10.0 years of education between 1982 and 2015 (Table 1).

The prevalence of excess weight before pregnancy increased from 22.1 and 22.8 % in 1982 and 1993, respectively, to 29.4% in 2004 and 47.0 % in 2015 (Table 1). An increase in the prevalence of excess weight before pregnancy was observed in all tertiles of income, but this increase was slightly smaller among women in the highest tertile of income than those in the bottom and middle tertiles of income (Fig. 1(a)). In 2015, the prevalence of excess weight before pregnancy was 40 % among women in the highest tertile of income, whereas this proportion was 50 % in the group with the lowest tertile of income.

Exclusive breast-feeding at 3 months increased from 7 % in 1993 to 45 % in 2015 (Table 1). This increase was observed in all income tertiles, but it was less accentuated in the lowest than in the highest tertile of income (Fig. 1(b)). Among those in the

lowest tertile, the proportion of exclusive breast-feeding at 3 months of age increased from 5.2 to 38.8 %, whereas this proportion increased from 11.2 to 57.1 % in the highest income group.

The prevalence of weaning at 3 months of age decreased from 1982 to 2015. In the 2015 cohort, 24.0% of children were weaned before 3 months of life. Overall, the prevalence of weaning at 3 months was lower among children born in the wealthiest income tertile and higher among those in the poorest tertile of income (Fig. 1(c)).

Associations between excess weight before pregnancy and weaning at 3 months of age are presented for each cohort in Fig. 2. Overall, no association between excess weight before pregnancy and weaning was observed in the pooled analyses (RR = 0.97; 95 % CI 0.90, 1.04; online Supplementary Table S2). This was mostly driven by the associations observed in the 1982, 1993 and 2004 cohorts. However, in the 2015 cohort women with excess weight before pregnancy were 19 % more likely to have weaned their infants at 3 months of age (RR = 1.19 (95 % CI 1.04, 1.36)) than those with normal or underweight.

Estimated hazard ratios for duration of exclusive breast-feeding at 6 months and duration of any breast-feeding up to 12 months for each cohort are presented in Fig. 3 and 4, respectively. Overall, excess weight before pregnancy was associated with reduction of exclusive breast-feeding at 6 months (online Supplementary Table S2). The magnitude of this association was stronger in the 2015 cohort than in the 1993 cohort. Women with excess weight before pregnancy in the 2015 cohort had 22 % higher risk of discontinuing exclusive breast-feeding within the first 6 months since birth (hazard ratio = 1.22 (95 % CI 1.15, 1.30) $P < 0.001$) (Fig. 3, panel c) than women with normal weight. Excess weight before pregnancy was not associated with the duration of any breast-feeding from birth to 12 months of age in any of the cohorts (Fig. 4).

Discussion

The aims of this study were to investigate the associations between maternal excess weight before pregnancy and breast-feeding patterns, and to compare these associations across four decades. By collecting data from four large population-based birth cohorts conducted over the last four decades in southern Brazil, we found that excess weight before pregnancy was associated with higher risk of weaning at 3 months and shorter duration of exclusive breast-feeding at 6 months of age, but these associations were observed only in the most recent cohort (2015). These emerging associations coincided with a marked rise in the prevalence of both excess weight and breast-feeding between 1982 and 2015. Our observations reinforce the findings of previous studies that current high rates of maternal excess weight⁽⁵⁾ and low rates of breast-feeding^(25,26) are major public health concerns. Our study provides important insights into maternal excess weight before pregnancy and breast-feeding patterns. Prospective analyses conducted across four decades indicate that women with excess weight and became pregnant in the most recent decade were

Table 1. Sample characteristics of Pelotas/RS, Brazil over the cohort studies (1982–2015) (Numbers and percentages; mean values and standard deviations)

| Characteristics | 1982 (n 5913) | | 1993 (n 5248) | | 2004 (n 4231) | | 2015 (n 4275) | | P† | P‡ |
|---|---------------|------|---------------|------|---------------|------|---------------|------|---------|---------|
| | n | % | n | %* | n | % | n | % | | |
| Maternal skin colour | | | | | | | | | < 0.001 | – |
| White | 4851 | 82.1 | 4058 | 77.6 | 3090 | 73.0 | 3071 | 71.9 | | |
| Brown | – | – | 234 | 4.4 | 295 | 7.0 | 561 | 13.1 | | |
| Black | 1060 | 17.9 | 955 | 18.0 | 846 | 20.0 | 639 | 15.0 | | |
| Maternal marital status | | | | | | | | | < 0.001 | < 0.001 |
| With partner | 5424 | 91.8 | 4600 | 87.8 | 3536 | 83.6 | 3667 | 85.8 | | |
| Single mother | 485 | 8.2 | 649 | 12.2 | 695 | 16.4 | 607 | 14.2 | | |
| Family income (in tertiles) | | | | | | | | | < 0.001 | |
| T1 (poorest) | 2361 | 39.9 | 2226 | 42.8 | 1727 | 40.8 | 1705 | 39.9 | | |
| T2 | 2365 | 40.0 | 1890 | 36.9 | 1674 | 39.6 | 1709 | 40.0 | | |
| T3 (richest) | 1188 | 20.1 | 1021 | 20.3 | 830 | 19.6 | 859 | 20.1 | | |
| Pre-pregnancy BMI | | | | | | | | | < 0.001 | < 0.001 |
| Underweight/normal weight | 3880 | 77.9 | 3958 | 77.1 | 1997 | 70.6 | 2193 | 53.0 | | |
| Excess weight | 1096 | 22.1 | 1139 | 22.8 | 829 | 29.4 | 1948 | 47.0 | | |
| Weaning at 3 months | | | | | | | | | < 0.001 | < 0.001 |
| No | 2756 | 52.0 | 786 | 57.0 | 3022 | 74.0 | 3137 | 76.0 | | |
| Yes | 2578 | 48.0 | 656 | 43.0 | 1070 | 26.0 | 965 | 24.0 | | |
| Exclusive breast-feeding at 3 months | | | | | | | | | < 0.001 | < 0.001 |
| No | – | – | 1343 | 93.0 | 3006 | 73.0 | 2269 | 55.0 | | |
| Yes | – | – | 99 | 7.0 | 1086 | 27.0 | 1833 | 45.0 | | |
| | Mean | sd | Mean | sd | Mean | sd | Mean | sd | | |
| Maternal age (in years) | 25.8 | 6.1 | 26.0 | 6.4 | 26.1 | 6.8 | 27.1 | 6.6 | | < 0.001 |
| Maternal schooling (in complete years of education) | 6.5 | 4.2 | 6.8 | 3.6 | 8.1 | 3.5 | 10.0 | 4.0 | | < 0.001 |
| Parity (number of previous children) | 2.3 | 1.7 | 2.5 | 1.7 | 2.3 | 1.6 | 1.9 | 1.2 | | < 0.001 |

* Percentage (%) considering the svy, with sample weighting.

† P-value difference between cohorts: χ^2 test for heterogeneity.

‡ P-value value difference between cohorts: test for linear trend. Data for the 1982 cohort's prevalence of exclusive breast-feeding are not shown because status could not be assessed using available data.

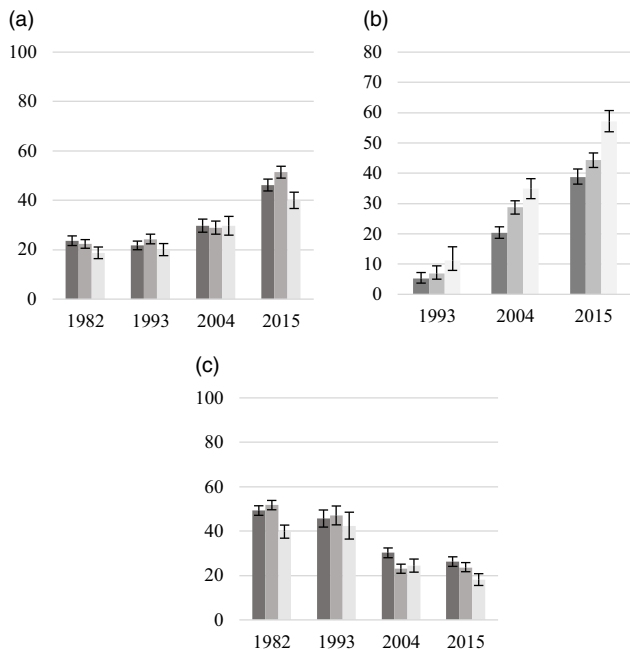


Fig. 1. Prevalence of excess weight before pregnancy (a), exclusive breast-feeding (b) and weaning at 3 months of age (c), according to the cohort and the family monthly income in tertiles. Cohort studies (1982–2015), Pelotas/RS, Brazil. In panel (b), data for the 1982 cohort's prevalence of exclusive breastfeeding are not shown because status could not be assessed using available data. *Statistically significant association P -value < 0.05: chi-square test for heterogeneity for comparison between cohorts. ■, tertile 1; ■, tertile 2; ■, Tertile 3.

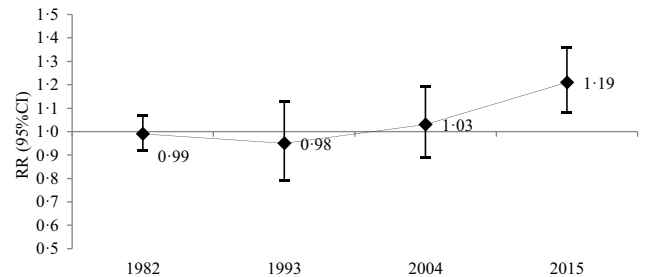


Fig. 2. Adjusted association between excess weight before pregnancy and weaning at three months of age. Cohort studies (1982–2015), Pelotas/RS, Brazil. *Analyses adjusted for maternal skin colour, maternal age, maternal schooling, family income in tertiles, parity and marital status.

more likely to discontinuing breast-feeding than women with normal weight.

Similar findings have been reported in previous studies^(10,27–30). A study in the United Kingdom with approximately 17 000 participants found that, compared with women with normal weight before pregnancy, those with excess weight before pregnancy were more likely to discontinue breast-feeding 1 week postpartum and less likely to continue with breast-feeding after 4 months postpartum⁽⁹⁾. A meta-analysis from seventeen studies also demonstrated that women with excess weight before pregnancy had nearly 60 % higher probability of interrupting exclusive breast-feeding before 6 months of age than women with underweight or normal weight⁽⁸⁾.

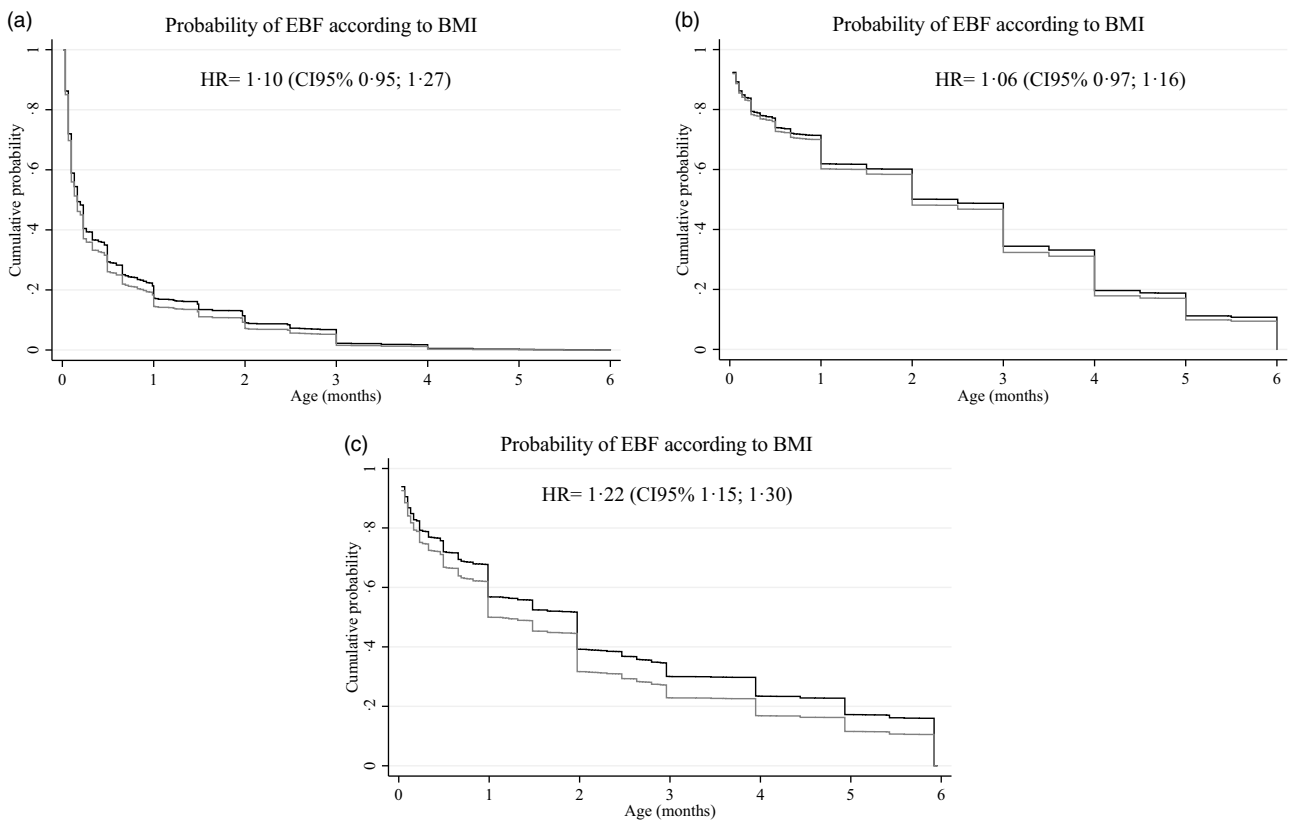


Fig. 3. Survival analyses for duration of exclusive breast-feeding at six months of age among mothers with excess weight before pregnancy in the 1993 (a), 2004 (b) and 2015 (c) cohort. Cohort studies, Pelotas/RS, Brazil. Data for the 1982 cohort's prevalence of exclusive breastfeeding are not shown because status could not be assessed using available data. *Analyses adjusted for maternal skin colour, maternal age, maternal schooling, family income in tertiles, parity and marital status. —, underweight/normal weight; —, overweight/obesity.

Previous research has suggested that women with overweight and obesity are likely to experience a delay in milk release after birth due to reduced prolactin response to suckling during the first 48 h postpartum⁽¹⁴⁾. However, a causal relationship between excess weight before pregnancy and breast-feeding patterns cannot be inferred from our observational data. The inconsistency in the associations over four decades, especially the lack of associations observed in three out of the cohorts (1982, 1993 and 2004), raises the issue on whether the association observed in 2015 refers to a causal relationship or the association was driven by confounding variables. Further and more thorough investigation regarding this association is still needed.

Socio-economic position is a potential confounder of the association between excess weight before pregnancy and breast-feeding. Data from our study showed large differences in the prevalence of excess weight, weaning and exclusive breast-feeding according to family income. Moreover, the magnitude of temporal changes in the prevalence of excess weight, weaning and exclusive breast-feeding varied across tertiles of family income. For example, from 1982 to 2004, there were no marked differences in excess weight according to family income. However, women in the highest tertile of income were less likely than their counterparts to have excess weight in 2015. Weaning and exclusive breast-feeding were also the lowest among those

women in 2015, a pattern that was not consistently observed from 1982 to 2004. These differences are likely to be explained by social norms, given that in the 1990s, wealthier mothers were more likely to use formulas and other types of milk⁽²⁵⁾. However, from the moment the benefits of exclusive breast-feeding began to be evidenced, there was a marked increase in exclusive breast-feeding among the richest group⁽²⁵⁾.

Brazil has experienced rapid demographic, economic, nutritional and epidemiological transitions in the last decades, and many of these changes directly affect maternal and child health^(17,31). Among the changes, the increase in breast-feeding prevalence, including exclusive breast-feeding⁽²⁵⁾, and the large increases in the prevalence of excess weight before pregnancy were likely to affect the observed associations. These changes varied across income categories, with a more pronounced increase in the prevalence of exclusive breast-feeding among women with high income accompanied by a less dramatic increase in the prevalence of excess weight among wealthier women than those in the lowest and middle tertile of income.

Our study has several strengths. To our knowledge, this is the first study that investigated the association between excess weight before pregnancy and breast-feeding patterns in a middle-income country. The use of standardised protocols in four large population-based birth cohort studies enabled comparability of the associations across four decades within the same

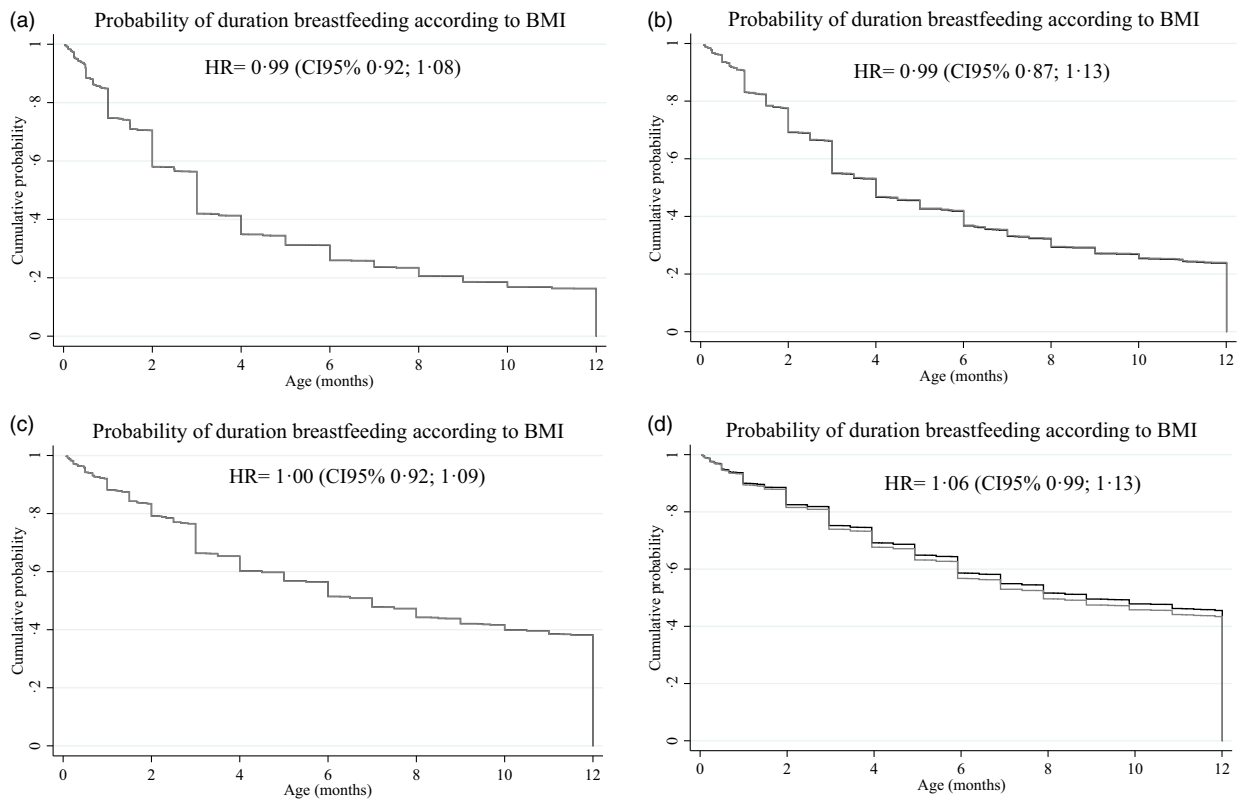


Fig. 4. Survival analyses for duration of any breast-feeding until 12 months of age among mothers with excess weight before pregnancy in the 1982 (a), 1993 (b), 2004 (c) and 2015 (d) cohort. Cohorts studies, Pelotas/RS, Brazil. *Analyses adjusted for maternal skin colour, maternal age, maternal schooling, family income in tertiles, parity and marital status. —, underweight/normal weight; - - -, overweight/obesity.

city. Furthermore, the use of data collected between 1982 and 2015, a period in which Brazil has undergone substantial social and economic changes, provided a unique opportunity to explore the potential effect of maternal excess weight before pregnancy on breast-feeding and to account for different structures regarding unmeasured confounding variables.

Limitations of our study should be considered. Pre-pregnancy height and weight were self-reported, which may have resulted in underestimation of weight and overestimation of height, and therefore resulting in lower BMI estimates. However, these errors are likely to be consistent across groups all four cohorts and, despite reporting might be biased towards lower estimates of BMI, it is unlikely to change the direction of the associations observed. In our study, only excess weight before pregnancy was investigated. However, when sensitivity analyses were conducted using BMI categorised in four groups (underweight, normal weight, overweight and obese) results indicated similar results for women with overweight and obesity.

Conclusion

Excess weight before pregnancy was associated with exclusive breast-feeding and weaning in the most recent cohort (2015), coinciding with important increases in both excess weight prevalence and in breast-feeding behaviour. These results are consistent with the evidence from studies carried out in high-income countries, which have found similar associations.

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T. R. F. idealised the research, worked in the supervision of data collection, analysed and interpreted the data, wrote the manuscript and reviewed the final version. G. I. M. worked on supervising data collection and reviewing all stages of the manuscript, reviewed and approved the final version. A. M., I. S., M. F. S., D. G. B., M. R. D., H. G. and B. L. H. are coordinators of the research, reviewed all the steps and approved the final version of the manuscript. A. D. B. is the coordinator of the general study, guided this work, contributed to the analyses, reviewed and approved the final version of the manuscript.

The authors have no conflicts of interest to declare.

Supplementary material

For supplementary material referred to in this article, please visit <https://doi.org/10.1017/S0007114521003019>

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