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Associations Between Temperament at Age 1.5 Years and Obesogenic Diet at Ages 3 and 7 Years

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Abstract

Objective—To investigate whether temperament in 1.5-year-olds predicts their consumption of potentially obesogenic foods and drinks at ages 3 and 7 years.

Methods—Participants were 6 997 mothers and infants from the Norwegian Mother and Child Cohort Study. Questionnaires were collected during pregnancy, at birth, and at child ages 6 months and 1.5, 3, and 7 years. Predictor variables: children's temperament at age 1.5 (internalizing, externalizing, surgent) and mothers' negative affectivity. Outcome variables: children's consumption of sweet foods, sweet drinks, and fruits/vegetables at ages 3 and 7 (dichotomized at the 85th percentile).

Results—Controlling for covariates, internalizing 1.5-year-olds (anxious, dependent) were 77% and 63% more likely to consume sweet drinks daily at ages 3 and 7, respectively; they were 55% and 43% more likely to consume sweet foods daily at ages 3 and 7, respectively. Externalizing 1.5-year-olds (hyperactive, aggressive) were 34% more likely to consume sweet drinks daily at age 7, 39% and 44% more likely to consume sweet foods daily at ages 3 and 7, respectively, and they were 47% and 33% less likely to consume fruits/vegetables daily at ages 3 and 7, respectively. Surgent 1.5-year-olds (active, sociable) were 197% and 78% more likely to consume two portions of fruits/vegetables daily at ages 3 and 7, respectively. The association of maternal negative affectivity was limited to the child's consumption of sweet foods at 3 and 7 years.

Conclusion—Early child temperament is a risk factor for obesogenic diet in later childhood. Mechanisms explaining this association need to be explored.

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Keywords

child; temperament; obesity; diet; eating

INTRODUCTION

Obesity is the fastest growing health problem in children and adolescents, reaching epidemic proportions across most developed countries.[1] In Norway, 13%–18% of 4-to 15-year-olds are overweight or obese.[2] There is growing evidence that consuming sweet foods and drinks at the expense of foods rich in dietary fiber is associated with body fat accumulation.[3–7] These "obesogenic" food consumption patterns in children are in turn associated with low parental education and socioeconomic status.[8]

Recent studies have suggested that temperamental characteristics of mothers and children are associated with obesogenic diets in children. Temperament refers to biologically based, relatively stable patterns of emotional behavior and regulation that can be observed from birth.[9] In adults the temperament dimensions of negative emotionality/affectivity, positive emotionality, and control have been distinguished.[10] Corresponding broad dimensions of infant and child temperament include internalized negative emotionality (e.g., being sad, fearful, anxious), positive emotionality or surgency (e.g., being social, active), and externalized negative emotionality (e.g., having low self-control, being defiant, aggressive).[9] Several recent studies on temperament and feeding found that both maternal and infant negative emotionality traits are associated with mothers' obesogenic feeding practices. For example, mothers high in negative emotionality wean their child earlier from breast milk, introduce solid foods prematurely, and feed the infant high-sugar and low-fiber foods and drinks.[11–14] In a similar vein, the infants' own temperament trait of negative emotionality (both internalizing and externalizing) is associated with these feeding practices.[11,12,15,16] It has recently emerged that in kindergarteners and primary schoolchildren, a third temperament trait, surgency or extraversion, is a correlate of eating fruits and vegetables.[17,18]

Given a lack of longitudinal studies, it is unknown whether the associations of maternal and child temperament with diet observed in infants are transient or persist over time. On the one hand, as children grow, they gain increasing control over their environment and the foods that they consume, which potentially strengthens the influence of their own preferences. On the other hand, as they get older, children are exposed to new environments like kindergarten and school offering different kinds of foods and drinks, which may weaken the associations between their early temperament and later eating. Hence, it is not sure that associations of early child and maternal temperament with the child's diet observed in infancy survive into childhood.

This study extends a previous cross-sectional study, in which we found associations of negative emotionality traits in 1.5-year-olds and their mothers' negative affectivity with the infants' greater intake of sweet foods and drinks.[11] Here, we examine the associations of these temperament traits and the infant trait of surgency with the children's intake of obesogenic foods (sweet drinks, sweet foods, and fruits and vegetables) 1.5 years and 5 years later. We expected to find similar, albeit weaker associations of the infants' negative emotionality traits and their mothers' negative affectivity with their later consumption of sweet foods and sweet drinks. We also examine associations of these temperament traits with the intake of fruits and vegetables. Given the associations between surgency and eating fruit and vegetables found in kindergarteners and schoolchildren, we expect that 1.5-year-olds low in surgency will consume fewer fruits and vegetables.

METHODS

Study design and participants

The Norwegian Mother and Child Cohort Study, conducted by the Norwegian Institute of Public Health, is an ongoing longitudinal investigation of health determinants in mothers and children, including more than 108000 pregnancies. Participants were recruited from all over Norway from 1999 to 2008 at routine ultrasound scans in week 17 to 18 of gestation. The participation rate was 38.5%.[19] Follow-up is conducted by questionnaires at regular intervals. This study was approved by the Regional Committee for Medical Research Ethics in South-Eastern Norway. The present analyses base on the quality-controlled Norwegian Mother and Child Cohort Study data files released for research in August 2011 (version 6). We included the questionnaires at gestation weeks 17 and 30, and at child age 6 months and 1.5, 3, and 7 years. Participation rates in women who gave *informed consent* were 95% at 17 weeks, 92% at 30 weeks, 87% at 6 months, 79% at 1.5 years, 62.5% at 3 years, and 61.0 % at 7 years. Information on the child's sex and birth weight and on maternal parity and age was retrieved from the Norwegian Medical Birth Registry.[20] The dataset included mothers of singletons (n = 9 384) that had received and returned the questionnaires at gestation weeks 17 and 30 and at child age 6 months, 1.5, 3, and 7 years. Among these, 6 997 participants had complete or substitutable information on maternal temperament, education, age, parity, body mass index (BMI), and breastfeeding at child age 6 months, as well as information on the child's temperament, sex, birth weight, and weight and height at 1.5 and 3 years.

Dependent variables

Mothers reported how often their children consumed sweet foods and drinks as well as fruits and vegetables at ages 1.5, 3, and 7 years. Across the three time points, *sweet drinks* were assessed with the following items: fruit juice; fruit nectar (not at age 1.5 years); soft drinks; artificially sweetened soft drinks; syrup mixed with water; artificially sweetened syrup mixed with water. *Sweet foods* were assessed with the following items: cakes, waffles, and cookies; biscuits, deserts, ice cream; water ice (ice made of lemonade [assessed at 3 years only]); chocolate; other sweets, jelly beans, candies. *Fruits and vegetables* were assessed as follows at 1.5 and 3 years: fruits; raw vegetables and salads; cooked vegetables. At 7 years, the items were: carrots; cabbage, cauliflower, broccoli; salads; other vegetables; oranges, tangerines; apples, pears, grapes; bananas; other fresh fruits or berries.

In accordance with changing patterns of consumption response categories varied across ages. At child age 1.5, response categories for drinks varied between 1 (never) and 7 (5 or more times a day), and response categories for foods varied between 1 (never) and 6 (3 or more times a day). * At age 3, response categories for drinks and discretionary solid foods, including fruits, ranged from 1 (rarely, less than once a week) to 7 (4 or more times a day). Response categories for solid foods that form part of a meal, including *salad and vegetables*, however, ranged from 1 (once a month or less frequently) to 7 (5 or more times a week).† To make responses commensurate across fruits and vegetables, we transformed them into 3 categories, ranging from 1 (rarely/less than once a week) to 3 (3 or more times daily). ‡ At

*Drinks: 1 (never), 2 (less than once a week), 3 (1–3 times a week), 4 (4–6 times a week), 5 (1–2 times a day), 6 (3–4 times a day), and 7 (5 or more times a day). Foods: 1 (never), 2 (less than once a week), 3 (1–3 times a week), 4 (4–6 times a week), 5 (1–2 times a day), 6 (3–4 times a day).

†Fruits: 1 (rarely. less than once a week), 2 (1–3 times a week), 3 (4–6 times a week), 4 (once a day), 5 (2 times a day), 6 (3 times a day), and 7 (4 or more times a day). Vegetables: 1 (once a month or less frequently), 2 (2–3 times a month), 3 (once a week), 4 (2 times a week), 5 (3 times a week), 6 (4 times a week), and 7 (5 or more times a week).

‡The recoding scheme for fruits was: 1 = 1, 2, 3 = 2, 4–7 = 3. The recoding scheme for vegetables was: 1, 2 was coded 1; 3–6 was coded 2; 7 was coded 3.

age 7, response categories ranged from 1 (never/rarely) to 6 (1 or more times daily).[§] At each assessment, we calculated separate sum scores for the three food groups. To capture clinically relevant dietary habits, the scores were dichotomized at the 85th percentile. For all three foods and drinks groups, the sum scores at the 85th percentile represented daily consumption. The longitudinal correlations among the non-dichotomized scales were highly significantly different from zero and ranged from $r = 0.39$ to $r = 0.45$ for sweet drinks, from $r = 0.26$ to $r = 0.43$ for sweet foods, and from $r = 0.37$ to $r = 0.51$ for fruits and vegetables, indicating moderate stability of consumption habits over time—in spite of differences in items assessed and great variation in the response categories.

Independent variables

When the Norwegian Mother and Child Cohort Study was initiated, 17 items from the Child Behavior Checklist (CBCL/1.5–5)[21] were selected by consensus among clinical child psychologists to assess the domains of externalizing and internalizing problems at child age 1.5 years. In addition, a validated 11-item version of the Emotionality, Activity, and Sociability Questionnaire was included in the questionnaire.[22] After excluding items related to eating problems, 25 items describing child emotions and behavior were available. In view of the high associations between temperament scales and behavior scales in children, we pooled these items and factor-analyzed them. The resulting factors represented infant *internalizing temperament* (e.g., sad, fearful, anxious), infant *externalizing temperament* (e.g., defiant, aggressive, impulsive), and infant *surgent temperament* (e.g., sociable, active) (for details see[11]). Alpha reliabilities were 0.51 for internalizing temperament (7 items), 0.66 for externalizing temperament (8 items), and 0.67 for surgent temperament (8 items). The alpha for the internalizing temperament scale was low, but the mean inter-item correlation was 0.15, which is considered acceptable in the literature.[23] To assess the stable aspects of maternal negative affectivity, we averaged scores on the 5-item version of the Hopkins Symptom Checklist (SCL-5) across four assessments: at gestation weeks 17 and 30, and at 6 and 18 months postpartum. The SCL-5 is a short form of the SCL-25, measuring the anxiety and depression dimensions of the full checklist.[24] Bivariate correlations of the SCL-5 across assessments were in the range 0.44 to 0.56, and Cronbach's α for the averaged scale was 0.89.

Covariates

Covariates were maternal age, parity, educational attainment, maternal BMI at child age 1.5 years, breastfeeding at child age 6 months (recorded on a scale ranging from 1 (never) to 6 (daily), the child's sex, birth weight, and the child's BMI at ages 1.5 and 3 years. Educational attainment was assessed at gestation week 17 by means of 6 categories, ranging from 9 to 17 or more years of completed education. The child's sex and birth weight were registered in the Medical Birth Registry of Norway.[20] The child's height and weight at age 1.5 and 3 years was copied by the mother from the child's health chart to the questionnaire. These charts are issued by community health stations, where all Norwegian preschoolers are examined regularly. We adjusted for the child's BMI at age 1.5 years in the age 3 analyses and for the child's BMI at age 3 in the age7 analyses, because mothers may restrict a child's diet in response to his or her overweight.

Statistical analysis

All analyses were conducted using SPSS version 17.[25] Incorrect or missing values for the independent and control variables were substituted by means of a maximum likelihood imputation algorithm, using information from all correlated variables across the

[§]1 (never, rarely), 2 (1–3 times a month), 3 (1–2 times a week), 4 (3–4 times a week), 5 (5–6 times a week), 6 (once a day or more).

questionnaires.[26] Missing diet variables were not substituted. Two logistic regression models were calculated. In Model 1, we examined the adjusted effects of the independent variables (maternal and child temperament) and covariates on the child's diet at ages 3 and 7 years. In Model 2, we also adjusted for the consumption of the corresponding foods or drinks at the previous assessment. Thus, we could examine the *net additional* effect of temperament on the child's diet at the following point in time.

RESULTS

Study participants were similar to the cohort that had not reached 7 years in 2011—both at birth and at age 1.5 years (Table 1). Participating children resembled the cohort with respect to two of three temperament traits but were slightly more externalizing at 1.5 years. They were similar with respect to the sex distribution and weight at 1.5 years, but they weighed 50 grams less at birth on average. Their mothers had lower negative affectivity (0.01 points), were 0.12 years older when giving birth, had a marginally shorter education (0.34 years), and were similar to the cohort with respect to their BMI and how long they breastfed the child. The main difference was that participating mothers were less often primiparous when they gave birth to the child. Taken together, the effect sizes for these differences, measured in Cohen's d or H-statistics, varied between 0.01 and 0.12 (parity), showing that the sample of participants that had reached age 7 was representative for the cohort of the Norwegian Mother and Child Study for all practical purposes. The children's mean weight and height at ages 1.5, 3, and 7 years were within the middle percentile range of Cole's international growth charts.[27] Insert Table 2

Sweet drinks

The adjusted odds ratios for Model 1 showed that every unit increase in internalizing temperament at 1.5 years increased the children's odds for daily consumption of sweet drinks at ages 3 and 7 years by 77% and 62%, even after controlling for the child's other temperament traits, the mother's negative affectivity, and the covariates (Table 2). Adjusting for the child's previous consumption habits (Model 2) reduced the children's odds to 31% (non-significant) and 38%, respectively. Externalizing temperament only increased the odds for drinking sweet drinks at age 7 (Model 2; 34%). Neither child surgent temperament nor maternal negative affectivity was associated with the child's consumption of sweet drinks.

Sweet foods

Internalizing temperament at 1.5 years also increased the children's odds for eating sweet foods daily, by 55% at 3 years and 43% at 7 years (Model 1). Adjusting for earlier consumption of sweet foods (Model 2) reduced these associations to non-significant levels. *Externalizing temperament* at 1.5 years augmented the children's odds for eating sweet foods daily by 39% at age 3 and 44% at age 7. Adjusting for consumption of sweet foods at the previous assessment rendered the association of externalizing with sweet foods non-significant at age 3; but at age 7, the association remained (40%). Surgent temperament was not associated with the child's consumption of sweet foods. However, every unit of maternal negative affectivity increased the child's consumption of sweet foods at ages 3 and 7 years by 30% and 26%, respectively.

Fruits and vegetables

Internalizing temperament did not change the children's odds for eating fruits and vegetables at either age 3 or age 7. However, every unit increase in externalizing temperament lowered the children's odds for eating fruits and vegetables at age 3 by 47% (1/0.68) and 33% (1/0.75) at 7 years. Surgency was the strongest predictor of eating fruits and vegetables daily. Every unit increase in surgency nearly doubled the children's odds for

eating fruits and vegetables at age 3 (197%) and augmented them by 78% at age 7. Associations were only slightly reduced when adjusting for the child's previous habits of consuming fruits and vegetables. Surprisingly, maternal negative affectivity was not associated with children eating fruits and vegetables at either age.

DISCUSSION

Our study showed appreciable associations between infant temperament and the child's potentially obesogenic diet 1.5 and 5.5 years later, after controlling for most of the well-established predictors of diet. Maternal temperament, in contrast, showed only restricted associations with the child's diet. For internalizing temperament, the associations with later consumption of sweet drinks and foods were explained by the association established in infancy. For externalizing temperament and surgency, the associations were cumulative, i.e., the effects of temperament added up over time and were not merely a consequence of the association established in infancy.

These findings are novel and remarkable, because they demonstrate that the associations between early negative emotionality and a high-sugar, low-fiber diet observed in infants between 4 and 18 months cross-sectionally[11,12,15] is not only stable but even increases across early childhood. This is in spite of the rapid development that infants undergo during their early childhood and the changing and expanding food environments that they are exposed to during this time. With respect to surgency and the intake of fruits and vegetables, similar associations have been reported from cross-sectional studies in kindergarteners, primary school children, and adults.[17,18,28,29] As child temperament traits are moderately stable and precede adult personality traits,[10] we can speculate that the relation between temperament and eating habits persists into adolescence and adulthood.

Mothers' negative affectivity was associated with the children's intake of sweets but not with the child's intake of fruit and vegetables. This is in keeping with an earlier study on 18-month-olds showing that mothers' negative affectivity was associated with an "unhealthy dietary factor" but not with a "wholesome" dietary factor.[13] Yet, this finding does not disprove the influence of maternal temperament on child diet in general. It is possible that other maternal traits, such as control or conscientiousness, would have been associated with the obesogenic diet examined here.

An array of mechanisms can explain our findings. Children can reward or punish their mothers to obtain the foods and drinks they desire and to be spared from eating the foods they do not like. Sulking, crying, and throwing temper tantrums are highly effective strategies in the battles conducted between children and their parents about food. These strategies may be preferably deployed by children with higher internalizing and externalizing temperaments in distressing situations.[30] Consistent with this explanation, a recent study showed that mothers of young children used sweet foods to calm their child in stressful situations; they were more likely to do so when the child was high in negative emotionality.[31] This may ultimately lead to early learned preferences for sweet taste, which paves the way for lifelong preferences.[32] Children high in externalizing traits may not be sufficiently encouraged to eat fruits and vegetables, which are often rejected by young children because of their sour and bitter tastes.[33] Consistent with this explanation, children high in externalizing temperament tend to show vehement negative reactions such as temper tantrums when coaxed to eat new foods in general.[17,34] Children high in surgent temperament (i.e., extraverted) have high approach motivation,[9] whereby they may learn more quickly to accept and enjoy fruits and vegetables.[35] In line with this, a recent study showed that surgent children exhibit greater enjoyment of eating compared to non-surgent children.[34]

There are also plausible psychobiological explanations. For instance, individual differences with respect to sensitivity to rewards have been postulated.[36] Children with internalizing and externalizing temperaments may be more sensitive to rewards and therefore have stronger constitutional preferences for sweet foods. The finding that adults' high impulsiveness and neuroticism—traits emanating from childhood externalizing and internalizing emotionality —are associated with sweet taste preference is consistent with this suggestion.[29,37]

Alternatively, the link between temperament and sweet taste preference may reflect shared genes, as genes influence temperament, self-regulation, eating behavior, and preference for sweets.[38,39] Moreover, temperament may be genetically linked to hormones regulating appetite and satiety. For example, leptin levels appear to be associated with depression, which in turn may emanate from child internalizing temperament.[40] Still other mechanisms may mediate the association between surgent temperament and consumption of fruits and vegetables.

This study has limitations. All information except for child's sex and birth weight was obtained from the mother, which introduces shared method bias. The food frequency questionnaires were short and used different food categories and changed the response categories at the different ages. This weakens the observable stability of consumption of specific food groups. Complete and comprehensive measures of maternal and child temperament were lacking. This limited the range of dimensions that we were able to examine. Temperament measures in children typically assess six to 10 traits,[41] and in adults, five dimensions are the norm today.[42] In the children, for instance, a measure distinguishing between aggression and self-control would have been preferable; in the mothers, we missed a measure of conscientiousness, which is associated with prudent health behaviors and competent parenting.[43,44] Complete temperament measures instead of short scales would have enhanced the scales' reliability and made it easier to find associations with the diet variables. Taken together, these limitations suggest that our findings rather underestimate than overestimate the range and magnitude of the associations between maternal and early child temperament and the child's later eating.

The positive prospective association that we found in spite of these limitations is all the more interesting and may be used to derive some avenues for intervention and future research. Health authorities and health professionals could educate parents to avoid using sweet foods and drinks to regulate children's behavior, as this may familiarize children with using food as a means of emotion regulation. Moreover, parental awareness concerning the patience and persistence needed to habituate introverted (low surgency), and reluctant/acting out children to eating fruits and vegetables should be raised.

CONCLUSION

Early temperament appears to be an important and lasting risk (or protective) factor in child obesogenic diet. Future studies could investigate associations of child and maternal temperament with diet in different populations, using more complete instruments and following the participants over longer periods of time. Moreover, there is a need for research on the mechanisms mediating the association between temperament and diet in children.

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Table 1

Characteristics of the 7-Year-Olds and their Mothers (n = 6997) Included in the Analysis, Compared with the Cohort (n = 32 745)

	7-Year-Olds (N = 6997)		**Cohort N = 32 745**		**ANOVA Chi²**
Child and Maternal Characteristics	Birth	1.5 Years	Birth	1.5 Years	F/χ^2
Temperament variables					
Internalizing (0–2)		0.25±0.23		0.25±0.22	1.72
Externalizing (0–2)		0.65±0.29		0.63±0.28	17.78***
Surgent (0–2)		1.49±0.22		1.48±0.21	0.10
Maternal negative affectivity (0–3)		0.22±0.27		0.23±0.29	6.25**
Covariates Mother					
Age (M±SD)	30.24±4.33		30.38±4.40		6.07**
Primiparous (%)	40.5%		47.3%		107.67***
Education in years (9–18 years) (M±SD)	14.51±2.44		14.85±2.46		108.88***
Body mass index (BMI)		24.71±4.28		24.82±4.39	3.38
Breastfeeding 6 months (1–6)	[3.48±1.11]		[3.46±1.14]		3.01
Covariates Child					
Sex (% boys)	51.0%		51.1%		0.44
BMI 1.5 Years (M±SD)	-	16.68±1.25		16.71±1.24	3.37
[BMI 3 Years] (M±SD)		[16.09±1.37]			
[BMI 7 Years] (M±SD)		[15.91±1.95]			
Birth weight, kg (M±SD)	3.62±0.58		3.67±0.57		9.64**

* $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$

Table 2

Associations of Child Temperament (at 1.5 Years) and Maternal Negative Affectivity (NA) with Child Diet at 3 and 7 Years (Logistic Regression)

	Child Age 3 Years				Child Age 7 Years			
	Model 1		Model 2		Model 1		Model 2	
	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI
Temperament	*Sweet drinks*				*Sweet drinks*			
Internalizing	1.77***	1.32–2.37	1.31	0.96–1.79	1.62**	1.20–2.19	1.38*	1.00–1.91
Externalizing	1.03	0.81–1.30	0.99	0.74–1.26	1.23	0.97–1.56	1.34*	1.04–1.73
Surgency	0.99	0.74–1.34	0.84	0.61–1.15	1.14	0.83–1.56	1.12	0.80–1.57
Maternal NA	1.13	0.90–1.42	1.12	0.88–1.44	1.14	0.90–1.44	1.05	0.81–1.35
Temperament	*Sweet foods*				*Sweet foods*			
Internalizing	1.55**	1.15–2.08	1.10	0.80–1.50	1.43**	1.08–1.89	1.26	0.97–1.69
Externalizing	1.39**	1.11–1.76	1.19	0.93–1.51	1.44***	1.15–1.79	1.40**	1.11–1.77
Surgency	1.05	0.78–1.42	0.92	0.67–1.26	1.30	0.98–1.74	1.31	0.97–1.77
Maternal NA	1.25	0.99–1.56	1.30*	1.02–1.66	1.26*	1.01–1.57	1.26*	1.00–1.59
Temperament	*Fruits and vegetables*				*Fruits and vegetables*			
Internalizing	1.17	0.79–1.73	1.07	0.72–1.60	1.20	0.88–1.64	1.24	0.90–1.71
Externalizing	0.68**	0.50–0.93	0.72**	0.53–0.98	0.75*	0.59–0.96	0.75*	0.58–0.96
Surgency	1.97***	1.33–2.09	1.73**	1.15–2.56	1.78***	1.30–2.43	1.68***	1.22–2.32
Maternal NA	1.08	0.79–1.47	1.05	0.76–1.44	1.10	0.86–1.41	1.10	0.85–1.41

OR, odds ratio; 95% CI, 95% confidence interval; NA, negative affectivity.

Model 1: Temperament variables are adjusted to each other and for child sex, child BMI, maternal education level at childbirth, maternal parity, maternal age, maternal BMI, and breastfeeding at 6 months postpartum.

Model 2: Same adjustment as in Model 1 *plus* the child's previous intake of the same food/drink group.

P values of odds ratios:

* $p \leq 0.05$;

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** $p \leq 0.01$;

*** $p \leq 0.001$.