




## REGULAR ARTICLE

# No significant associations between breastfeeding practices and overweight in 8-year-old children

Asborg A. Bjertnæs<sup>1,2</sup>  | Jacob H. Grundt<sup>3</sup> | Hilde M. Donkor<sup>1</sup> |  
Petur B. Juliusson<sup>4,5,6</sup>  | Tore Wentzel-Larsen<sup>7,8</sup> | Arild Vaktskjold<sup>9,10</sup> |  
Trond Markestad<sup>9</sup>  | Mads N. Holten-Andersen<sup>1,2</sup>

<sup>1</sup>Department of Paediatrics, Innlandet Hospital Trust, Lillehammer, Norway

<sup>2</sup>Department of Clinical Medicine, University of Oslo, Norway

<sup>3</sup>Department of Paediatrics, Oslo University Hospital, Oslo, Norway

<sup>4</sup>Department of Health Registries, Norwegian Institute of Public Health, Norway

<sup>5</sup>Department of Clinical Science, University of Bergen, Bergen, Norway

<sup>6</sup>Department of Paediatrics, Haukeland University Hospital, Bergen, Norway

<sup>7</sup>Norwegian Centre for Violence and Traumatic Stress Studies, Oslo, Norway

<sup>8</sup>Regional Centre for Child and Adolescent Mental Health, Eastern and Southern Norway, Oslo, Norway

<sup>9</sup>Department of Research, Innlandet Hospital Trust, Brumunddal, Norway

<sup>10</sup>Department of Public Health Science, Inland Norway University, Elverum, Norway

## Correspondence

Asborg A. Bjertnæs, Department of Paediatrics, Innlandet Hospital Trust, Lillehammer, Norway.  
Email: asborg.aanstad.bjertnaes@sykehuset-innlandet.no

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## Abstract

**Aim:** The aim was to examine if breastfeeding practices were associated with body mass index (BMI) and risk of overweight or obesity in third grade (8 years) of elementary school.

**Methods:** In a regional cohort, we related BMI z-scores and presence of overweight or obesity at 8 years of age with ever being breastfed and with duration of exclusive and partial breastfeeding after adjusting for potential confounders. Parents completed questionnaires on breastfeeding and sociodemographic and lifestyle factors at school entry, and public health nurses measured height and weight. For non-participants, the nurses anonymously reported these measurements together with sex and age.

**Results:** 90% of participants had been breastfed. In adjusted analyses, BMI z-scores were not significantly related to whether or not the child had been breastfed ( $P = .64$ ), or to the duration of exclusive ( $P = .80$ ) or partial breastfeeding ( $P = .94$ ). Logistic regression also showed no significant association between breastfeeding measures and overweight or obesity.

**Conclusion:** This study on 8-year-old Norwegian children did not support a commonly held notion that breastfeeding reduces the risk of overweight or obesity.

## KEYWORDS

BMI z-score, breastfeeding, child, obesity, overweight

**Abbreviations:** BMI, body mass index; WHO, World Health Organization.

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## 1 | INTRODUCTION

It is widely accepted that overweight or obesity in childhood has a high, negative impact on adult health and well-being in a global perspective.<sup>1</sup> Established risk factors for childhood overweight or obesity include environmental, sociodemographic and behavioural factors.<sup>2</sup> The World Health Organization (WHO) endorses breastfeeding as a means of promoting optimal growth in early infancy and limited weight gain later in life.<sup>3</sup> The WHO growth standards are based on children who are exclusively breastfed for at least 4 months according to strict feeding criteria.<sup>4</sup> This implies that breastfed children represent the norm in terms of growth.<sup>5</sup>

Nordic breastfeeding recommendations state that extended periods of both exclusive and partial breastfeeding have a protective effect against overweight and obesity in childhood and adolescence.<sup>6</sup> This notion accords with WHO claims and is supported by meta-analyses of observational studies.<sup>7-9</sup> However, the Belarusian PROBIT study and other smaller, randomized studies have not shown a protective effect of breastfeeding promotion on overweight and obesity beyond a child's second year.<sup>10,11</sup> The inconsistent results of such studies challenge the assumption of causality between breastfeeding and childhood overweight and obesity.<sup>12</sup> Motivation and ability to breastfeed are commonly associated with socio-economic and behavioural factors, and relationships between breastfeeding and childhood overweight and obesity may, therefore, be difficult to interpret.<sup>13</sup> Indeed, in a meta-analysis by Horta et al<sup>8</sup>, which included randomized, controlled trials and observational studies, adjustments for potential confounders led to a decreasing protective effect of breastfeeding.

Current Norwegian guidelines recommend exclusive breastfeeding for 6 months and continued partial breastfeeding until the child is at least 12 months old.<sup>14</sup> In a recent large-scale, regional register study, 74% of mothers exclusively breastfed and 17% partially breastfed their infants at 6 weeks, and the respective figures were 19% and 55% at 6 months.<sup>15</sup> Given that breastfeeding is widely adopted in Norway and characterised by large variations in extent and duration, our aim was to examine whether any breastfeeding or whether duration of exclusive and partial breastfeeding was associated with body mass index (BMI) z-scores and a risk of overweight or obesity at 8 years of age in a regional cohort after adjusting for potential confounders.

## 2 | METHODS

### 2.1 | Population

The parents of all children who started school in 2007 in Oppland County, Norway, were invited to participate in the study during the routine school-entry health assessments at 5-6 years of age. Consenting parents completed a questionnaire on breastfeeding practices, lifestyle factors of the child and family, anthropometric measurements and sociodemographic data of the family and health of the child. School nurses measured the height and weight of all

### Key notes

- Body mass index (BMI) z-score in the third grade (8 years of age) was not significantly associated with breastfeeding practices.
- There was no significant association between duration of breastfeeding in infancy and BMI z-score or overweight or obesity, indicating no significant dose-response relationship.
- In this cohort with high frequency of breastfeeding, we do not support previous observational studies of associations between breastfeeding and overweight in children from high-income populations.

eligible children in third grade of elementary school (about 8 years of age). For the children with parental consent, the measurements were merged with data obtained on school entry, and length and weight at birth reported by the obstetric departments. For children without parental consent, the nurses anonymously reported sex, current age, height and weight to the researchers. Oppland is a predominantly rural county with approximately 185 000 inhabitants living in 26 municipalities. Two of the municipalities have cities of 25 000-30 000 inhabitants; the rest are rural areas with towns of variable sizes and 44% of the population lives in scattered areas.<sup>16</sup>

### 2.2 | Outcome and adjusting measures

Body mass index standard deviation score (z-score) in third grade was the primary outcome and overweight or obesity vs not the secondary outcome. BMI z-scores were based on updated Norwegian growth reference data,<sup>17</sup> and overweight or obesity were defined according to the International Obesity Task Force.<sup>18</sup>

Explanatory variables were obtained before school entry, and included whether the child had been breastfed or not, whether the child had been exclusively breastfed for <4 months, duration of partial breastfeeding (months) and duration of exclusive breastfeeding (months). The additional adjusting variables represented four additional thematic groups: lifestyle parameters, anthropometric data, sociodemographic factors and general health of the child. *Lifestyle parameters* of the child and family included: proxies for child nutrition (eating vegetables <5 times/wk vs more often and eating four main meals including: cereals or sandwich for breakfast, sandwiches and fruit for lunch, a hot meal prepared at home for dinner and sandwiches for supper <5 days per week vs more often), proxies for physical activity (a level of exertion generating heavy breathing or sweating <4 times per week vs more often and daily screen time >2 hours vs shorter) and parental smoking (yes/no). *Anthropometric data* included weight and length of the child at birth. Current parental and sibling heights and weights were reported by the parents. *Sociodemographic factors* included: maternal age at delivery, the

**TABLE 1** Characteristics of the participants and non-participants of the study

|   | Total<br>(n = 2012) | Participants<br>(n = 951) | Non-participants<br>(n = 1061) | P-value* |
|---|---------------------|---------------------------|--------------------------------|----------|
| Boys, n (%)                                     | 996 (49.5)          | 440 (46.3)                | 556 (52.4)                     | .006     |
| Age (years), mean (SD)                          | 8.3 (1.0)           | 8.26 (1.0)                | 8.3 (1.1)                      | .98      |
| Height (cm), mean (SD)                          | 131.6 (8.1)         | 131.78 (8.2)              | 131.3 (8.0)                    | .22      |
| Weight (kg), mean (SD)                          | 29.7 (7.2)          | 29.80 (7.1)               | 29.7 (7.3)                     | .67      |
| Body mass index (kg/m <sup>2</sup> ), mean (SD) | 17.0 (2.6)          | 17.0 (2.5)                | 17.0 (2.6)                     | .83      |
| Overweight or obese <sup>a</sup> , n (%)        | 415 (20.6)          | 201 (21.1)                | 214 (20.2)                     | .62      |
| Girls   | 234 (23.0)          | 116 (22.7)                | 118 (23.4)                     |          |
| Boys  | 181 (18.2)          | 85 (19.3)                 | 96 (17.3)                      |          |

Abbreviation: SD, standard deviation.

<sup>a</sup>Based on body mass index, iso-BMI  $\geq 25$ .

\*Chi-square for categorical variables and Student's test for continuous variables.

child's sex, current marital status of the parents, number of children in the family, maternal and paternal education  $\leq 12$  years vs longer,  $\geq 1$  parent originating from countries outside Europe or North America or not and residency in rural districts vs the two cities. *Proxy variables for general health of the child* included premature vs term birth, having had caries or not, ever having been treated with antibiotics or not, having suffered a chronic disease or not and using asthma medication beyond 2 years of age or not.

### 2.3 | Statistical analysis

Differences in means and proportions between participants and non-participants were calculated using the Student's *t* test and Pearson's chi-square test. Associations were investigated between each of the breastfeeding variables and BMI z-score and having overweight or obesity or not, respectively, using unadjusted and adjusted linear and logistic regression analyses. Differences in smoking habits and education for mothers that report exclusive breastfeeding more or less than 4 months were also investigated using Pearson's chi-square test. All listed variables in the adjusted models were included since previous research has found them to be associated with overweight or obesity.<sup>9,19</sup> Multicollinearity was assessed using variance inflation factor (VIF), and the significance level was set to 5%. Interactions between duration of partial breastfeeding and maternal smoking and duration of partial breastfeeding and maternal education were tested in additional models. Statistical analyses were carried out using SPSS Statistics for Windows, Version 23.0.0.2 Armonk, NY: IBM Corp and STATA 15.0 software (STATA).

### 2.4 | Ethics

Signed consent from one parent was obtained for each participating child, and the Regional Committee for Medical Research Ethics approved the study (project number: 1.2006.3491).

## 3 | RESULTS

Consent was obtained from parents of 951 (47%) of the 2012 eligible children. Participating children did not differ significantly from non-participants in mean age, height, weight, BMI or in rates of overweight or obesity, but the proportion of boys was slightly lower among the participants (Table 1). Of the participating children, 21% had overweight or obesity and 90% had been exclusively breastfed for a mean (standard deviation) duration of 4.6 (2.6) months and partially breastfed for 10.7 (6.1) months.

Except for the unadjusted linear regression analysis for <4 months of exclusive breastfeeding, none of the univariate analyses displayed significant associations between breastfeeding practises and BMI. Furthermore, we found no significant adjusted associations between duration of partial breastfeeding (Table 2) or any of the other breastfeeding measures and neither BMI z-score, nor rates of overweight or obesity in linear or logistic regression analyses (Table 3). We found a significantly higher fraction of less educated mothers among those who reported exclusive breastfeeding <4 months as compared with  $\geq 4$ -month exclusive breastfeeding (difference 0.18 [0.07, 0.29],  $P < .001$ ). There were no indications of multicollinearity (VIF scores were  $\leq 1.3$  in multivariable regression analyses) or, in additional analyses, significant interactions between duration of partial breastfeeding and maternal education ( $P = .61$ ) or maternal smoking ( $P = .52$ ) (data not shown).

## 4 | DISCUSSION

Body mass index z-score or having overweight or obesity in the third grade (at about 8 years of age) were not significantly related to being breastfed or not, or to the duration of exclusive or partial breastfeeding.

We found indications of an association between being exclusively breastfed <4 months in univariate analyses, but not in adjusted analyses for neither linear, nor logistic regression. The result

**TABLE 2** Unadjusted and adjusted linear regression analyses<sup>a,b</sup>

|   | Unadjusted analysis |                   |             |         | Adjusted analysis |             |         |  |
|---|---------------------|-------------------|-------------|---------|-------------------|-------------|---------|--|
|   | Mean (SD) or %      | Coef <sup>c</sup> | 95% CI      | P-value | Coef <sup>c</sup> | 95% CI      | P-value |  |
| <b>Breastfeeding practices</b>                        |                     |                   |             |         |                   |             |         |  |
| Ever breastfed  | 90.3                | 0.209             | -0.02, 0.44 | .075    |                   |             |         |  |
| <4 mo of exclusive breastfeeding                      | 28.1                | 0.230             | 0.08, 0.37  | .003    |                   |             |         |  |
| Exclusive breastfeeding (months)                      | 4.6 (2.6)           | -0.009            | -0.04, 0.02 | .544    |                   |             |         |  |
| Partial breastfeeding (months) <sup>b</sup>           | 10.7 (6.1)          | -0.007            | -0.02, 0.01 | .242    | 0.00              | -0.01, 0.01 | .941    |  |
| <b>Lifestyle of the child and family</b>              |                     |                   |             |         |                   |             |         |  |
| Eating vegetables <5 times/wk                         | 49.9                | 0.004             | -0.13, 0.14 | .959    |                   |             |         |  |
| Not having regular meals <sup>b,d</sup>               | 29.5                | 0.040             | -0.11, 0.19 | .569    | 0.06              | -0.11, 0.23 | .466    |  |
| Activity <4 times/wk <sup>b</sup>                     | 47.7                | -0.070            | -0.20, 0.07 | .357    | -0.05             | -0.20, 0.11 | .555    |  |
| Screen time > 2 h/d <sup>b</sup>                      | 31.1                | 0.160             | 0.01, 0.31  | .035    | 0.03              | -0.14, 0.19 | .774    |  |
| Maternal smoking <sup>b</sup>                         | 19.1                | 0.470             | 0.30, 0.64  | <.001   | 0.34              | 0.12, 0.56  | .003    |  |
| Paternal smoking <sup>b</sup>                         | 21.7                | 0.220             | 0.05, 0.38  | .009    | -0.04             | -0.25, 0.16 | .689    |  |
| <b>Anthropometric data</b>                            |                     |                   |             |         |                   |             |         |  |
| Birth length z-score                                  | 0.07 (1.0)          | 0.104             | 0.03, 0.18  | .004    |                   |             |         |  |
| Birth weight z-score <sup>b</sup>                     | -0.11 (1.1)         | 0.170             | 0.11, 0.23  | <.001   | 0.12              | 0.06, 0.19  | <.001   |  |
| Maternal BMI <sup>b</sup>                             | 24.3 (3.8)          | 0.074             | 0.06, 0.09  | <.001   | 0.05              | 0.03, 0.08  | <.001   |  |
| Paternal BMI <sup>b</sup>                             | 26.5 (3.3)          | 0.090             | 0.07, 0.11  | <.001   | 0.06              | 0.04, 0.09  | <.001   |  |
| Mean sibling BMI z-score <sup>e</sup>                 | -0.24 (1.2)         | 0.230             | 0.16, 0.30  | <.001   |                   |             |         |  |
| <b>Sociodemographic factors</b>                       |                     |                   |             |         |                   |             |         |  |
| Age of mother at delivery (years)                     | 30.0 (4.8)          | 0.004             | -0.01, 0.02 | .551    |                   |             |         |  |
| Boy <sup>b</sup>                                      | 46.3                | 0.173             | 0.04, 0.31  | .013    | 0.27              | 0.12, 0.42  | .001    |  |
| Single caretaker <sup>b</sup>                         | 12.5                | 0.320             | 0.11, 0.52  | .003    | 0.23              | -0.05, 0.50 | .108    |  |
| No siblings   | 8.9                 | 0.080             | -0.16, 0.32 | .523    |                   |             |         |  |
| Maternal education ≤12 y <sup>b</sup>                 | 44.2                | 0.210             | 0.07, 0.34  | .003    | -0.05             | -0.22, 0.12 | .567    |  |
| Paternal education ≤12 y <sup>b</sup>                 | 60.6                | 0.320             | 0.18, 0.46  | <.001   | 0.07              | -0.10, 0.24 | .422    |  |
| ≥1 parent originating outside Europe or North America | 2.5                 | 0.060             | -0.38, 0.49 | .803    |                   |             |         |  |
| Rural living (<20 000 inhabitants) <sup>b</sup>       | 65.8                | 0.320             | 0.18, 0.47  | <.001   | 0.36              | 0.20, 0.52  | <.001   |  |
| <b>General health of the child</b>                    |                     |                   |             |         |                   |             |         |  |
| Prematurity (gestational week <37)                    | 6.4                 | 0.160             | -0.12, 0.43 | .272    |                   |             |         |  |
| Caries <sup>b</sup>                                   | 18.7                | 0.210             | 0.04, 0.39  | .020    | 0.12              | -0.09, 0.34 | .255    |  |
| Treatment with antibiotics <sup>b</sup>               | 58.7                | 0.120             | -0.01, 0.26 | .077    | 0.11              | -0.04, 0.27 | .144    |  |
| Chronic diseases <sup>f</sup>                         | 1.6                 | 0.140             | -0.40, 0.69 | .603    |                   |             |         |  |
| Asthma medication after 2 y of age                    | 11.6                | 0.080             | -0.14, 0.29 | .477    |                   |             |         |  |

Note: Dependent Variable: Body mass index (BMI) z-score in third grade.

Abbreviation: CI, Confidence Interval.

<sup>a</sup>Adjusted R<sup>2</sup> = 17.8%.

<sup>b</sup>Variables included in multivariable analysis.

<sup>c</sup>Unstandardized regression coefficient.

<sup>d</sup>Not eating all of the four daily principal meals >5 times / week.

<sup>e</sup>N = 551.

<sup>f</sup>Coeliac disease, diabetes, cerebral palsy, autism, chromosome disorders and congenital malformations.

for the crude analysis can be explained by our finding of an association between breastfeeding and socio-economy, and is in line with earlier research showing that exclusive breastfeeding at 4 months is associated with socio-economic factors.<sup>13</sup>

Our results are in agreement with those of the PROBIT study where breastfeeding was not found to have any protective effect on overweight and obesity beyond the age of 2 years<sup>11</sup> and do not agree with the findings of most other observational studies in

**TABLE 3** Adjusted regression analyses for all breastfeeding exposures

|   | Linear regression (dependent variable: BMI z-score) |             |         | Logistic regression (dependent variable: OWOB) |            |            |         |
|---|---|-------------|---------|--|------------|------------|---------|
|   | Coef <sup>a</sup>                                   | 95% CI      | P-value | %  | Odds Ratio | 95% CI     | P-value |
| Ever breastfed <sup>b</sup>                   | -0.06   | -0.34, 0.21 | 0.64    | 20.1   | 0.99       | 0.48, 2.02 | 0.97    |
| <4 mo of exclusive breastfeeding <sup>c</sup> | 0.06  | -0.11, 0.21 | 0.51    | 0.06   | 1.06       | 0.67, 1.66 | 0.80    |
| Exclusive breastfeeding (months) <sup>d</sup> | 0.00  | -0.03, 0.04 | 0.80    | 20.3   | 0.98       | 0.90, 1.08 | 0.77    |
| Partial breastfeeding (months) <sup>e</sup>   | 0.00  | -0.01, 0.01 | 0.94    | 19.0   | 1.02       | 0.99, 1.06 | 0.25    |

Abbreviation: CI, Confidence Interval.

<sup>a</sup>Unstandardized regression coefficient.

<sup>b</sup>Adjusted for all variables included in Table 2 except <4 mo of exclusive breastfeeding, exclusive breastfeeding and partial breastfeeding.

<sup>c</sup>Adjusted for all variables included in Table 2 except ever breastfed, exclusive and partial breastfeeding.

<sup>d</sup>Adjusted for all variables included in Table 2 except ever breastfed, <4 mo of exclusive breastfeeding, and partial breastfeeding.

<sup>e</sup>Adjusted for all variables included in Table 2 except ever breastfed, <4 mo of exclusive breastfeeding and exclusive breastfeeding.

children, adolescents and adults.<sup>8</sup> However, it has been argued that the differences between the control and intervention groups of the PROBIT study were too small to result in a difference on child obesity, and that the result may not be easily generalised, as the prevalence of overweight and obesity was substantially lower than for instance in the US.<sup>20</sup> Furthermore, in high-income countries, such as Norway, breastfeeding and the duration of breastfeeding are associated with a number of beneficial health and lifestyle factors.<sup>15,21</sup> The risk of increasing BMI with unfavourable social characteristics in the current study (Table 2) underscores the importance of adjusting for such factors when assessing the importance of breastfeeding per se.

Studies from low- and medium-income countries may not provide a valid comparison since breastfeeding is not necessarily associated with the same social and lifestyle determinants as in high-income countries.<sup>22,23</sup> Given the relative homogeneity of our population and the lack of appreciable differences in weight and height between the participants and non-participants, we suggest that the main potential confounders were accounted for, and that potential residual confounding was limited.<sup>24</sup> We, therefore, suggest that the lack of a significant association between breastfeeding and overweight and obesity at early school age is a valid finding in a population from a high-income country. A previous study from Norway and Belgium has also suggested that environmental and genetic backgrounds are of greater importance for growth than breastfeeding, even in sub-populations of breastfed infants with non-smoking mothers.<sup>5</sup>

From this cohort, we have previously reported that exclusive breastfeeding for at least 4 months was not significantly associated with a risk of overweight and obesity at pre-school age.<sup>25</sup> The present study adds that there were no significant effects on BMI or risk of overweight or obesity in the third grade, an age at which children are becoming more independent. This study also adds that there were no indications of dose-responsive relationships between the extent or duration of breastfeeding and BMI z-score or overweight or obesity in the third grade.

A key strength of this study was the comprehensive data obtained on breastfeeding duration, sociodemographic factors and health and lifestyle characteristics of the children and their families. The relatively low participation rate was a weakness, but the participating children

and their families were considered representative of the regional population since their anthropometric measurements and sex distribution were similar to those who did not participate. Also, we did not have data on maternal BMI during pregnancy. Such data could probably have contributed in exploring the relationship between determinants of early life and BMI in childhood.<sup>26</sup> Information was volunteered by the parents when the children were 5 years old and may be inaccurate for instance due to recall bias. However, studies have shown that a recall of duration of breastfeeding is quite accurate after three<sup>27</sup> six<sup>28</sup> and even 20 years,<sup>29</sup> although there were slight overestimations of duration of breastfeeding. This may also be true for the current cohort since the mean duration of exclusive breastfeeding was slightly longer than reported in previous studies from other parts of Norway where data were collected prospectively.<sup>13,15</sup> Less accurate recall on breastfeeding duration has been reported among maternal smokers and multiparous mothers,<sup>28</sup> but we found no significant interaction for duration of breastfeeding and maternal smoking. We, therefore, assume that maternal smoking likely had little impact on the results of our study. Unfortunately, our data did not include information on parity. Another limitation is the possibility of a type II error of a not found effect, as our population had a low frequency of not breastfed children. This may lead to a lower power for our study. Another factor is whether parental education is the best indicator of socio-economic status, or whether additional information on family income and occupation would have given a more accurate picture.

## 5 | CONCLUSION

This study on 8-year-old Norwegian children did not corroborate previous observational studies which suggest that breastfeeding reduces the risk of childhood overweight and obesity.

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## CONFLICT OF INTEREST

The authors have no conflicting interests to declare and have signed the ICMJE uniform disclosure form at [http://www.blackwellpublishing.com/pdf/apa\\_contributors.pdf](http://www.blackwellpublishing.com/pdf/apa_contributors.pdf)

## ORCID

Asborg A. Bjertnæs  <https://orcid.org/0000-0002-0504-4606>

Petur B. Juliusson  <https://orcid.org/0000-0002-7064-1407>

Trond Markestad  <https://orcid.org/0000-0002-4725-1769>

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