

# Eating in the absence of hunger in 18-month-old children in a home setting

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## Summary

**Background:** Eating in the absence of hunger (EAH), the susceptibility to eat despite satiety, may increase overweight. While EAH has been established in school-aged children, less is known about it during toddlerhood.

**Objectives:** This study assessed to what extent 18-month-old children eat in the absence of hunger, the stability of this behaviour at 24 months and the association of child eating behaviours with EAH.

**Methods:** Children were presented with four palatable finger foods (total 275 kcal) after dinner. Univariate GLM's assessed the association between EAH, child satiety and eating behaviours and energy intake of dinner at 18 and 24 months ( $n = 206$  and  $103$ , respectively). Another GLM was run to assess the association between EAH at both time points.

**Results:** Mean ( $\pm$ SD) energy intakes from dinner and finger foods were 240 kcal ( $\pm 117$ ) and 40 kcal ( $\pm 37$ ), respectively. No association was found between energy intake of dinner and finger foods. Enjoyment of food was significantly related to intake of finger foods ( $P = .005$ ). EAH at 18 months predicted EAH at 24 months.

**Conclusion:** Eighteen-month-old children ate in the absence of hunger, irrespective of satiety. Thus, preceding energy intake was not compensated for. Other factors, for example, enjoyment of food seem to determine finger food intake.

## KEYWORDS

child eating behaviour, eating in the absence of hunger, satiety, self-regulation of energy intake, toddler

## 1 | INTRODUCTION

The rates of childhood overweight have increased dramatically over the last decades. To illustrate, worldwide the number of children with

overweight or obesity below the age of 5 years increased from 32 million in 1990 to 38 million in 2019.<sup>1</sup> In the Netherlands in 2018, 12% of all children aged from 2 to 8 years were overweight.<sup>2</sup>

The fundamental cause of overweight and obesity is a positive physiological imbalance between energy intake and energy expenditure over an extended period of time.<sup>3</sup> An imbalance between intake and expenditure of only 2% on a daily basis, sustained over time, can induce overweight in growing children.<sup>4</sup> Also, children with

**Abbreviations:** BFB, Baby's First Bites; BMI, body mass index; BMI-z, body mass index z-score; CEBQ-T, child eating behaviour questionnaire for toddlers; EAH, eating in the absence of hunger; GLM, general linear model; NEVO, Nederlands Voedingsstoffenbestand; WHO, World Health Organization.

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overweight are at higher risk of remaining overweight in adulthood.<sup>3,5</sup> Therefore, prevention of overweight and obesity should start early in life since eating behaviours are learned and established during childhood, especially in the first 2 years of life.<sup>6</sup>

There is a need for better understanding of behavioural risk factors contributing to overweight in childhood. For instance, individual eating behaviours affect children's responses towards food, and are related to a greater risk of overweight and obesity.<sup>7-12</sup> Larger appetite ratings, greater enjoyment of food, greater food responsiveness, faster eating rate, and lower satiety responsiveness were found to be related to higher body weights and faster weight gain in infants aged 3 to 15 months.<sup>11</sup> In addition, lower satiety responsiveness and greater food responsiveness have been associated with higher prevalence of adiposity in older children aged 3 to 5 years.<sup>13</sup>

Children are born with the ability to self-regulate short-term energy intake but this ability seems to diminish with age, when the effects of sensory, cognitive, and social factors on energy intake become stronger.<sup>14-16</sup> For example, external cues such as availability of palatable foods, portion size effects, presence of other people, time of day, and parental feeding practices may overrule or have a greater influence on intake than internal cues of hunger and satiety and consequently reduce the ability to self-regulate energy intake.<sup>17,18</sup> A poor ability to self-regulate short-term energy intake is associated with a positive energy balance in children aged 5 to 12 years,<sup>19,20</sup> thereby increasing the risk of developing overweight later in life.<sup>5,21</sup>

Eating in the absence of hunger (EAH) refers to the failure to self-regulate energy intake, and the susceptibility to eat palatable, often energy-dense foods despite experiencing satiety,<sup>10</sup> making it a behavioural risk factor for developing overweight.<sup>7,20,22,23</sup> Previous work in preschoolers and primary school age children has shown that EAH increases with age and is consistent within individuals over time.<sup>20,22,24-27</sup> Also, EAH has been observed in children as young as 21 months<sup>25,28</sup> suggesting it already occurs at a very young age. However, the age at which self-regulation of short-term energy intake diminishes and EAH emerges may be even younger than this. Also, it remains unclear how individual eating behaviours play a role in the emergence and dynamics of EAH over time.

Extending our knowledge on the determinants of EAH is important for early recognition of risk behaviours contributing to overeating in children, and for the timing of early targeted interventions to prevent overeating. Furthermore, such insights in risk behaviour could be translated into practical guidelines for parents and caregivers. To this aim, we performed a study among 18-month-old children ( $n = 217$ ) in a home setting to assess to what extent they eat in the absence of hunger. This procedure was repeated in a subset of the sample ( $n = 107$ ) when the children were 24 months of age, to examine whether EAH remained stable over time. In addition, the association of satiety of the child (as perceived by the mother) and child eating behaviours with EAH was investigated. It was expected that children who ingested more energy during the evening meal, and were perceived as being more satiated, would ingest less energy from the finger foods presented during the EAH procedure. It was also hypothesized that certain child eating behaviours, such as greater

enjoyment of food, greater food responsiveness, and lower satiety responsiveness would result in a relatively higher energy intake of finger foods. Finally, it was expected that EAH at 18 months would predict EAH at 24 months in the subset of children where EAH was measured twice, at 18 and 24 months of age.

## 2 | METHODS

### 2.1 | Study design and participants

The current study presents data collected as part of a large longitudinal study, Baby's First Bites (BFB), of which a detailed description of the study protocol has been published elsewhere.<sup>29</sup> In short, BFB is a four-arm randomized controlled trial that studies the role of the start of complementary feeding in infancy in promoting vegetable intake. It included 243 first-time Dutch mothers and their infants. Interventions started with a standardized feeding schedule after parents indicated their child was ready to start complementary feeding (age 4-6 months), and lasted until the age of 16 months.<sup>29</sup> Home assessments were performed at the ages of 12, 18, 24, and 36 months. As part of this RCT, EAH was measured during the home assessment at the ages of 18 and 24 months. The home assessments were performed by trained Master and PhD students and entailed anthropometric measurements and a videotaped meal and play session between mother and child.<sup>29</sup>

Written informed consent was obtained from both parents before participation in the BFB trial and the protocol was approved by the Ethical Review Board of Education and Child Studies, Leiden University (protocol number ECPW-2015/116) and the Medical Ethical Review Board of Wageningen University and Research (METC-WU protocol number NL54422.081.15). The trial was registered during inclusion of participants at the Netherlands National Trial Register (identifier NTR6572) and at ClinicalTrials.gov (NCT03348176).

For each assessment, mothers received a €25 gift voucher and the child received a small present (eg, colouring or reading book).

The EAH measurements were conducted between July 2017 and June 2019. In total, 217 mother-child pairs participated in the EAH procedure when the child was 18 months old. Due to constraints in budget and manpower, the repeated measurement at 24 months did not include the full sample, but a subsample of 107 mother-child pairs living in the surroundings of Leiden University.

General information, such as child's date of birth, sex and maternal ethnicity, and educational level, was obtained from written and online surveys completed at the start of the BFB trial.

### 2.2 | Child eating behaviour

Prior to the home visits at 18 and 24 months, mothers filled out the Child Eating Behaviour Questionnaire for toddlers (CEBQ-T)<sup>30</sup> online. This is a well-validated, reliable, and widely used questionnaire consisting of 26 items to assess six eating styles that have been related to overeating and overweight: food responsiveness (FR), satiety

responsiveness (SR), enjoyment of food (EF), food fussiness (FF), emotional overeating (EOE), and slowness in eating (SE).<sup>10,31</sup> Mothers reported on a five-point Likert scale ('1 = never' to '5 = always') how frequently they observed their child demonstrating a range of eating behaviours on a typical day. The scales have good internal consistency with Cronbach's Alpha ranging from .74 to .91 (FR: .80, SR: .74, EF: .91, FF: .91, EOE: .79 and SE: .74).<sup>10</sup>

### 2.3 | Anthropometrics

Children's and maternal bodyweight was measured during every home visit using a calibrated digital scale (SECA robusta 813), in kilograms to the nearest 0.1 kg. Children's length was measured on an infant measuring mat to the nearest 0.5 cm. Maternal height was measured at the start of the BFB trial using a portable stadiometer to the nearest 0.5 cm. For children, body mass index (BMI) was calculated and transformed into age and sex-standardized z-scores (BMI-z) based on the WHO Child Growth Standards for boys and girls aged 0 to 60 months.<sup>32</sup> Maternal height and body weight were used to calculate BMI in kg/m<sup>2</sup>. In case the mother was pregnant or had recently given birth, the bodyweight of the mother measured during the home visit when the child was 12 months old was used to calculate maternal BMI (n = 37).

### 2.4 | Measurement of child's EAH

The protocol for measuring EAH was based on the free-access procedure for children aged 3 to 5 years old in a laboratory setting as described by Fisher and Birch (1999), where children's snack food intake was measured after consuming their usual lunch. In that study, children were provided with 10 snack foods and some toys for 10 minutes and only children who indicated that they were not hungry following lunch participated in the experiment.<sup>33</sup> For the present study, the described protocol was adapted to suit 18- and 24-month-old

children in a home setting. The following adjustments were made: (a) testing was done in a home-setting instead of a laboratory setting after an evening meal prepared by the parents, (b) mothers estimated the level of satiety of their child, as children this young are not yet able to report this themselves, (c) children participated in the procedure irrespective of the satiety score, (d) intake of the child's evening meal was assessed, and (e) toys were provided and mothers were asked to play with their child as usual for 8 minutes. Thereafter four finger foods (Table 1) were presented to all children for the 10-minute EAH procedure. Children had the opportunity to continue playing with the toys or eat the provided foods. Prior to the home visits, mothers were asked for permission to offer the child the selected foods. Only if the child was allergic to a food or the mother disapproved of a food an alternative was offered (Table 1). Twenty-four children were offered at least one alternative finger food.

The EAH procedure was piloted in four sessions at a day care centre in Wageningen, The Netherlands (n = 17, age 16-24 months), to test the procedure's feasibility and children's behaviour toward multiple finger foods. In total, 11 foods were tested (breadsticks, cream crackers, Nibbit sticks, salty biscuits, cake, gingerbread, banana, Miffy shaped cookies, pouch of pureed fruit, raisins, and plain sweet biscuits) of which four were selected to be offered during the EAH procedure (breadsticks, Nibbit sticks, gingerbread, and plain sweet biscuit). Selection was based on the criteria that children were able to take and eat the food without help, the food attracted the interest of the children and was considered to be age appropriate by the Netherlands Nutrition Centre. Selected foods were frequently consumed according to the Dutch National Food Consumption Survey (2010) among 1-year-old children. The procedure itself was considered feasible and remained unchanged.

Parents were asked to prepare an evening meal for the child as part of their usual daily routine. The child's intake was assessed by obtaining a detailed description of the ingredients and preparation of the meal, drink, and desert. Everything the child ate and drank was weighed on a calibrated digital kitchen scale (Soehnle, Fiesta 65106)

**TABLE 1** Finger foods provided during the EAH procedure

Standard foods	Serving	Weight (g) per serving	Energy per serving (kcal)
Savoury			
Breadstick	Two sticks	14	57
Nibbits sticks	One handful	15	72
Sweet			
Gingerbread	One slice	27	84
Plain biscuit	Two pieces	14	62
Alternative foods	Serving	Weight (g) per Serving	Energy per serving (kcal)
Savoury			
Rice cracker	Two pieces	14	53
Cream cracker	Two pieces	16	72
Sweet			
Banana	0.5 Piece	65	62
Raisins	One spoonful	15	52

and photographed by the researcher before and after consumption. Photographs were taken at a 45° angle and a ruler was placed under the plate as a visual reference for portion size estimation.<sup>34</sup> This method for assessing the weight, energy, and macronutrient content of the evening meal was evaluated within the sample of the BFB trial (*data not reported*) using a weighed food record as the reference method. The mean energy and macronutrient content intakes assessed by detailed description, weight, and photographs were not significantly different from the reference method. Indicating it as a reliable method for estimating energy intake of the evening meal.

The nutritional data were processed by trained dietitians. Portion sizes of each food item were estimated based on the description, weight and photographs of the meal, food items were coded and converted into total amount eaten in grams, and energy and macronutrient intake were calculated using the online program Compl-eat<sup>35</sup> using the Dutch food composition database (NEVO) edition 2016/5.0.

Directly after the evening meal mothers were asked to rate the child's satiety on a five-point Likert scale (from '1 = not at all satiated' to '5 = very satiated'). This was followed by an 8 minute free-play session between mother and child. After this the researcher offered the child a plate with two savoury and two sweet finger foods (see Table 1) for 10 minutes. The researcher told the child that these were for him/her to eat; 'hello <name child> these foods are for you'. Mothers remained in the room but were asked not to interfere with the child's behaviour so the child had the opportunity to continue playing with the toys or eat the provided foods without interference. Finger foods were weighed before and after the EAH procedure and the weight was multiplied by the energy content<sup>36</sup> of each individual food to determine the weight (grams) and energy (kcal) consumed by the child respectively. An EAH score was calculated using the following formula<sup>37</sup>:

$$\text{EAH score} = \text{EI from finger foods} / \text{EI from evening meal} \times 100\%.$$

A score of 0% indicates that the child did not consume any of the finger foods. A higher score indicates greater energy intake of the finger foods, proportionately to the energy intake of the evening meal.<sup>37</sup>

## 2.5 | Statistical analysis

Statistical analyses were carried out in SPSS (version 25; SPSS Inc., Chicago, Illinois). For the measurements at 18 months, data of 11 participants (5.1%) were excluded from analysis because parents did not allow their child to participate in the EAH procedure as planned, for instance they did not consent to the standardized amount of finger foods or stopped the procedure within 10 minutes. At 24 months, data of four participants (3.7%) were excluded from the analysis because parents did not comply with the requirements of the procedure as described above.

Data are presented as mean values with standard deviations or numbers with percentages, unless otherwise specified. Tests were performed two-sided and *P*-values <.05 were considered significant. Distribution of the EAH scores was not normal and, therefore, the EAH score was log transformed. In addition, a one way ANOVA was run to test if EAH

scores of the children differed between the four intervention groups, no significant differences were found and data were collapsed for further analysis. Maternal BMI was not related to EAH ( $r[198] = -.07, P = .31$ ) and not taken into account for further analysis.

Few children were rated as being 'not at all satiated' and 'not satiated', the lowest satiety scores after dinner ( $n < 20$  for both measurements). Therefore, these categories were pooled into one group, resulting in a four-point scale for satiety (ie, 1 = not satiated; 2 = neutral; 3 = satiated; 4 = very satiated) for further analyses.

To explore the association of satiety of the child (as perceived by the mother), energy intake of the evening meal, child eating behaviours measured with the CEBQ-T at age 18 and 24 months and child BMI-z score with EAH, we used a Univariate General Linear Model (GLM) with energy intake of finger foods as the dependent variable. Child sex and intervention group were added as independent variables.

Finally, a Univariate GLM was used to investigate the association between EAH score at age 18 and 24 months in the group of children who had participated in both measurements. Sex and intervention group were added in the model as independent variables.

Assumptions for linearity, normality of residuals, homoscedasticity, and multicollinearity were checked. Boxplots revealed two outliers (>3 SD) for EAH-scores. However, these outliers were not due to measurement error and re-running the analyses without these outliers did not change the results. Therefore, outliers were included in the analysis.

## 3 | RESULTS

### 3.1 | Sample characteristics

The final sample consisted of 206 mother-child pairs ( $n = 98$  boys and 108 girls) and 103 mother-child pairs ( $n = 45$  boys and  $n = 58$  girls) at the 18 and 24 month measurement, respectively. Mothers were on average ( $\pm$ SD) 31.6 ( $\pm$ 4.6) years old and 21.7% had a university degree or higher. The majority of the participants were from Dutch Caucasian origin (71%), with an additional 4% of mixed ethnicity (one parent Dutch, the other from a different ethnic group). The remaining 25% of participants came from different ethnic groups such as Surinamese, Turkish, and Antillean. Maternal BMI ( $\text{kg}/\text{m}^2$ ) was on average ( $\pm$ SD) 26.6 ( $\pm$ 5.8)  $\text{kg}/\text{m}^2$ . The majority of mothers, 53.5%, were overweight ( $\text{BMI} > 25 \text{ kg}/\text{m}^2$ ), 45% had a normal weight ( $\text{BMI}$  between 18.5 and 25  $\text{kg}/\text{m}^2$ ), and 1.5% were underweight ( $\text{BMI} < 18.5 \text{ kg}/\text{m}^2$ ). Characteristics of the children are presented in Table 2.

### 3.2 | EI, EAH score and mothers perceived satiety

The mean time ( $\pm$ SD) between the evening meal and the EAH task was 21 ( $\pm$ 5) minutes. EI from the evening meal (including drink and dessert), finger foods and total energy intake (EI from evening meal + EI from finger foods), and EAH scores are shown in Table 3.

Of the full sample, 185 (89.8%) children ate from the finger foods at 18 months with a mean ( $\pm$ SD) intake of 40 kcal ( $\pm$ 37), of whom

**TABLE 2** Characteristics of the children at 18 and 24 months

	18 Months n = 206	24 Months n = 103
	Mean ± SD or n (%)	Mean ± SD or n (%)
Age (months)	18.0 ± 0.7	24.0 ± 0.7
Sex		
Boys	98 (47.6)	45 (43.7)
Girls	108 (52.4)	58 (56.3)
BMI-z <sup>a</sup>		
Underweight	5 (2.4)	0 (0)
Normal weight	185 (89.8)	87 (84.5)
Overweight	16 (7.8)	16 (15.5)
Eating behaviour <sup>b</sup>	n = 182	n = 98
Enjoyment of food	4.20 ± 0.57	4.06 ± 0.57
Satiety responsiveness	2.35 ± 0.53	2.58 ± 0.49
Food responsiveness	2.66 ± 0.78	2.55 ± 0.74
Emotional overeating	1.80 ± 0.61	1.78 ± 0.67
Slowness in eating	2.94 ± 0.44	3.06 ± 0.48
Food fussiness	2.94 ± 0.26	2.94 ± 0.27

<sup>a</sup>Underweight when BMI-z ≤ -2; normal weight when BMI-z between -2 and 2; overweight when BMI-z ≥ 2.

<sup>b</sup>Eating behaviour assessed with the CEBQ-T. Scores ranged from 1 to 5 on a five-point Likert scale: 1 = rarely, 2 = never, 3 = sometimes, 4 = often, 5 = always.

143 (69.4%) were considered satiated based on the mother's estimation (score 3 satiated or score 4 very satiated). At 24 months, 96 (93.2%) children ate from the finger foods with an average (±SD) intake of 33 kcal (±29), of whom 40 (41.7%) were considered satiated. Twenty-one children (10.2%) ate nothing from the finger foods at 18 months, of whom 17 (81%) were considered satiated. Seven children (6.8%) ate nothing from the finger foods at 24 months, of whom four (58.8%) were considered satiated.

The EAH score between satiated and non-satiated children did not differ significantly ( $P = .31$ ) and ( $P = .28$ ) at 18 and 24 months, respectively. Total EI of satiated children was significantly higher than that of non-satiated children ( $P < .001$ ) and ( $P = .003$ ) at 18 and 24 months, respectively.

Furthermore, EAH at 18 months predicted EAH at 24 months  $F(1, 88) = 8.520, P = .004$ . The proportion of variance explained by EAH at 18 months after excluding variance explained by the other predictors (sex and intervention group) was 8.8% (partial eta squared,  $\eta^2 = 0.088$ , a medium effect size).

### 3.3 | Association between EI finger foods, EI evening meal, mothers perceived satiety, and eating behaviours

Mother's perceived satiety was significantly positively related to the energy intake of finger foods at child age 18 months,  $F(3,166) = 3.859, P = .01$  (Table 4). Figure 1 shows the energy intake of finger foods

grouped according to satiety score. It shows that group 1, consisting of children whose mother reported them to be 'not at all satiated' or 'not satiated' had a lower energy intake than the other groups. The other three groups ('neutral', 'satiated', and 'very satiated') were quite similar concerning energy intake from finger foods intake. In addition, Figure 1 shows that every satiety group included children who did not eat any finger foods. When removing the group with the lowest satiety score from the analysis, the association between satiety and the energy intake of finger foods was no longer significant  $F(2,152) = 1.867, P = .16$ .

Enjoyment of food was significantly related to the energy intake of finger foods in both the model with and without the group with the lowest satiety score,  $F(1, 166) = 8.040, P = .005$  and  $F(1, 152) = 7.246, P = .008$ , respectively. As was expected, enjoyment of food was positively associated with finger food intake. The other factors in the model such as energy intake of the evening meal, food responsiveness and BMI-z score did not explain additional variation in finger food intake at 18 months, as can be seen in Table 4. A child's enjoyment of food was weakly marginally correlated with energy intake of the evening meal ( $r[180] = .14, P = .07$ ).

At child age 24 months only sex was marginally significantly related to the energy intake of finger foods,  $F(1,82) = 3.795, P = .06$ , as can be seen in Table 4. The energy intake of the evening meal was not significantly different between boys and girls. Figure 2 shows the finger food intake grouped according to satiety score at 24 months. It shows a different intake pattern of finger foods per satiety group compared to 18 months and the energy intake of group 1 does not deviate from the other groups.

## 4 | DISCUSSION

The present study performed an adapted EAH protocol in 18-month-old children to assess if children this young overeat when put in a situation where palatable foods are offered. In addition, we aimed to assess the stability of EAH at age 24 months in the same sample. Finally, the study aimed to examine how individual eating behaviours and satiety are related to EAH.

The main findings indicate that EAH occurs already at this very young age (18 months), with the majority (89.8%) of children consuming on average (±SD) 40 kcal (±37) ranging from 0 to 237 kcal from palatable finger foods despite just having eaten a meal (240 kcal ±117 [17-627]). Second, we found that EAH at 18 months predicted EAH at 24 months. Furthermore, unexpectedly, a positive association was found between satiety of the child (as estimated by the mother) and the energy intake of finger foods. Finally, a child's enjoyment of food was positively associated with the intake of finger foods; on average children increased their energy intake with 17 kcal for every point scored higher on the questions regarding enjoyment of food in the CEBQ-T. These findings and their implications will be discussed in more detail below.

We observed that 18-month-old children eat in the absence of hunger when offered palatable finger foods, indicating that EAH

**TABLE 3** Evening meal and finger foods intake and eating in the absence of hunger score in the full sample vs satiated children at 18 and 24 months

Energy intake (N)	18 Months		18 Months		24 Months		24 Months	
	Full sample (206)		Satiated children <sup>a</sup> (143)		Full sample (103)		Satiated children <sup>a</sup> (50)	
	Mean ± SD (min-max)	Mean ± SD (min-max)	Mean ± SD (min-max)	Mean ± SD (min-max)	Mean ± SD (min-max)	Mean ± SD (min-max)	Mean ± SD (min-max)	Mean ± SD (min-max)
Intake evening meal <sup>b</sup> kcal	240 ± 117 (17-627)	264 ± 108 (23-597)	186 ± 122 (17-627)	34 ± 34 (0-150)	209 ± 106 (8-705)	241 ± 125 (21-705)	178 ± 77 (8-344)	
Intake finger foods kcal	40 ± 37 (0-237)	42 ± 38 (0-237)	34 ± 34 (0-150)	33 ± 29 (0-113)	33 ± 29 (0-113)	35 ± 24 (0-109)	30 ± 25 (0-112)	
Total energy intake <sup>c</sup> kcal	280 ± 127 (23-664)	306 ± 118 (23-642)*	220 ± 128 (32-664)	242 ± 113 (36-733)	242 ± 113 (36-733)	276 ± 132 (41-733)*	208 ± 83 (36-408)	
EAH score % <sup>d</sup>	23.1 ± 52.5 (0-704)	18.7 ± 21.2 (0-158)	33.1 ± 89.5 (0-704)	23.4 ± 38.8 (0-346)	23.4 ± 38.8 (0-346)	19.9 ± 23.9 (0-128)	26.5 ± 50 (0-346)	

\*Statistically significant ( $P < .05$ ).

<sup>a</sup>Score reported by the mother, satiety score  $\geq 3$  was considered satiated.

<sup>b</sup>Energy intake of the evening meal including drinks and dessert.

<sup>c</sup>Total energy intake = EI from the evening meal + EI from the finger foods.

<sup>d</sup>EAH score = EI from finger foods/EI from evening meal  $\times 100\%$ .

**TABLE 4** Association between finger food intake, evening meal intake, mothers perceived satiety, and subscores of the CEBQ at 18 (n = 182) and 24 months (n = 98)

Variable	18 Months				24 Months			
	Mean intake (kcal)	B	95% CI	P-value	Mean intake (kcal)	B	95% CI	P-value
Intake evening meal	240	0.15	-0.34 - 0.64	.544	209	0.04	-0.03 - 0.10	.264
Satiety <sup>a</sup>				.011*				.384
1 not satiated	18	-22.91	-47.07 to 1.25		34	8.053	-16.22 to 32.33	
2 neutral	42	14.98	-4.79 to 34.75		29	1.956	-20.11 to 24.02	
3 satiated	40	1.99	-14.04 to 18.04		37	13.32	-8.05 to 34.69	
4 very satiated	49	-	-		30	-	-	
Sex <sup>b</sup>				.103				.055
Male		9.09	-1.85 to 20.04			12.48	-0.27 to 25.22	
Female		-	-			-	-	
Eating behaviour <sup>c</sup>		17.06	5.18 to 28.95	.005*		2.24	-1.02 to 5.50	.175
Enjoyment of food								
Satiety responsiveness		-7.46	-22.54 to 7.62	.330		1.42	-1.77 to 4.61	.378
Food responsiveness		5.68	-4.22 to 15.58	.259		1.50	-1.31 to 4.32	.290
Emotional overeating		-1.55	-11.50 to 8.40	.758		-0.93	-4.93 to 3.07	.644
Slowness in eating		11.45	-3.32 to 26.22	.128		-1.93	-5.79 to 1.93	.322
Food fussiness		-13.34	-34.96 to 8.28	.225		0.32	-3.78 to 4.43	.877

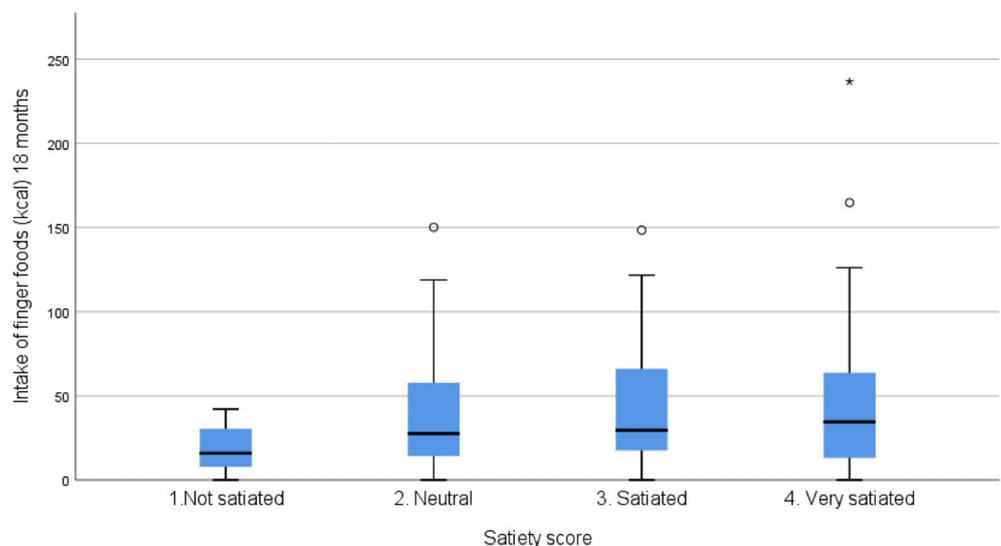
\*Statistically significant ( $P < .05$ ).

<sup>a</sup>Satiety score 4 was the reference in the model, B's as shown for satiety are relative to the reference.

<sup>b</sup>Female was the reference in the model, B's as shown for sex are relative to the reference.

<sup>c</sup>Eating behaviour assessed with the CEBQ-T. Scores ranged from 1 to 5 on a five-point Likert scale: 1 = rarely, 2 = never, 3 = sometimes, 4 = often, 5 = always.

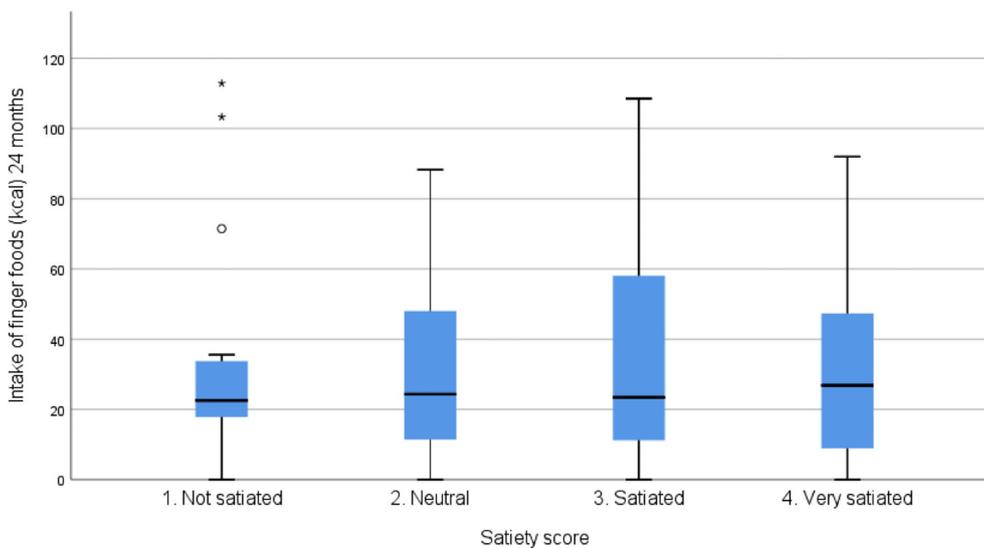
**FIGURE 1** Children's finger food intake (kcal) at the age of 18 months categorized per satiety score (1-4). For group 1 the scores 'not at all satiated' and 'not satiated' were pooled into one group resulting in a four-point scale for satiety (ie, 1 = not satiated; 2 = neutral; 3 = satiated; 4 = very satiated). Mild outliers are represented by circles (○) and extreme outliers are represented by asterisks (\*)



emerges at a very young age. In a previous home-based study, toddlers aged 21 months were found to eat on average ( $\pm$ SD) 87 kcal ( $\pm$ 50) in the absence of hunger.<sup>25</sup> This is twice as much as we observed in our sample (40 kcal  $\pm$ 37). An explanation for this difference could be the difference in the methodology applied between the studies. The EAH protocol in the previous study took place directly after children consumed their typical lunch (rather than after dinner in our study), satiety was not taken into account and the researchers

modelled eating an Oreo cookie which could have encouraged children to increase their intake. Finally, the presented foods were more energy dense and more of a 'special treat', for example, chocolate chip cookies, Oreos and pringles, than the foods in our study, likely increasing intake.

We measured children's finger food intake on one occasion, after one meal. The intake ranged from 0 to 237 kcal with an average intake of 40 kcal in our study. We consider this to be quite substantial



**FIGURE 2** Children's finger food intake (kcal) at the age of 24 months categorized per satiety score (1-4). For group 1 the scores 'not at all satiated' and 'not satiated' were pooled into one group resulting in a four-point scale for satiety (ie, 1 = not satiated; 2 = neutral; 3 = satiated; 4 = very satiated). Mild outliers are represented by circles (○) and extreme outliers are represented by asterisks (\*)

for children aged 18 months. Most healthy children are able to maintain a balance between energy intake, expenditure, storage, and growth over the long term despite large day-to-day fluctuations.<sup>4</sup> However, if over the long term a positive energy balance of 2% was maintained children could be at risk of becoming overweight.<sup>3,4</sup> Possibly, children who display certain eating behaviours (eg, high food responsiveness and low satiety responsiveness) are at greater risk of eating in the absence of hunger and ultimately increased weight.

EAH at 18 months predicted EAH at 24 months and showed a medium, yet significant, effect size. This implicates that EAH could be a behavioural trait that remains stable over time. In a previous longitudinal study with children aged 21 to 33 months,<sup>25,28,38</sup> children ate more in the absence of hunger as they got older. Similarly cross-sectional studies in older children have repeatedly shown an increase in EAH with age.<sup>4,23</sup> We did not find an increase of EAH with age. An explanation for the absence of age effects in the present study could be the smaller age range, where 6 months is not sufficient to detect age-related increases in EAH.

The trend between sex and EAH did not emerge until the age of 24 months, with boys consuming slightly more energy from the finger foods than girls. This finding is in line with previous studies among older children (3-13 years).<sup>23,25,37,39,40</sup> In older children, this association with sex has been attributed to the fact that girls are more influenced by social desirability than boys and may therefore restrain their food intake more due to the desire not to be seen overeating.<sup>23</sup> However, considering the young age of our sample it seems unlikely that this was the case.

Counterintuitively, a positive association was found between satiety of the child and intake of finger foods (ie, higher satiety scores were associated with an increased intake of finger foods). However, when removing the group with the lowest satiety score from the analysis, the association between satiety and the energy intake of finger foods was no longer significant. The variation in energy intake from the finger foods was small for the non-satiated group compared to the other groups. These children had on average a lower BMI-z score than the average of the total sample and were mostly boys. On other

factors, such as CEBQ-T scores and BMI of the mother, the not-satiated children did not differ from the rest of the sample. It remains speculative, but a possible explanation for the lower finger food intake and BMI-z scores of these children is that they might be so-called 'small eaters'. In a study investigating repeated exposure to vegetables in children aged 4 to 38 months researchers observed four distinct patterns of eating behaviour.<sup>41</sup> Children were categorized as 'learners', who increased their intake over time; 'plate cleaners', who consumed more than 75% of the meal that was offered from the start of the intervention onwards; 'non-eaters', still eating less than 10 g by the fifth exposure after the start of the intervention; and 'others', whose eating pattern was highly variable. Possibly, the group of children we categorized as 'small eaters' fall within the eating behaviour pattern that the authors proposed to be 'non-eaters'.

Alternatively, previous research in older children (2-6 years) has shown that intra-individual variation in day-to-day regulation of energy intake is large.<sup>42,43</sup> Therefore, the ability of the mothers to estimate their child's fullness following a single meal, as was the case in the current study, may be limited, as a child's daily energy intake varies, and the intake per meal also fluctuates.

Energy intake of the evening meal was not significantly related to the energy intake of finger foods. This suggests that other factors than energy intake of the evening meal and satiety influenced finger food intake. Previous research in older children (3-6 years) suggested that a child's environment and the portion size of meals or snacks offered determine energy intake more than the amount of food and composition of the meal they ate previously.<sup>17,42,44,45</sup> In addition, it has been proposed that EAH reflects responses to external cues rather than the ability to regulate intake.<sup>23</sup> We cannot exclude the possibility that we observed a 'salience' effect. With the EAH procedure we placed the children in an unusual situation by presenting them with an abundance of palatable foods and giving them permission to do with it as they pleased. This context may have triggered the majority of children eating the finger foods despite having just finished a meal.

Both individual traits of the child and external factors such as parental behaviour may contribute to the development of eating behaviours that make children prone to overeating at a young age.<sup>7,23,33,37,46</sup> However, of the six child eating behaviours measured in this study, only enjoyment of food was positively related to intake of finger foods. Other types of eating behaviour (satiety responsiveness, food responsiveness, emotional overeating, slowness in eating, and food fussiness) and BMI-z were not related to finger food intake in our study. This suggests that the context or environment in which food is offered stimulates children to (over) eat more than individual eating behaviours.

This study has several strengths. To our knowledge this is the first study to examine EAH in children this young. We developed an accurate method for assessing evening meal intake in a home setting using photographs, a detailed description, and weight of the meal. The experiment was done in the natural environment of the child, and the food consumed was representative of the children's usual eating habits, which increased ecological validity. The longitudinal design and adequate sample size of the study allowed us to study the dynamics of EAH over time in a subsample of children.

However, there are some elements of the study design that should be noted. The presence of the mother, researcher, and the camera may have influenced the child's behaviour. For example, some children were very aware of the camera and wanted to touch it or danced in front of the lens. Also, some parents mentioned that their child always waits for permission to eat and parents were instructed not to interfere with the child's behaviour for the duration of the experiment. Possibly these children would have behaved differently if the instruction had come from the parent instead of the researcher. Finally, the choice of highly palatable finger foods suitable for 18-month-old children was limited and the selected foods were different from previous studies investigating EAH in children.

In conclusion, this study showed that children as young as 18 months old already eat in the absence of hunger when offered palatable finger foods, and that EAH was moderately stable over a 6-month period. Contrary to our expectations, the majority of children ate finger foods irrespective of satiety as reported by the mother and no association was found between children's energy intake of the evening meal and energy intake of finger foods thereafter. Factors other than preceding energy intake, such as enjoyment of food or the simple availability of palatable snacks, may have determined intake. These findings suggest that even at this very young age children are sensitive to the context in which food is offered and factors in the environment that offer the opportunity to overeat.

The present study shows that EAH can be demonstrated in children well within the first 2 years of life, which is a critical time window for establishing healthy eating behaviours. This implies that the phenomenon of EAH in very young children deserves greater attention in feeding practices and awareness should be increased in parents and care givers, in order not to facilitate this type of eating behaviour. Some children may be more sensitive to eating in the absence of hunger than others, and future research should focus on moderating factors, including child eating characteristics (eg, high food

responsiveness, low satiety responsiveness), context in which (finger) foods are offered, and social and environmental factors that facilitate eating in the absence of hunger.

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## CONFLICT OF INTEREST

Vanessa E.G. Martens is an employee of Danone Nutricia Research. The authors declare that they have no other competing interests.

## AUTHOR CONTRIBUTIONS

Janneke M. Schultink and Victoire W. T. de Wild developed the EAH protocol, with relevant input from Gerry Jager, Jeanne H. M. de Vries, Shelley M. C. van der Veek, and Merel S. van Vliet. Janneke M. Schultink and Merel S. van Vliet conducted data collection. Janneke M. Schultink performed statistical analysis with relevant input from Gerry Jager, Jeanne H. M. de Vries, and Shelley M. C. van der Veek. Janneke M. Schultink drafted the manuscript with critical input from all authors. All authors have read and approved the final manuscript.

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