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RESEARCH ARTICLE

# Duration of exclusive breastfeeding may be related to eating behaviour and dietary intake in obesity prone normal weight young children

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## Abstract

Infants who are breastfed are introduced to a variety of flavours from the maternal milk, and thus the transition from maternal milk to complementary foods may be easier for these children. The aim of this study was to investigate if duration of exclusive breastfeeding was associated with pickiness or dietary intake of vegetables, fruit, starchy foods or sugar sweetened beverages among obesity prone normal weight children aged 2–6 years. This cohort study was based on data from the Healthy Start primary intervention study, the Danish Medical Birth registry and the Danish Health Visitor’s Child Health Database. Infant feeding was registered by health nurses while home-visiting the mother and child up to four times within the first year. Information on eating behaviour and diet intake at age 2–6 years was obtained by parents. Crude and adjusted logistic and general linear regression models were used to investigate associations. A total of 236 children had complete information on all variables. Data showed lower odds of picky eating behaviour when exclusively breastfed until age 4–5 months compared to exclusively breastfed for 0–1 months (OR = 0.35, 95CI = 0.16;0.76, p = 0.008). In the crude analysis only, exclusively breastfed until age 6–10 months was associated with a higher daily intake of vegetables (p = 0.04). This study suggests that exclusive breastfeeding duration seems to influence pickiness and may contribute to facilitate the consumption of more vegetables in later childhood in obesity prone normal weight children.

## Introduction

The many benefits of breastfeeding are well known [1, 2]. As recommended by the World Health Organisation (WHO), six months is the optimal duration of exclusive breastfeeding (no intake of additional food or drink) in relation to optimal growth, health and development

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of the child [1, 3]. Still, in many European countries only some 50% [4, 5], or even fewer [6, 7], are breastfed until 6 months of age.

Childhood pickiness is prevalent in the Western world with 20–50% picky eaters especially in the age group 2–4 years [8, 9]. Children that tend to have picky eating behaviours often have a lower diet quality [10], eat less fruit and vegetables [11–14] and have higher intakes of sugary foods and drinks [15]. The consequences of pickiness can be malnutrition and may, if prolonged, have an impact on weight development and risk of overweight and obesity [16], even though not all studies have observed this association [13]. The acceptance of healthy food choices later in childhood seems associated with breastfeeding duration independent of socio-economic status (SES) [17]. Several studies have also shown associations between a longer duration of breastfeeding and a lower degree of pickiness in childhood [11, 12, 18, 19], and some studies have suggested six months of exclusive breastfeeding to be a threshold for not developing pickiness [12, 19], which corresponds well with the recommendations by the WHO.

The transition from breast milk to complementary foods seems easier for children being exclusively breastfed compared to formula fed children. One suggested explanation is that a variety of flavours from the maternal diet have been introduced in the breast milk, which are not present in formula, and thus makes it easier for the breastfed infants to accept similar flavoured foods [20–22].

Studies have also shown that children who were breastfed for a short duration or exclusively formula fed tended to eat a less healthy diet in later childhood [23, 24]. Understanding early infant eating behaviours is therefore important for the promotion of healthy childhood eating, including increased fruit and vegetables consumption, especially in a population of children with increased risk of later obesity.

We aimed to investigate if duration of exclusive breastfeeding was associated with pickiness or intake of vegetables, fruit, starchy foods or sugar sweetened beverages in obesity prone normal weight children.

## Materials and methods

This cohort study was based on data from the Healthy Start primary intervention study, data from the Danish Medical Birth registry (MBR) and the Danish Health Visitor's Child Health Database.

The Healthy Start study was a randomized controlled primary prevention intervention conducted between 2009 and 2011 in 11 municipalities around the greater Copenhagen area [25]. The aim was to prevent overweight in children, who were yet normal weight, but were susceptible to future overweight (obesity prone), as they were all either born with a high birth weight (> 4,000 grams) and/or had a mother who was overweight prior to pregnancy (body mass index (BMI) > 28 kg/m<sup>2</sup>). In addition, a subgroup of children was selected because their mother had a short educational level ( $\leq 10$  years). This intervention aimed in a 15 months period to improve dietary and physical activity behaviours, reduce stress and improve sleep quality and quantity and thereby diminishing the children's risk of developing childhood obesity. The methodology of the Healthy Start primary intervention study has been described in closer detail elsewhere [25]. From the Healthy Start primary intervention we have data on diet intake and picky eating behaviour at baseline, when the children were 2–6 years. Further, we have data on picky eating behaviour again in the same children 15 months later. The intervention did not show any effects on picky eating behaviour [13], thus we use data on picky eating behaviour from the 15 months follow-up to investigate if eating behaviour changed over time.

We obtained information on maternal smoking during pregnancy, gestational age of birth, birth weight, parity and municipality of residence from the MBR. From the Danish Health Visitor's Child Health Database we obtained information about breastfeeding duration and number of health nurse visits collected by health visitors. The Database Steering Committee provided the data.

This study was conducted according to the guidelines laid down by the Declaration of Helsinki. The Danish Data Protection Agency approved the usage of the data obtained in the Healthy Start primary prevention intervention (journal number: 2015-41-3937). The Scientific Ethical Committee of the Capital Region in Denmark decided that the project was not a bioethics project, and consequently did not need approval from the Danish Bioethics Committee (journal number H-A-2007-0019). Written informed consent to use the collected data for research purposes was obtained from all parents. The ClinicalTrials.gov identifier for The Health Start study is NCT01583335.

### Study population

The Healthy Start intervention study initially invited 3,058 children, identified in registries, born in 2004–2007 (n: 1,523 intervention group and 1,535 control group) and aged 2–6 years to participate, and about 21% in each group agreed. Thus, the original study population included a total of 543 normal weight obesity prone children with baseline information on among others weight, eating habits, sleep, stress and physical activity [25]. For the present study, children with missing information on the exposure variables (breastfeeding, n = 221) and the outcome variable (pickiness, n = 59) were excluded, and therefore the final study population in the crude analysis consisted of 263 children and 236 children in the analyses adjusted for potential confounders.

When we investigated changes in eating behaviour from baseline and after the intervention we included all children with data on picky eating behaviour at baseline (n = 484).

Children with and without breastfeeding information were not different in regard to pickiness at baseline (chi-square p-value = 0.20).

### Determination of infant feeding

Infant feeding was registered by health nurses while visiting the new mothers when the child was few days old and until the child was approximately 10 months old. They visited the family up to 4 times. All women in Denmark are offered these home-visits free of charge.

The exposure variable was categorized into exclusively breastfed until age 0–1 months, 2–3 months, 4–5 months and 6–10 months. Exclusively breastfed means that the infant did not have an intake of additional foods or drinks. Thus, children who were formula fed from birth would be in the group 0–1 months of exclusively breastfeeding, and children supplemented with formula from e.g. month 3 would be in the group of 2–3. Children starting complementary food at age 6 months would be in the group of 4–5 months of exclusively breastfeeding.

### Determination of eating behaviour

At baseline and follow-up parents completed questionnaires on meal habits and family well-being. Information on pickiness was based on the question "How would you describe your child's way of eating?" The parents could answer if they perceived their child as being "picky", "a little picky" or "likes everything".

Due to power issues in the analysis of breastfeeding and eating behaviour we cumulated children with picky eating behaviour and children who were a little picky, to get a dichotomised outcome variable used in the main analysis (picky/non-picky).

## Dietary measurements

Information on the child's diet intake was obtained by parents at baseline when the children were 2–6 years of age using a 4-day (Wednesday–Saturday) diet record, applying a picture book as guidance in reporting portion sizes [26]. The software Dankost 3000 was used for nutrient calculation (<http://dankost.dk/>). Since it was not possible to define food groups using Dankost 3000, this was done manually by studying the list of all food items eaten by the children. A Stata program was then developed by a statistician to extract information and generate food groups (fruit, vegetables, starchy foods and sugar sweetened beverages). Definitions of food groups were based on standards developed by the National Food Institute, Technical University of Denmark [27] and further modified to fit the Danish dietary guidelines and to suit the Healthy Start primary intervention study. Dietary food group information was used to investigate if there were any associations between duration of exclusive breastfeeding and intake of vegetable, fruit, starchy foods and sugar sweetened beverages. Fruit was defined as: fresh, canned and frozen (excluding jam, fruit juice, dried fruit and fruit products with added sugar), vegetables as: fresh, canned and frozen (excluding fried onion, ketchup, pickles and potatoes), starchy foods as: rice, pasta or potatoes, and sugar sweetened beverages as: all beverage with added sugar. All food groups were presented in g/day.

## Statistical methods

Logistic regression was used to analyse crude and adjusted associations between infant feeding and eating behaviour in early childhood.

In analysis investigating dietary intake we used general linear models with dietary intake as the continuous outcome variable in grams per day, and breastfeeding duration.

In the multiple logistic regression models we adjusted for confounding by *a priori* known and potential confounding variables, namely smoking during pregnancy (no/yes), parity (1 child/ 2 children/  $\geq 3$  children), problems establishing breastfeeding (yes/no), maternal age at pregnancy (tertiles: 19–30 / 30–33/ 34–46 years) [10] and maternal municipality of residence at date of giving birth.

On pickiness and dietary groups, we examined interactive effects of duration of breastfeeding and maternal education (no academic/ up to bachelor degree/ academic degree), and child's age at baseline (2–3 / 3–5 / 5–6 years).

We further investigated changes in pickiness from baseline to follow-up using McNemer's test for symmetry.

Statistical analysis of the data was performed with SAS Enterprise Guide software, version 7.1 for Windows (SAS Institute Inc., NC, USA).

## Results

As shown in Table 1, the median birth weight of 4150 (1800–5450) reflects the inclusion criteria well. 20.2% of the children were only exclusively breastfed until age 0–1 month, and 14.8% were exclusively breastfed until age 6–10 months. The majority, 52.9% of the children, were exclusively breastfed until age 4–5 months. Picky eating behaviour was observed in 16.0% of the children and 46.4% were a little picky at baseline, when they were on average 3.9 (2.1–6.0) years old (Table 1).

We investigated changes in picky eating behaviour from baseline to follow-up, e.g. changes over a period of 15 months. Overall the children did not change picky eating behaviour which was also confirmed by a McNemer's test for symmetry of 2.55 between baseline and follow-up eating behaviour, with a corresponding p-value of 0.20 (data not shown). In total 41% of the data was missing at follow-up, and thus no further analyses were made in this data.

**Table 1. Characteristics of the mother and child.**

<i>Child characteristics</i>	n	Median (range)	%
Birth weight	263	4150 (1800–5450)	
Gestational age at birth	263	284 (230–299)	
Age in days at:			
first health nurse visit	244	9 (0–43)	
second health nurse visit	198	69 (8–144)	
third health nurse visit	228	133 (92–252)	
fourth health nurse visit	216	258 (182–311)	
Mothers with 4 health nurse visits	225		85.6
Exclusively breastfeeding duration (months)	263	4 (0–10)	
Exclusively breastfed at age:			
0–1 months	53		20.2
2–3 months	32		12.2
4–5 months	139		52.9
6–10 months	39		14.8
Exclusively formula fed at first visit	9		3.8
Exclusively formula fed at second visit	23		10.4
Exclusively formula fed at both visits	6		2.9
Problems establishing breastfeeding	73		29.4
Age in years at baseline	263	3.9 (2.1–6.0)	
Age in years at follow-up	174	5.3 (3.2–7.3)	
Child’s Body Mass Index (kg/m <sup>2</sup> ) <sup>a</sup>	263	16 (12–18)	
Picky eater <sup>a</sup>	42		16.0
A little picky eater <sup>a</sup>	122		46.4
Likes almost everything <sup>a</sup>	99		37.6
<i>Maternal characteristics</i>			
Maternal age at pregnancy <sup>b</sup> (yrs)	263	32.3 (21.6–42.8)	
Parity <sup>b</sup> :			
1 child	101		39.3
2 children	121		47.1
≥3 children	35		13.6
Smoking during pregnancy <sup>b</sup>	16		6.1
Maternal education <sup>a</sup> :			
No academic education	65		25.9
Bachelor degree	120		47.8
Master degree	66		26.3

<sup>a</sup> At baseline when the children were 2–6 years of age.

<sup>b</sup> Data obtained from the Medical Birth Registry

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When investigating the association between duration of exclusive breastfeeding and pickiness, we observed a lower odds ratio (OR) of picky eating behaviour among those exclusively breastfed until age 4–5 months and those exclusively breastfed for 0–1 month in both crude (OR<sub>crude</sub> = 0.51 95CI = 0.27;0.98, p = 0.04) and adjusted analyses (OR<sub>adjusted</sub> = 0.35, 95CI = 0.16;0.76, p = 0.008) (Table 2).

We observed a higher daily intake of vegetables for those breastfed until age 6–10 months compared to those breastfed for 0–1 month, but this was statistically significant only in the crude analysis (Table 3). No associations between breastfeeding duration and fruit, starchy

**Table 2. Picky eating behaviour by infant exclusively breastfeeding.**

Exclusively breastfed in months	n	OR <sub>crd</sub>	95% CI	P-value	OR <sub>adj.</sub>	95% CI	P-value
0–1	53	1	-	-	1	-	-
2–3	32	0.71	0.29;1.73	0.45	0.43	0.15;1.20	0.11
4–5	<b>139</b>	<b>0.51</b>	<b>0.27;0.98</b>	<b>0.04</b>	<b>0.35</b>	<b>0.16;0.76</b>	<b>0.008</b>
6–10	39	0.58	0.23;1.36	0.21	0.51	0.19;1.37	0.18

Adjusted for parity, smoking during pregnancy, maternal age at pregnancy, problems establishing breastfeeding, and maternal municipality at time of birth.

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foods or sugar sweetened beverages were observed in either crude or adjusted analyses (Table 3).

No interactions between maternal education, age of the child at baseline or pickiness and duration of breastfeeding and dietary intake were observed (data not shown).

## Discussion

Food preferences by children are initiated early in life, partially by genetics but also by infant feeding and the family environment [28, 29]. Understanding these factors may be important to obtain a healthy lifestyle especially in children with increased risk of obesity. In this study we investigated if exclusive breastfeeding duration was associated with pickiness or dietary intake in early childhood among normal weight children with increased risk of obesity.

In our study population children who were breastfed exclusively until age 4–5 months were less likely to be picky compared to children breastfed exclusively for 0–1 month only, regardless of maternal education level. Children exclusively breastfed until end of 5 months of age fulfilled the breastfeeding recommendations by the WHO, of which complementary food should be given from the beginning of the 6<sup>th</sup> month of age [1]. Other studies have also confirmed that breastfeeding for the first 6 months (corresponding to 5 months of age) reduced the odds of a picky eating behaviour [12, 19]. It has been suggested that children who were breastfed and got complementary food from 4–6 months of age, may be less picky in childhood, because they are exposed to more flavours early in life from both maternal diet during breastfeeding and complementary food [30, 31]. Children exclusively breastfed for 6–10 months were not less picky compared to children breastfed for 0–1 months in our study. These children are exposed to additional flavours from complementary food later in infancy, which might be the reason for the lack of association. The children in our study who were not exclusively breastfed might have been partially breastfed and not exclusively formula fed, thus they might have received some flavours from breast milk or from complementary foods.

Despite our results showed that children breastfed until age 4–5 months were less picky we did not show that this group had a different intake of vegetables, fruit, starchy foods or sugar sweetened beverages than children breastfed for 0–1 month. An earlier study showed greater enjoyment of carrots among children whose mothers ate carrots while breastfeeding compared to children whose mothers did not, however the amount of carrot ate by the two child groups were the same [22]. We only had information on exclusive formula feeding in the two first health nurse visits, of which only 2.9% were bottle fed at both visits, thus we were not able to investigate this group separately. One previous study showed that infants increased their intake of mashed beans after 8 days of exposure, regardless if they were breast or formula fed [32]. However, other studies have shown benefits of breastfeeding duration on later childhood dietary intake [24, 33–35]. Although we did not show significant associations in the adjusted analysis of duration of breastfeeding and grams of vegetables consumed per day, we did show a



**Table 3. Vegetables, fruit, starch and sugar sweetened beverages intake pr day in relation to exclusively breastfeeding duration.**

Exclusively breastfed in months	n	Vegetables g/day					Fruit g/day					Starchy foods g/day					Sugar sweetened beverages g/day				
		Mean	Mean adj.	95%CI	<i>P</i> <sub>crude</sub>	<i>P</i> <sub>adj.</sub>	Mean	Mean adj.	95%CI	<i>P</i> <sub>crude</sub>	<i>P</i> <sub>adj.</sub>	Mean	Mean adj.	95%CI	<i>P</i> <sub>crude</sub>	<i>P</i> <sub>adj.</sub>	Mean	Mean adj.	95%CI	<i>P</i> <sub>crude</sub>	<i>P</i> <sub>adj.</sub>
0–1	53	81.7	90.0	(6.3;119.6)	(ref)	(ref)	91.3	92.2	(73.3;111.3)	(ref)	(ref)	51.9	54.3	(43.1;65.4)	(ref)	(ref)	81.5	89.5	(60.9;118.1)	(ref)	(ref)
2–3	32	89.0	98.1	(64.4;131.8)	0.63	0.63	85.0	87.9	(63.7;112.0)	0.64	0.77	61.1	59.8	(45.6;74.0)	0.24	0.52	64.0	67.3	(30.8;103.9)	0.38	0.33
4–5	139	99.1	102.0	(75.5;128.6)	0.11	0.33	89.0	95.2	(81.2;109.2)	0.81	0.78	56.8	54.4	(46.1;62.6)	0.38	0.99	73.9	81.5	(60.4;102.7)	0.50	0.63
6–10	36	<b>117.3</b>	113.1	(79.3;147.0)	<b>0.01</b>	0.15	108.7	106.7	(83.6;129.9)	0.17	0.30	57.1	54.8	(41.2;68.5)	0.48	0.94	48.4	55.2	(20.2;90.2)	0.08	0.11

Adjusted for parity, smoking during pregnancy, maternal age at pregnancy, problems establishing breastfeeding, and maternal municipality at time of birth.

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tendency of higher vegetable consumption corresponding to more months of exclusively breastfeeding. We attribute the lack of significance to the limited sample size.

Picky eating behaviour has been associated with obesity if prolonged [24]. Fortunately, we showed in a previous study in the same study population, that energy intake from unhealthy foods was similar for picky and non-picky children [13]. This is especially fortunate since the children in the present study were all in a higher risk of developing obesity. However, the long-term consequences of picky eating among obesity prone children is unknown, and thus, exclusive breastfeeding, as recommended by the WHO, should be encouraged in this population and in populations where duration of breastfeeding is short. The children in this study were normal weight at baseline but selected according to their increased risk of obesity. They were either born by an obese mother, came from a low SES family or had a high birth weight according to gestational age, since these factors increase the risk of obesity in later life [36–38]. We did not select children specifically by low birth weight, although low birth weight and subsequent rapid growth are additional factors predisposing children to obesity [38]. In this regard, a recent review on birth weight concluded that low birth weight was not associated with a higher energy intake or eating behaviours in later childhood [39].

An advantage of this study is that breastfeeding data was collected by health nurses while visiting the mothers at their private home and was thus not retrospectively collected or self-reported data. A total of 85.6% of the mothers had four visits by the health nurse up to the child was in average 9 months of age, thus recall bias is not an issue in this study. At the health nurse visits one of the main focus areas is breastfeeding, and these frequent visits, might encourage women to continue breastfeeding and help women with difficulties in initiating and maintaining breastfeeding. This is most likely the reason for the high proportion of children exclusively breastfed in Denmark [40] compared to other Western populations [19, 41].

This study also had some limitations in the form of a somewhat small sample size due to missing observations in the breastfeeding variable (n = 221), however we showed that the children with and without missing observations did not differ with respect to picky eating behaviour. The breastfeeding information was collected by the health nurses in their daily work and not as part of a research project, thus on a busy day the nurses might have forgotten to report the breastfeeding. To gain power in the analysis we cumulated children with picky eating behaviour and children who were a little picky into a dichotomised outcome variable. If, instead of using this dichotomised variable, we use the three levels outcome variable we would get cells in the nominal logistic regression model with as few as 7 observations, and hence these analyses could not be performed. However, the dichotomisation may also have resulted in some misclassification that would tend to attenuate our observed relations rather than inflate them, thus giving credit to the significant findings we observed. Another potential limitation is the use of a simple question to measure pickiness rather than multi-item validated scales. However, the fact that we found borderline significant associations given the use of



such more crude measure again suggests that our results are real and attenuated rather than inflated. The parents self-reported the child's eating behaviour and differences in how parents define pickiness may exist. Also, this potential misclassification introduced by using this more crude information may potentially have led to attenuation of our observed associations. In addition, we showed that eating behaviour did not change over a period of 15 months thus we believe that the outcome measure was robust in our population. Unfortunately, we did not have information on maternal SES, maternal income or maternal education at the time of birth. This is a potential confounder since children of parents with high education level or SES have a healthier lifestyle [42]. As proxies for SES in the multiple analyses we included municipality, since the residence of each of the 11 included municipalities have different SES; age of the mother, since young mothers often tend towards a lower SES than older mothers [43]; and parity, since mothers with few children might be associated with a higher SES [43]. We had information on maternal education at baseline when the children were 2–6 years of age, this potential mediator was included in the interaction analysis, but did not influence our results.

## Conclusion

This study found that breastfeeding duration influenced pickiness in young childhood, and potentially facilitate the consumption of more vegetables in later childhood. These results are in agreement with results from previous studies among healthy children, but to our knowledge our study is the first to provide results among obesity prone normal weight children.

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## Author Contributions

**Conceptualization:** Ina Olmer Specht.

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**Validation:** Jeanett Friis Rohde.

**Writing – original draft:** Ina Olmer Specht.

**Writing – review & editing:** Jeanett Friis Rohde, Nanna Julie Olsen, Berit Lilienthal Heitmann.

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