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Infant Temperament is Associated with Potentially Obesogenic Diet at 18 Months

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Abstract

Objective—This study investigated whether infants' temperament at 18 months is associated with the feeding of foods and drinks that may increase the risk for later obesity.

Methods—This was a cross-sectional study of mothers and infants (N = 40,266) participating in the Norwegian Mother and Child Cohort Study conducted by the Norwegian Institute of Public Health. Data were collected by questionnaire. Predictor variables were: infants' temperament at 18 months (internalizing, externalizing, and surgency/extraversion), and mothers' negative affectivity. Outcomes variables were feeding of sweet foods, sweet drinks, and night-time caloric drinks at 18 months (all dichotomized). Confounders were child's gender, weight-for-height at 18 months, breastfeeding, and mother's level of education.

Results—After controlling for confounders, infant temperament dimensions at 18 months were significantly associated with mothers' feeding of potentially obesogenic foods and drinks independent of mothers' negative affectivity. Infants who were more internalizing were more likely to be given sweet foods (OR 1.47, CI 1.32–1.65), sweet drinks (OR 1.76, CI 1.56–1.98), and drinks at night (OR 2.91, CI 2.54–3.33); infants who were more externalizing were more likely to be given sweet food (OR 1.53, CI 1.40–1.67) and sweet drinks (OR 1.22, CI 1.11–1.34); and infants who were more surgent were more likely to be given drinks at night (OR1.66, CI 1.42–1.92).

Conclusions—The association between infant temperament and maternal feeding patterns suggests early mechanisms for later obesity that should be investigated in future studies.

Keywords

infant temperament; sweet foods; sweet drinks; night-time caloric drinks

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Introduction

At 18 months, infants rely on their caretakers to provide nourishment, but they also exert an influence over the choice of foods and drinks they are offered and consume (1). Dietary patterns in infancy may be associated with later obesity, so identifying factors that influence these choices is important for prevention. One such factor, temperament, has not been studied in children under 3 years.

Temperament refers to biologically based, relatively stable patterns of emotional behavior and attention that can be observed from birth (2). Broad dimensions of infant temperament include internalized negative emotionality (e.g., sad, fearful, anxious), externalized negative emotionality (e.g., defiant, aggressive), and positive emotionality or surgency/extraversion (e.g., social, active) (3). Temperament appears to be related to early weight gain and later obesity. Babies' distress-prone temperament (e.g., fussing, crying, or frustration in the face of limitations) has been related to faster weight gain in the first 12 months (4,5,6,7). In prospective studies of children over 5 years, negative emotionality and behavioral and emotional problems have also been related to later obesity (8,9,10,11).

A mechanism by which infant temperament may lead to later weight gain is through mothers feeding certain types of foods and drinks in response to their infants' temperamental reactivity. Humans have an innate preference for sweet flavors (12), and sweetness can have a calming effect as a result of opioidergic and dopaminergic neurological mechanisms (13). Mothers report using food to calm fussy babies and infants (14), and consumption of sweet foods and drinks offered to soothe infants with distress prone temperaments, including at night, could result in excess calories and weight gain.

There does not appear to be an association between feeding sweet foods and drinks and weight status of pre-schoolers and infants (15), but there may be longer term effects on weight resulting from the development of obesogenic food preferences that persist through childhood and adulthood (16,17). Most studies of older children and adolescents show a positive association between the consumption of sweetened beverages and increased weight (18,19).

Mothers' temperament, specifically their negative affectivity (anxiety and depression) is related to feeding infants foods and drinks that may lead to later obesity, including less breastfeeding and more sweet drinks (20,21,22,23). Studies of the kinds of foods and drinks given to children under the age of 3 years are rare (24,25), and this study is the first to address the relation between dimensions of infant temperament and the specific kinds of foods and drinks they are offered. We hypothesized that infants who are more prone to internalize (e.g., are more fearful and sad) and ones who are more prone to externalize (e.g., are more fussy and liable to tantrums) are more likely to be given sweet foods and drinks in an attempt to calm and soothe them. No specific hypothesis was proposed for surgency/extraversion, defined in terms of greater positive emotion and more activity.

Method

Study Design and Participants

The Norwegian Mother and Child Cohort Study (MoBa) is an ongoing longitudinal investigation of health determinants in a cohort comprising more than 100 000 pregnancies conducted by the Norwegian Institute of Public Health (www.fhi.no/morogbarn). The cohort was recruited from all except two of the maternity units in Norway with more than 100 births annually (n=50). Recruitment started in 1999 and was completed in 2008. The women received a postal invitation to join the MoBa Cohort together with their appointment cards

for routine ultrasound scans in weeks 17 to 18 of gestation. The participation rate was 42.7% (26). The MoBa study releases updated versions of the datafiles once a year. The current study is based on version 4 of the quality-assured datafiles released in 2009, which included 71,614 births. We included data from questionnaires at 17 and 30 weeks' gestation and 18 months postpartum. Participation rates among those who gave informed consent initially were 95% at 17 weeks, 92% at 30 weeks, and 77% at 18 months postpartum. We also retrieved data from the Medical Birth Registry of Norway, which registers all births in Norway (27).

For the present study, we included mothers (*N*= 42,451) of singletons who completed questionnaires at gestation weeks 17 and 30, at 18 months postpartum. We excluded all mothers where information was missing for the child's birth weight and gender, or the frequency of feeding sweet foods, sweet drinks, or caloric drinks at night (*N*= 2,185). This resulted in a sample size of *N*= 40,266, representing 94.9% of the above dataset. We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during this research.

Dependent Variables

At 18 months postpartum, mothers reported on the drinks and solid foods they were currently feeding their children. Five questions queried the frequency with which the child consumed various sweetened drinks: 1. cordial (i.e. berry or fruit-juice concentrate, with added sugar that is mixed with water), 2. artificially sweetened cordial, 3. fruit juice, 4. soft drinks, and 5. artificially sweetened soft drinks, where 0= "never" and 6= "five or more times a day". From these 5 questions we constructed a summary score that was dichotomized at the 85th percentile (score 8.75), corresponding to drinking at least 1 type of sweet drink 5 or more times a day.

From a list of solid food items, we chose 4 sweet foods: 1. cakes or waffles or sweet cookies, 2. desserts or ice cream, 3. chocolate, and 4. other sweets, jelly beans, or confectionary. Response categories, ranged from 0= "never" to 6= "3 or more times a day". From these 4 items we constructed a summary score that was dichotomized at the 85th percentile (score 6.67), corresponding to eating at least 1 type of sweet food 3 or more times a day.

Two questions queried whether the child was fed the following caloric drinks at night: milk or cordial from a cup, and milk or cordial from a bottle. The frequency of consumption was categorized as 1="never/seldom", 2="occasionally", and 3="yes, most of the nights". We dichotomized this variable by assigning 1 to indicate that the child was fed either drink at least occasionally.

Independent variables

Child temperament at 18 months was assessed by means of 25 items, 14 from the Child Behavior Checklist for ages 1.5–5 years (CBCL/1.5–5) (28), and 11 from the Emotionality, Activity, and Sociability Questionnaire (EAS) (29). When the MoBa study was initiated in 1999, items from the CBCL were selected by consensus among clinical child psychologists to represent the domains of externalizing problems, internalizing problems, and other problems. Items from the EAS were chosen from the full 20-item version based on item-scale correlations among Norwegian infants and toddlers (30). We performed factor analysis on the 25 items and deemed a 3-factor solution to best represent the original constructs. The first factor clearly tapped externalizing items from both the EAS and the CBCL, such as "the child gets upset easily" (EAS) or "the child can't sit still, is restless or hyperactive" (CBCL). The second factor clearly denoted surgency/extraversion, tapping items from the EAS

subscales of activity, sociability, and (lack of) shyness. The third factor tapped internalizing items from the CBCL, representing the subscales emotional reactivity, anxiety/depression, and sleep problems, such as “does not want to sleep alone”, or “too fearful and anxious”. We excluded 2 items from the externalizing domain of the CBCL, because they did not load on any of the 3 factors. We then constructed 3 temperament scales by averaging the items with the highest loadings on each factor (see Appendix). Alpha reliabilities for the scales were 0.67 for externalizing (8 items), 0.68 for surgency (8 items), and 0.53 for internalizing (7 items). Although the alpha for the internalizing scale is low, the mean inter-item correlation was 0.15, which is considered acceptable in the literature.

Maternal negative affectivity, conceptualized as the combination of anxiety and depression, was measured in pregnancy using a 5-item version of the Hopkins Symptom Checklist (SCL-5) administered at 17 and 30 weeks’ gestation. The SCL-5 is a short form of the SCL-25, which measures only the anxiety and depression dimensions of the full checklist (31) (e.g., “Feeling fearful,” “Feeling hopeless about the future”). Scores were averaged across the two assessments in pregnancy (Cronbach’s alpha= 0.86).

Potential Confounders

Mothers indicated their highest level of completed education at gestation week 17 using one of 6 categories covering educational levels from 9 years (secondary school) to 18+ years (university). Each unit of this variable, which was treated as a continuous variable coded from 1 to 6, corresponds to an increase of 2–3 years of education. The variable was reversed, such that higher scores indicated *shorter* education.

Information on the child’s sex and weight and length at birth was obtained from the Medical Birth Registry of Norway (27). Information on the child’s weight and length at 1 year was available through the child’s health chart. In Norway, all infants are regularly measured and weighed by specialized staff at community-based health stations and the measurements are recorded on a health chart, a copy of which is retained by the mother. Mothers were asked to use this chart when reporting in the questionnaire on the child’s height and weight at age 1 year and 18 months. We used weight- for-length at 1 year as a confounding variable, as previous weight status may influence a mother’s feeding practices. A further confounding variable was sustained breastfeeding. For this study, we controlled for breastfeeding from age 15 to 18 months.

Statistical Analysis

There were incorrect or missing values in 0–1% of the cases for gender, birth weight, and breastfeeding, 6% missing values for mother’s education, and 9–10% missing variables for the child’s weight and length at age 1 year. Running the analysis based on listwise deletion would have reduced the number of mothers from 42,000 to 33,000 and caused sample distortions. Therefore, we substituted missing values by means of maximum likelihood imputation procedures (32) using information from correlated variables in the expectation-maximization algorithm. Missing maternal education level was estimated by means of the mothers’ self-reported income and their reports on the fathers’ educational level. Missing values regarding the child’s weight and length at 1 year were estimated from the child’s weight and length at birth and at 18 months. Missing values on the maternal personality and child temperament items were estimated on the basis of valid answers on other items from the same scale. Logistic regression modeling using SPSS (33) was used to calculate the effects of mothers’ negative affectivity, the child’s temperament and the potential confounders on the dependent variables. Because of the large size of the sample, we set the significance level of P to ≤ 0.001. In order to test potential distortions through the imputation procedure, an additional analysis based on non-imputed variables was performed

(n=33,000). The odds ratios from the latter analysis differed from the former only marginally--on the second decimal.

Results

Fifty percent of the mothers fed their child at least one type of sweet food 1–2 times daily (summary score 4), and 15% fed their child at least one type of sweet food 3 or more times daily (85% cut-off score 6.67). Fifty percent of the mothers fed their child at least 1 type of sweet drink 3–4 times a day, whereas 15% fed their child at least 1 type of sweet drink 5 or more times daily (85% cut-off score 8.75). Around 10% of the mothers fed their child milk or cordial at night, and 15.5% breastfed their child at age 15–18 months (see Table 1).

For all the temperament scales, except surgency/extraversion, as well as maternal negative affectivity, the means were low, indicating skewed distributions. This is not unusual for scales tapping undesired behaviors. Maternal education was high, with 14 years of completed education on average. There were 51.1% boys and 48.9% girls in the sample, a slight preponderance of boys that is to be expected in young children. The children's weight and length at 1 year were within the middle percentile range of Cole's international growth charts (34). Insert Table 2

The logistic regression analyses showed significant multivariate associations between child temperament, maternal negative affectivity, and all three dependent variables. All the odds were adjusted for one another. Children scoring higher on internalizing temperament had increased odds of being fed sweet foods (47%), sweet drinks (76%), and caloric drinks at night (291%). Children scoring higher in externalizing temperament showed increased odds of being fed sweet foods (53%) and sweet drinks (22%). Children scoring higher in surgency/extraversion had increased odds of being fed caloric drinks at night (66%). Mothers scoring high in negative affectivity had higher odds of feeding the child caloric drinks at night (60%). Among the confounders, lower education was the only one to show consistent effects across the dependent variables: Mothers with fewer years of education had increased odds for feeding the child sweet foods and drinks.

Discussion

To the best of our knowledge, this is the first study to report on the association between infant temperament and specific aspects of diet at age 18 months, and to examine drinks at night as a potential source of excess calories (25). Maternal characteristics have been studied in past research (22, 23), but infants' psychological traits have not hitherto been examined as potential influences on mothers' food choices for their child. Consistent with our hypotheses, children who were described by their mothers as having distress-prone temperaments on one or both of the internalizing and externalizing dimensions were more likely to be fed sweet foods, sweet drinks, and caloric drinks at night. Internalizing was related to all three dietary variables. In addition, surgency/extraversion was related to feeding of drinks at night. Consistent with previous studies, maternal negative affect also predicted these potentially obesogenic dietary patterns. The associations between infant temperament and dietary patterns were independent of maternal years of education and maternal negative affectivity, infant weight-for-height and gender, and of sustained breastfeeding (which reduces the necessity to feed the infant other foods and drinks (18).

These cross-sectional findings are open to various interpretations. Mothers may be responding to their infants' anxiousness, reactivity, and difficulty sleeping by attempting to comfort and calm them with sweet foods and drinks. This interpretation is consistent with a transactional view in which, as a result of their temperaments, infants effectively manipulate

their environment by evoking a particular pattern of behavior in another individual (35). Because sweet flavors are particularly soothing, it may be that mothers are moved to provide sweet foods and drinks because they are more likely to soothe the distress-prone infant than other foods. Mothers who are higher in negative affectivity may also be more upset by their infant's distress and hence even more likely to use sweet foods and drinks. We examined this possibility by including the interaction between mothers' negative affectivity and each of the infant's temperament dimensions in the regression analyses. None of these interactions were significant, indicating that mothers' and infants' temperaments have independent effects.

Although the preference for sweet flavors is innate (12), infants with more distress-prone temperaments may have an even stronger preference and their mothers may learn that these flavors are more readily accepted. Genes influence appetite regulation from as early as the first three months, and infants who are more avid suckers in the first three months are at greater risk for adiposity over the next three years (36). Infants who are more avid suckers are more inhibited (show more internalizing behavior) at 18 months (37), suggesting that appetite regulation and internalizing traits may have a common genetic basis in sensory sensitivity and responsivity, which may be implicated in obesogenic feeding styles. It is also likely that there is a reciprocal relation between the behavior of the infant and the mother. The more the mother feeds sweet foods and drinks, the more the infant is likely to prefer these foods. An alternative explanation is that that feeding sweet foods and drinks leads to increases in distress-prone temperament, as infants' distress is reinforced by sweet foods. The finding for surgency/extraversion was not predicted so requires replication. It could indicate that active children use more calories and therefore are more often hungry at night, and their mothers may perceive them as not weighing enough. Regardless of the underlying mechanisms, the independent effects of child temperament observed here indicate that potentially obesogenic early dietary patterns are associated with infant distress-prone and surgent temperament.

Limitations of this study include the cross-sectional design that precluded any definitive causal directions of effects to be inferred. Because temperament has a heritable component (3), mothers and infants are likely to share a genetic predisposition for negative affectivity, but this could not be examined here. All the data in this study were derived from one source: mothers' reports. Although mothers provided detailed food-frequency information on their dietary choices for their infants, we do not know what proportion of these offerings their infants actually consumed. More comprehensive, classical measures of maternal and child temperament would also have been desirable, but were not feasible in the frame of this multi-disciplinary study. The internalizing scale did not include the full bandwidth of the corresponding CBCL scale, and its internal reliability (coefficient alpha) was low. However findings were consistent across all the three outcomes for this measure. It was not possible to separate the effects of night-time sweet drinks from milk. While both provide extra energy, sweet drinks are devoid of protein and have specifically been associated with obesity in childhood. The items measuring sweet drinks did not specify day-time only, therefore there may have been overlap between this variable and night-time caloric drinks.

In conclusion, this study demonstrated concurrent associations between infant distress-prone temperament, particularly internalizing, and mothers' feeding of sweet foods and drinks to their 18-month old infants. One of several interpretations of these findings is that infant temperament may evoke specific feeding patterns in mothers, suggesting that health professionals should educate mothers to avoid using sweet foods and drinks to regulate their child's behavior. It is also important for parents to learn that infants do wake 2–3 times a night, and can be encouraged to use their own regulatory skills to soothe themselves (38). The long-term effects of establishing an early dietary pattern high in sweet foods and drinks

on later childhood overweight and obesity, after the adiposity rebound, have yet to be established. The stability of these dietary patterns, the influence of temperament assessed earlier in time on these patterns, and the relation of dietary patterns in infancy on subsequent overweight and obesity should all be examined in future prospective studies.

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Table 1

Characteristics (means ± standard deviations or percentages) of the mothers and children in the study.

Dependent variables	
Sweet foods (score value at 50th and 85th percentile)*	4; 6.67
Sweet drinks (score value at 50th and 85th percentile)†	5; 8.75
Caloric drinks at night (%)	10.4
Predictors	
Internalizing 18 months (range 0–2)	0.25±0.24
Externalizing 18 months (range 0–2)	0.64±0.30
Surgency 18 months (range 0–2)	1.49±0.23
Fussiness 6 months (range 0–6)	1.34±0.77
Mothers' negative affectivity in pregnancy (range 0–3)	0.21±0.30
Confounding variables	24.18±4.30
Completed education in years (9–18years)‡	2.46±1.20
Child sex (% boys)	51.1
Child weight 1 year (kg)	9.92±1.06
Child length 1 year (cm)	76.38±2.59
Child weight for length 1 year (kg/cm)	0.13±0.01
Breastfeeding at 18 months (%)	15.5

(N = 40,266).

*The score 4 corresponds to feeding at least 1 type of sweet food 1–2 times a day; the score 6.67 corresponds to feeding at least 1 type of sweet food 3 or more times a day.

†The score 5 corresponds to feeding at least 1 sweet drink 3–4 times a day; the score 8.75 corresponds to feeding at least 1 type of sweet drink 5 or more times a day.

‡Reverse coded (6–1), the score 2.46 corresponds to ca. 14 years of education.

Table 2

Associations of child temperament, maternal negative affectivity and confounding variables with obesogenic feeding practices at child age 18 months (adjusted odds ratios).

Predictors	**Sweet foods**		**Sweet drinks**		**Caloric drinks at night**	
Child characteristics	***OR***	***95% CI***	***OR***	***95% CI***	***OR***	***95% CI***
Internalizing	1,47*	1.32–1,65	1.76*	1.56–1.98	2.91*	2.54–3.33
Externalizing	1,53*	1.40–1.67	1.22*	1.11–1.34	1.13	1.01–1.26
Surgency	1,01	0.90–1.14	1.08	0.95–1.23	1.66*	1.42–1.92
Maternal characteristics						
Negative affectivity	1.03	0.95–1.12	1.14	1.04–1.24	1.62*	1.48–1.78
Confounding variables						
Completed education in years (9 to 16 years)†	1.10*	1.08–1.12	1.27*	1.24–1.30	1.25*	1.22–1.28
Child sex (reference boys)	1.10*	1.04–1.15	0.99	0.93–1.05	0.94	0.87–1.00
Child weight for length 1 yr (kg/cm)	0.31	0.03–3.24	0.74	0.06–9.42	0.30	0.02–5.86
Breastfeeding 15–18 mo	1.14*	1.06–1.22	0.91	0.84–0.99	0.37*	0.33–0.42

N=40 266.

OR, odds ratio; 95% *CI*, 95% confidence interval for odds ratio.

*P value of odds ratio ≤ 0.001

†Reverse coded, higher numbers denote lower education.

Appendix

Items of the three temperament scales at age 18 months

Externalizing	Surgency	Internalizing
EAS Gets upset easily	EAS Is very social	CBCL Does not want to sleep alone
CBCL Is defiant	EAS Likes to be together with people	CBCL Resists going to bed at night
EAS Reacts intensely when upset	EAS is always on the go	CBCL Gets too upset when separated from adults
EAS Cries easily	EAS Is off running as soon as wakes up	CBCL Disturbed by any change in routine
CBCL Can't sit still, restless or hyperactive	EAS Is friendly, trusting with strangers	CBCL Too fearful or anxious
CBCL Gets into everything	EAS Slow warming up to strangers	CBCL Clings to adults, is too dependent
CBCL Can't concentrate, pay attention for too long	EAS Prefers quiet games to more active ones	CBCL Afraid to try new things
CBCL Hits others	EAS Prefers to play with others rather than alone	

CBCL Child Behavior Checklist.

EAS Emotionality, Activity, and Sociability Questionnaire