

ORIGINAL ARTICLE

Duration of breastfeeding and risk of overweight in childhood: a prospective birth cohort study from Germany

M Weyermann, D Rothenbacher and H Brenner

Department of Epidemiology, The German Centre for Research on Ageing, Heidelberg, Germany

Background: Whereas a recently published meta-analysis showed that ever breastfeeding reduces the risk of obesity in childhood significantly, the recent literature describing the relationship between duration of breastfeeding and risk of overweight or obesity in childhood remains inconclusive.

Methods: Between November 2000 and November 2001, all mothers and their newborns were recruited after delivery at the Department of Gynecology and Obstetrics at the University of Ulm, Germany. Active follow-up was performed at the age of 12 months and 24 months.

Results: Of the 1066 children included in the baseline examination, information on body mass index was available for 855 (80%) at the 2-year follow-up. At this age 72 children (8.4%) were overweight and 24 (2.8%) were severely overweight. Whereas 76 children (8.9%) were never breastfed, 533 children (62.3%) were breastfed for at least 6 months, and 322 children (37.7%) were exclusively breastfed for at least 6 months. Compared to children who were breastfed for less than 3 months, the adjusted odds ratio (OR) for overweight was 0.4 (95% confidence interval (CI) 0.2–0.8) in children who were breastfed for at least 6 months. When considering the time of exclusive breastfeeding, the adjusted OR for overweight was 0.8 (95% CI 0.4; 1.5) in children who were exclusively breastfed for at least 3 but less than 6 months and 0.4 (95% CI 0.2; 0.9) in children who were exclusively breastfed for at least 6 months compared to children who were exclusively breastfed less than 3 months.

Conclusion: These results highlight the importance of prolonged breastfeeding for the prevention of overweight in children. *International Journal of Obesity* (2006) 30, 1281–1287. doi:10.1038/sj.ijo.0803260; published online 28 February 2006

Keywords: childhood overweight; duration of breastfeeding; prospective birth cohort study

Introduction

Obesity has become a global epidemic, and it continues to increase in both industrialized and developing countries.¹ Due to the many long-term adverse effects of childhood obesity, the prevention of child obesity has been recognized as a public health priority.² Thus, it is welcome news that breastfeeding within the first months of life may prevent excess weight gain later in childhood,³ because rates of breastfeeding initiation and duration appear modifiable over time.

A recently published systematic review and meta-analysis including nine epidemiological studies with more than

69 000 participants showed that breastfeeding reduced the risk of obesity in childhood significantly.³ The adjusted odds ratio (OR) for obesity in childhood was 0.78 (95% confidence interval (CI) 0.71–0.85) for children who were ever breastfed compared to never-breastfed children. However, among eight of the reviewed studies which provided data about the relationship between duration of breastfeeding and risk of overweight or obesity in later childhood, only four studies demonstrated an inverse association in adjusted analysis.^{4–7} One study found a dose–response relationship only in crude analysis⁸ and three studies found no statistically significant effect of duration of breastfeeding on overweight or obesity in later childhood.^{9–11}

Like in other countries,¹² the prevalence of breastfeeding has increased over the past decades in Germany, since the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) began their campaigns for breastfeeding in the 1980s,^{13–15} and consequently the extent to which we can generalize from former studies remains limited. Furthermore, most studies have estimated the effect

Correspondence: Dr M Weyermann, Department of Epidemiology, The German Centre for Research on Ageing, Bergheimer Str. 20, D-69115 Heidelberg, Germany.

E-mail: weyermann@dzfa.uni-heidelberg.de

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of breastfeeding duration on overweight by using the group of never breastfed children as reference group. However, mothers who chose to exclusively formula-feed their children could be different from mothers who chose to breastfeed their children, and these differences may have been not adequately considered in former studies. Owing to the increasing prevalence of breastfeeding, the diminishing group of mothers who decided not to breastfeed their child may have become an even more unsuitable group for the reference category when investigating the influence of duration of breastfeeding on obesity in childhood as pointed out recently.^{16–18}

The aim of this analysis was to assess the association between duration of breastfeeding and childhood overweight at the age of 2 within ever breastfed children under special consideration of confounding factors and duration of exclusive breastfeeding within a prospective birth cohort study.

Methods

Study design and study population

All women who came to the Department of Gynecology and Obstetrics at the University of Ulm between November 2000 and November 2001 for the delivery of their baby, their partners and their offspring were recruited for the study. In Germany, women were on average stay in the hospital for about 5 days after delivery, and recruitment was carried out during this time window. During the time of recruitment, the Department of Gynecology and Obstetrics at the University of Ulm was the only major department of obstetrics in the study area and served the vast majority of childbearing women in the city of Ulm and the nearby communities.

According to *a priori* defined exclusion criteria, we excluded women with less than 32 gestational weeks, with a baby of less than 2500 g birth weight, or who transferred their infants to in-patient pediatric care immediately after delivery. Furthermore, we excluded women with no understanding of German, Turkish or Russian language, as well as all women who left the hospital immediately after birth. Overall 1066 families could be included in this study (67% of all 1593 eligible families who fulfilled the inclusion criteria).

Active follow-up of all children included in the baseline examination was performed at the age of 12 months and 24 months. The current analysis focuses on the result of the 2-year follow-up. A participation rate of 82% (875 children) of all children included in the baseline examination was achieved for this follow-up. Among these, information on body mass index (BMI) was available for 855 children.

Participation was voluntary and informed consent was obtained from the parents in each case. The study was approved by the Ethics Boards of the University of Ulm and of the Physicians' Boards of the states of Baden-Wuerttemberg and Bavaria.

Data collection

At the baseline examination, all mothers underwent standardized interviews conducted by trained interviewers during hospitalization after delivery. Interviews included detailed questions about family demographics, socioeconomic status, housing and living conditions. In addition, self-reported height and weight of the mothers (at the beginning of pregnancy) and fathers were obtained. The interview was also offered in Turkish and Russian, as this was the mother tongue of a large proportion of mothers. At both follow-up examinations the parents again filled out a detailed questionnaire including infant feeding habits and children's height and weight. In particular, mothers were asked whether they were breastfeeding at that time (and if not, how long they did). If the mother continued to breastfeed for longer than 1 year, the information was supplemented from the mothers' questionnaire response at the 2-year follow-up. Exclusive breastfeeding was defined as no nutrition other than breast milk.

Also, the children's primary health-care pediatricians gave a detailed medical history during the first and second years of life. These questionnaires from the pediatricians included the children's height and weight, which were measured as part of regular health-screening examinations. Such regular health-screening examinations are offered free of charge around the first and second birthdays and are attended by most families in Germany. At the 2-year follow-up, measured height and weight were obtained from health-screening examinations from 772 children (90.3%). Weights were measured when the children were completely undressed, and length was determined as prone length. For the remaining 83 children, height and weight at the age of 2 were available only as reported by the parents.

Body mass index was calculated as weight (kg)/height² (m²). Overweight was defined as BMI above the 90th age- and sex-specific percentile of the German reference population, and severe overweight was defined as BMI above the 97th age- and sex-specific percentile of the German reference population.¹⁹

Statistical analyses

We first carried out descriptive analyses concerning main sociodemographic factors as well as parental and children's BMI and duration of breastfeeding. To investigate potential differences between mothers who decided to formula-feed their children and mothers who breastfed their children over various time periods, associations between sociodemographic and lifestyle characteristics of mothers and duration of breastfeeding were assessed by calculating a Mantel-Haenszel χ^2 statistic; if expected cell numbers were <5, Fisher's exact test (two sided) was used.

Furthermore, the association of duration of breastfeeding and various other determinants with children's overweight was ascertained by calculating a Mantel-Haenszel χ^2 statistic; if expected cell numbers were <5, Fisher's exact test (two

sided) was used. To describe the independent association between duration of breastfeeding (independent variable) and children's overweight (dependent variable), OR and their 95% CI were estimated by unconditional logistic regression. The following potential confounders were considered as covariates: age of mother (in years), school education of mother (categories ≤ 9 years; ≥ 10 years), nationality of mother (categories German, Turkish, other), BMI of mother at the beginning of pregnancy (in kg/m^2), smoking status of mother during pregnancy (no/yes) and birth weight of the child (in gram).

We conducted logistic regression analyses for the whole sample as well as separately for children for whom height and weight were available from the children's primary health-care pediatricians; in the latter analyses, we excluded 83 children from whom only height and weight at the age of 2 reported by parents were available.

All analyses were carried out with the SAS statistical software package (SAS Institute, Inc., SAS Language: Reference. Version 8, 1st edn. SAS Institute, Inc.: Cary, NC).

Results

Table 1 shows sociogeographic factors and the BMI of the 855 children and their parents, as well as the distribution of breastfeeding habits. 51.6% of the children were male. The mean age of mothers was 31.4 years (s.d. 4.7). The mean BMI of mothers at the beginning of pregnancy was 23.9 kg/m^2 (s.d. 4.2) and 249 mothers (29.2%) had a BMI $\geq 25 \text{ kg/m}^2$. Mean BMI of fathers at baseline examination was 25.0 kg/m^2 (s.d. 3.0) and 359 (42.8%) had a BMI $\geq 25 \text{ kg/m}^2$. Of the included children, 159 (18.6%) had a birth weight less than 3000 g and 99 (11.6%) had a birth weight of at least 4000 g. At the age of 2, the BMI of children ranged from 9.4 to 27.4 kg/m^2 and had a mean value of 16.0 kg/m^2 . According to the definition of Kronmeyer-Hausschild *et al.*,¹⁹ 72 children (8.4%) were overweight at the age of 2 and 24 (2.8%) were severely overweight. Seventy-six children (8.9%) were never breastfed, 533 children (62.3%) were breastfed for at least 6 months and 322 children (37.7%) were exclusively breastfed for at least 6 months.

Table 2 shows the sociodemographic and lifestyle factors of the children and their families according to duration of exclusive breastfeeding. Compared to all groups of children who were ever breastfed exclusively, children who were never breastfed exclusively more often had mothers of Turkish nationality (6.5%), mothers with less than 10 years of school education (28.0%), mothers with a BMI of at least 25 kg/m^2 at the beginning of pregnancy (44.9%) and mothers who smoked during pregnancy (17.8%) or during follow-up (37.4%). Also, they more often lived in households with less than $\leq 25 \text{ m}^2$ living area per person (43.4%).

Table 3 shows the association of overweight in children at the age of 2 with breastfeeding habits and with other known or suspected determinants of overweight in children.

Table 1 Sociodemographic factors, body mass index of children and their parents and breastfeeding history

Factors	n	%
<i>Children's gender</i>		
Male	441	51.6
Female	414	48.4
<i>Age of mother at baseline</i>		
Mean (s.d.)	31.4 (4.7)	
<i>Body mass index of mother</i>		
Mean (s.d.) (range)	23.9 (4.2)	16.7–45.7
$\geq 25 \text{ kg/m}^2$	249	29.2
<i>Body mass index of father</i>		
Mean (s.d.) (range)	25.0 (3.0)	18.5–49.0
$\geq 25 \text{ kg/m}^2$	359	42.8
<i>Birth weight of children</i>		
<3000 g	159	18.6
3000 g– ≤ 3500 g	337	39.4
3500 g– ≤ 4000 g	260	30.4
≥ 4000 g	99	11.6
<i>Body mass index of children at age 2</i>		
Mean (range)	16.0	9.4–27.4
Overweight	72	8.4
Obese	24	2.8
<i>Breastfed</i>		
Never	76	8.9
Ever	779	91.1
<i>Duration of breastfeeding</i>		
<3 months	106	12.4
3–<6 months	138	16.1
6–<9 months	207	24.2
≥ 9 months	326	38.1
<i>Duration of exclusive breastfeeding</i>		
Never	107	12.5
<3 months	149	17.4
3–<6 months	277	32.4
≥ 6 months	322	37.7

Prevalence of overweight was higher in children whose mothers were of Turkish nationality (20.8%) than in children whose parents were of German nationality (7.9%) or those of other than German or Turkish nationality (9.8%) ($P=0.07$). Furthermore, prevalence of overweight was higher in children whose mothers did smoke during follow-up compared to children whose mothers did not smoke during follow-up (13.0 vs 7.4%, $P=0.02$). It increased with increasing birth weight ($P<0.0001$) and decreased with increasing duration of breastfeeding ($P=0.004$), as well as with duration of exclusive breastfeeding ($P=0.07$). Prevalence of obesity was associated with the nationality of mother ($P=0.005$) as well as with birth weight ($P=0.01$) in the same pattern as shown for overweight. By contrast, no association was seen between duration of breastfeeding or duration of exclusive breastfeeding and children's obesity. Children's gender, mother's age, mother's school education,

Table 2 Sociodemographic and lifestyle factors according to duration of exclusive breastfeeding

Factors	All n (column %)	Duration of exclusive breastfeeding n (column %)				P ^a
		Never	< 3 months	3–< 6 months	≥ 6 months	
All	855	107	149	277	322	
<i>Nationality of mother</i>						
German	770 (90.1)	93 (86.9)	138 (92.6)	244 (88.1)	295 (91.6)	0.01
Turkish	24 (2.8)	7 (6.5)	6 (4.0)	4 (1.4)	7 (2.2)	
Other	61 (7.1)	7 (6.5)	5 (3.4)	29 (10.5)	20 (6.2)	
Mean age of mother at baseline (years)	31.4	30.9	29.9	31.8	32.0	<0.0001 ^b
<i>Number of older siblings</i>						
0	411 (48.1)	48 (44.9)	97 (63.1)	137 (49.5)	132 (41.0)	0.0006
1	340 (39.8)	46 (43.0)	47 (31.5)	108 (39.0)	139 (43.2)	
≥ 2	104 (12.1)	13 (12.1)	8 (5.4)	32 (11.5)	51 (15.8)	
<i>Education of mother^c</i>						
≤ 9 years	153 (18.2)	30 (29.1)	29 (20.0)	44 (16.0)	50 (15.7)	0.002
10–11 years	342 (40.6)	41 (39.8)	69 (47.6)	115 (41.8)	117 (36.7)	
≥ 12 years	347 (41.2)	32 (31.1)	47 (32.4)	116 (42.2)	152 (47.6)	
BMI of mother (≥ 25 kg/m ²)	249 (29.2)	48 (44.9)	42 (28.2)	74 (26.7)	85 (26.4)	0.002
<i>Smoking of mother</i>						
During pregnancy	91 (10.6)	19 (17.8)	26 (17.5)	22 (7.9)	24 (7.5)	0.0004
During follow-up	161 (18.8)	40 (37.4)	43 (28.9)	39 (14.1)	39 (12.1)	<0.0001
Day-care-center attendance (yes)	57 (6.7)	8 (7.6)	13 (8.8)	19 (6.9)	17 (5.3)	0.54
Housing density (< 25 m ² /person)	285 (34.1)	46 (43.4)	57 (39.6)	90 (33.5)	92 (29.2)	0.024
Birth weight (mean) (g)	3420	3403	3415	3442	3408	0.004 ^b

BMI = body mass index. ^a χ^2 test for differences between groups. ^bWilcoxon test. ^cInformation missing for 13 children.

mother's and father's BMI, as well as mother's smoking status during pregnancy showed no relationship with overweight in children at the age of 2 in bivariate analysis.

Table 4 shows the crude and adjusted ORs for overweight in children at the age of 2 associated with breastfeeding history. The crude OR for overweight of the children at the age of 2 was 2.4 (95% CI 0.7–7.7) for children who were ever breastfed compared to children who were never breastfed. After adjustment for birth weight and the mother's nationality, age, school education, BMI and smoking status during pregnancy, the OR was 2.2 (95% CI 0.7–7.2). Compared to children who were breastfed up to 3 months, the adjusted OR for overweight was 0.2 (95% CI 0.1–0.9) for never breastfed children, 1.0 (95% CI 0.5–2.0) for children who were breastfed for at least 3 but less than 6 months, and 0.4 (95% CI 0.2–0.8) for children who were breastfed for 6–9 months and for children who were breastfed for at least 9 months. When considering the time of exclusive breastfeeding, the adjusted OR for overweight was 0.6 (95% CI 0.2–1.4) for children who were never exclusively breastfed compared to children who were exclusively breastfed for less than 3 months. The adjusted OR for overweight was 0.8 (95% CI 0.4–1.5) for children who were exclusively breastfed for at least 3 but less than 6 months and 0.4 (95% CI 0.2–0.9) for

children who were exclusively breastfed for at least 6 months. There was a significant trend of decreased odds of obesity with both duration of breastfeeding and duration of exclusive breastfeeding.

When we excluded the 83 children from whom only height and weight reported by parents were available, results were very similar, and some of the associations were even stronger.

Discussion

In this prospective birth cohort study from Germany, we found no decreased risk for overweight at the age of 2 among ever breastfed children compared to children who were never breastfed. However, compared to children who were breastfed for less than 3 months, the risk for overweight was strongly decreased among children who were breastfed for at least 6 months. Furthermore, compared to children who were exclusively breastfed for less than 3 months, we found a decreasing risk for overweight children with increasing duration of exclusive breastfeeding.

In Germany, exclusive breastfeeding is recommended for at least 6 months, especially for prevention of allergies.²⁰ In

Table 3 Prevalence of overweight and obesity among children at the age of 2 according to sociodemographic and lifestyle-factors

Factors	n	Overweight		Obese	
		n (%)	P ^a	n (%)	P ^a
<i>Children's gender</i>					
Male	441	40 (9.1)	0.48	11 (2.5)	0.57
Female	414	32 (7.7)		13 (3.2)	
<i>Nationality of mother</i>					
German	770	61 (7.9)	0.07	17 (2.2)	0.005 ^b
Turkish	24	5 (20.8)		3 (12.5)	
Other	61	6 (9.8)		4 (6.6)	
<i>Age of mother at baseline (years)</i>					
16–25	104	10 (9.6)	0.76	6 (5.8)	0.17 ^b
26–35	579	46 (7.9)		15 (2.6)	
36–45	172	16 (9.3)		3 (1.7)	
<i>Education of mother (years)</i>					
≤9	153	14 (9.2)	0.65	7 (4.6)	0.18
10–11	342	32 (9.4)		11 (3.2)	
≥12	347	26 (7.5)		6 (1.7)	
<i>Body mass index of mother (kg/m²)</i>					
<20	101	8 (7.9)	0.94	3 (3.0)	0.61 ^b
20–<25	503	42 (8.4)		16 (3.2)	
25–<30	181	17 (9.4)		5 (2.8)	
≥30	68	5 (7.4)		0 (0.0)	
<i>Body mass index of father (kg/m²)</i>					
<20	13	0 (0.0)	0.39 ^b	0 (0.0)	0.73 ^b
20–<25	466	37 (7.9)		11 (2.4)	
25–<30	311	32 (10.3)		11 (3.5)	
≥30	48	2 (4.2)		1 (2.0)	
<i>Mother's smoking status during pregnancy</i>					
Did not smoke	763	66 (8.7)	0.89 ^b	23 (3.0)	1.0 ^b
<10 cigarettes/day	58	5 (8.6)		1 (1.7)	
≥10 cigarettes/day	24	1 (4.2)		0 (0.0)	
<i>Mother's smoking status during follow-up</i>					
Did not smoke	694	51 (7.4)	0.02	18 (2.6)	0.43
Did smoke	161	21 (13.0)		6 (3.7)	
<i>Birth weight (g)</i>					
<3000	159	9 (5.7)	0.0001	0 (0.0)	0.013 ^b
3000–≤3500	337	19 (5.6)		8 (2.4)	
3500–≤4000	260	25 (9.6)		11 (4.2)	
≥4000	99	19 (19.2)		5 (5.1)	
<i>Breastfeeding</i>					
Never	76	3 (3.9)	0.19 ^b	2 (2.6)	1.0 ^b
Ever	779	69 (8.9)		22 (2.8)	
<i>Duration of breastfeeding (months)</i>					
<3	106	16 (15.1)	0.004	5 (4.7)	0.53 ^b
3–<6	138	19 (13.8)		5 (3.6)	
6–<9	207	13 (6.3)		3 (1.5)	
≥9	326	21 (6.4)		9 (2.8)	
<i>Duration of exclusive breastfeeding (months)</i>					
Never	107	8 (7.5)	0.07	4 (3.7)	0.44 ^b
<3	149	18 (12.1)		6 (4.0)	
3–<6	277	28 (10.1)		8 (2.9)	
≥6	322	18 (5.6)		6 (1.9)	

^aχ² test for differences between groups. ^bFisher's exact test.

our study population, more than 60% of children were breastfed for at least 6 months, and only a minority of children (8.9%) were never breastfed.

As noted already by other authors,^{16–18} we also found that the small group of mothers who never breastfed their children was different in many other aspects besides breastfeeding habits. Compared to mothers who decided to breastfeed their children, mothers who decided to exclusively formula-feed their children were more often of Turkish nationality, had more often less than 10 years of school education, a higher housing density, a higher BMI, and had more often smoked during pregnancy or during follow-up. In contrast to other studies,^{10,12,21,22} we found no relations of risk for children's overweight to some of the mother's and father's BMI, mother's education or smoking during pregnancy. One possible explanation for these differences might be that the follow-up time in our study was relatively short and the impact of these factors may increase when children get older. Furthermore, the characteristics of the non-breastfeeding mothers in our study population may indicate that the associations described in other studies with these factors (BMI, education, smoking) might be partly due to incomplete control for confounding using the non-breastfeeding group as reference. Therefore, using this group as reference when estimating the influence of duration of breastfeeding on overweight in childhood might be problematic. This issue may be particularly important in our study population, where prevalence of breastfeeding was much higher than in previous studies, and the group of never breastfeeding was very small, which may also explain the apparent differences from results of previous studies.

For example, in contrast to our results, two former cross-sectional studies conducted in Germany found a decreased risk for overweight or obesity in children who were ever breastfed when compared to never breastfed children.^{4,6,23} Compared to children who were never breastfed, the adjusted OR of breastfeeding for any length of time were 0.66 (95% CI 0.52–0.87) for overweight in the study by Liese *et al.*⁶ and 0.71 (95% CI 0.56–0.90) for obesity and 0.77 (95% CI 0.66–0.88) for overweight in the study by von Kries *et al.*^{4,23} The much higher prevalence of never breastfed children in these studies (44% in the study by von Kries *et al.*^{4,23} and 17% in the study by Liese *et al.*⁶) compared to our study (8.9%) may be one explanation for the apparent differences in the results. Furthermore, in both studies, the impact of maternal pre-pregnancy BMI on childhood obesity was not considered. Given the known association between high maternal pre-pregnant BMI and unsuccessful initiation of breastfeeding,²⁴ this may lead to an overestimation of the effect of ever breastfeeding compared to never breastfeeding.

In another birth cohort study conducted in Germany,²² the prevalence of never breastfed children (8.1%) was comparable to the prevalence in our study population. In this study,²² differences in obesity prevalence between bottle-fed and breastfed children were not statistically significant at the ages of 3 and 4 years, but larger and

Table 4 Crude and adjusted ORs with 95% CI for overweight of children at the age of 2 according to breastfeeding history

History of breastfeeding	Total sample (n = 839)				Children with height and weight as measured by pediatricians only (n = 756)			
	Crude OR	P [†]	Adjusted OR ^a	P [†]	Crude OR	P [†]	Adjusted OR ^a	P [†]
<i>Breastfed</i>								
Ever	2.4 [0.7; 7.7]		2.2 [0.7; 7.2]		3.2 [0.8; 13.3]		3.0 [0.7; 12.8]	
Never	1 _{reference}		1 _{reference}		1 _{reference}		1 _{reference}	
<i>Duration of breastfeeding (months)</i>								
Never	0.2 [0.1; 0.8]		0.3 [0.1; 0.9]		0.2 [0.1; 0.8]		0.2 [0.1; 0.8]	
<3 ^b	1 _{reference}	0.001	1 _{reference}	0.002	1 _{reference}	0.006	1 _{reference}	0.004
3–<6	0.9 [0.4; 1.8]		1.0 [0.5; 2.0]		0.8 [0.4; 1.8]		0.9 [0.4; 2.0]	
6–<9	0.4 [0.2; 0.8]		0.4 [0.2; 0.8]		0.4 [0.2; 0.8]		0.3 [0.2; 0.8]	
≥9	0.4 [0.2; 0.8]		0.4 [0.2; 0.8]		0.4 [0.2; 0.9]		0.4 [0.2; 0.8]	
<i>Duration of exclusive breastfeeding (months)</i>								
Never	0.6 [0.3; 1.4]		0.6 [0.2; 1.4]		0.4 [0.1; 1.0]		0.3 [0.1; 0.9]	
<3 ^b	1 _{reference}	0.01	1 _{reference}	0.02	1 _{reference}	0.007	1 _{reference}	0.005
3–<6	0.8 [0.4; 1.5]		0.8 [0.4; 1.5]		0.8 [0.4; 1.5]		0.6 [0.3; 1.3]	
≥6	0.4 [0.2; 0.9]		0.4 [0.2; 0.9]		0.4 [0.2; 0.8]		0.3 [0.2; 0.7]	

OR = odds ratio. ^aAdjusted for nationality of mother, age of mother, school education of mother, BMI of mother, smoking status of mother during pregnancy, birth weight. ^bThis group was considered the reference because the group that never breastfed was small and possibly different in other aspects than in breastfeeding habits. [†]P for trend within groups of ever breastfed children.

significant at the ages of 5 and 6 years (adjusted OR for obesity at the age of six 0.46, 95% CI 0.23–0.92). However, children who had never been breastfed (8.1%) and those breastfed in part for 2 months only (23.4%) were combined in the category of bottle-fed infants in these analyses.²² Our results suggest that differences in prevalence of obesity according to duration of breastfeeding might also have been greater at younger ages when children who were never breastfed were excluded from the reference group in this study.

Like in our study, duration of exclusive breastfeeding was inversely related to obesity or overweight in the studies by von Kries *et al.*^{4,23} and Liese *et al.*⁶ However, like most other studies the studies by von Kries *et al.*^{4,23} have estimated the effect of duration of breastfeeding on overweight only using the group of never breastfed children as reference. Therefore, comparison of our results with those of these former studies may be difficult.

Our results were in agreement with those of the analyses restricted to ever breastfed children in the study of Liese *et al.*,⁶ demonstrating also a positive effect of duration of overall and exclusive breastfeeding. Compared to children breastfed for less than 6 months, children who were breastfed for 6–12 months (OR 0.74, 95% CI 0.54–1.02) and children breastfed for more than 1 year (OR 0.41, 95% CI 0.18–0.90) were less likely to be overweight. A similar pattern emerged regarding exclusive breastfeeding. Compared to children exclusively breastfed for less than 2 months, the OR was 0.91 (95% CI 0.66–1.24) for children exclusively breastfed for 2–4 months, 0.70 (95% CI 0.45–1.10) for children exclusively breastfed for 5–6 months and 0.47 (95% CI 0.21–1.06) for children exclusively breastfed for more than 6 months. Although we used different definitions

for our reference groups, the associations seen in our much younger study population were somewhat stronger. One possible reason for these differences might be that the impact of breastfeeding may become smaller, and the impact of other factors may increase when children grow up.

Gillman *et al.*⁵ reported that among 15 341 children aged 9–14 years and participating in the Growing Up Today Study, the adjusted OR for being overweight was 0.80 (95% CI 0.67–0.96) among those who were breastfed for at least 7 months compared with children who had been breastfed for 3 months or less. In our study population, we found a stronger protective effect (adjusted OR 0.40; 95% CI 0.2–0.8) among those who were breastfed for at least 6 months compared with children who had been breastfed for 3 months or less. Again, one possible reason for these differences might be the much younger age of our study population whose weight may be less affected by other factors that might become relevant when children grow up.

In the recently published meta-analysis, the adjusted OR for obesity in childhood was 0.78 (95% CI 0.71–0.85) for children who were ever breastfed compared to never-breastfed children,³ and a recent review concluded that breastfeeding seems to have only a small protective effect against obesity in children.²⁵ Another explanation may be, however, that a possibly much stronger effect of long-term breastfeeding may have been diluted by children with short-term duration of breastfeeding, who may not benefit from breastfeeding with respect to development of obesity and by the use of a reference group which differs from breastfed children in important aspects. Given the major differences between breastfed children and children who were not breastfed at all, we suggest using children with short-term breastfeeding rather than children who were never breastfed

as the reference group for assessing breastfeeding effects in further studies, at least in study populations in which breastfeeding is as common as in ours.

When looking at the results, the following limitations have to be kept in mind: We investigated the influence of breastfeeding on overweight among children at the age of 2 years. Whether the protective effect observed in our 2-year-old children will persist with increasing age as seen in some former studies³ remains to be seen. Despite the overall large size of our study population, the study had limited power to assess the impact of breastfeeding on severe overweight. An apparent inverse dose–response relationship of duration of breastfeeding with this outcome was non-significant in bivariate analysis and could not be adequately addressed in multivariate analyses, given the small number of affected children. Furthermore, in our study maternal smoking during pregnancy did not appear as a risk factor for overweight in children as seen in former studies.^{7,21,22} As maternal smoking habits were self-reported only, these associations should be interpreted with caution as smoking during pregnancy may have been under-reported. Finally, we have no information about sociodemographic or other characteristics of the families who decided not to participate in the baseline recruitment of our study. This, however, should not affect the internal validity of findings from this longitudinal study.

Despite these limitations, our large-scale epidemiological study provides evidence that, at least in industrialized countries with increasing prevalence of breastfeeding, prolonged breastfeeding might protect against childhood obesity. Therefore, in addition to the many benefits of breastfeeding for child health, preventing obesity in childhood may be a further argument for the promotion of breastfeeding for at least 6 months as the feeding method of choice.

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