Food and nutrient intakes by temperament traits – findings in the Helsinki Birth Cohort Study

Mia-Maria Perälä[1,2*], Anna-Maija Tiainen[1,2*], Jari Lahti[3,4], Satu Männistö[1], Marius Lahti[3], Kati Heinonen[3], Niina E Kaartinen[1], Anu-Katriina Pesonen[3], Eero Kajantie[1,5,6], Katri Räikkönen[3], Johan G Eriksson[1,2,7,8,]

[1] Department of Public Health Solutions, National Institute for Health and Welfare, Helsinki, Finland

[2] Folkhälsan Research Center, Helsinki, Finland

[3] Department of Psychology and Logopedics, University of Helsinki, Helsinki, Finland.

[4] Helsinki Collegium for Advanced Studies, University of Helsinki, Helsinki, Finland.

[5] Hospital for Children and Adolescents, Helsinki University Hospital and University of Helsinki, Helsinki, Finland

[6] PEDEGO Research Unit, MRC Oulu, Oulu University Hospital and University of Oulu, Oulu, Finland

[7] Department of General Practice and Primary Health Care, University of Helsinki, Helsinki and Helsinki University Hospital, Helsinki, Finland

[8] Vasa Central Hospital, Vasa, Finland

*These authors contributed equally to this work

Correspondence: MM Perälä, Department of Public Health Solutions, National Institute for Health and Welfare, Mannerheimintie 168b, FI-00271, Helsinki, Finland, E-mail: mia.perala@thl.fi

Running title: Diet and temperament

C**onflict of interest:** The authors declare no conflict of interest

Abstract

Background/Objectives: Previous studies have shown that the temperament traits are related to risk factors for chronic diseases, which could be partly explained by lifestyle habits. However, little is known whether temperament traits associate with diet. The aim of this study was to examine the cross-sectional associations between temperament traits and the whole diet.

Subjects/Methods: We studied 1668 men and women, aged 56 to 70, from the Helsinki Birth Cohort Study. Temperament was measured using the Tridimensional Personality Questionnaire. Information on diet was collected by a validated 128-item food frequency questionnaire. The associations of temperament traits; novelty seeking (NS), harm avoidance (HA), reward dependence (RD), and persistence (P), with diet were tested by linear regression analysis.

Results: After adjustment for potential confounders, greater HA was related to poorer diet quality, including lower consumption of vegetables, fruits, fish and several vitamins. RD was associated with healthier diet quality, including higher consumption of vegetables and intake of vitamin E and lower intake of alcohol. NS was significantly related to higher intake of fish, fat and alcohol and lower consumption of cereals, milk products and carbohydrates. No significant associations between P and intake of foods and nutrients were observed.

Conclusions: Our results suggest that there are association between temperament traits and diet. Especially greater HA seems to associate with poorer diet quality and greater RD with healthier diet quality.

Introduction

Temperament refers to individual differences in behavioural tendencies that present early in life (1) and do not change substantially (2). According to the Cloninger´s psychobiological theory there are four genetically independent temperament dimensions: novelty seeking (NS), harm avoidance (HA), reward dependence (RD), and persistence (P) (3, 4). NS implies behavioural activation in response to novel stimuli, with individuals scoring high in this trait being impulsive, easily bored, and quick-tempered. HA refers to behavioural inhibition in order to avoid situations seen as threatening, with high scorers being fearful, socially inhibited, passive and pessimistic. RD refers to responding intensely to especially social reward, depending on approval from others and being empathetic. P is described as being hard-working, perfectionistic and ambitious.

In recent years, temperament traits have been associated with risk factors for cardiovascular disease, such as elevated serum triglyceride levels and systolic blood pressure (5), as well as preclinical atherosclerosis (6, 7) and markers for metabolic syndrome (8). The association between temperament and disease may in part be explained by temperament being associated with health behaviours, such as smoking (8, 9) and physical activity (10). Diet is also one potential explanatory factor, however, only two small studies have been investigated the role of temperament on food intake and observed that low NS and HA or high RD is related to healthy diet (11, 12).

Our aim was to investigate whether the temperament traits NS, HA, RD, and P were associated with the whole diet (foods and nutrients) in a cross-sectional study design. We hypothesize that there are associations between high NS and HA and eating more foods considered unhealthy and high RD and P and eating foods considered healthy, such as vegetables and fruits.

Subjects and Methods

Subjects

The subjects of the present cross-sectional study were part of the Helsinki Birth Cohort Study, originally including 4630 men and 4130 women born between 1934 and 1944 in the Helsinki University Central Hospital and described previously in more detail (13, 14). To obtain a sample size of 2000 or more, 2902 subjects were invited to a clinical study using random-number tables. . A total of 2003 cohort members (928 men and 1075 women) participated in an examination conducted between 2001 and 2004.

At clinical examination, the level of educational attainment was asked using questionnaire, and height and weight were measured. Body mass index (BMI) was calculated by dividing the weight (kg) by the square of height (m). Educational attainment as reported by the subject was used to indicate socioeconomic status and the subjects were divided as follows: completed <12y of education and completed ≥12y of education.

The study was approved by the Ethics Committee of the Hospital District of Helsinki and Uusimaa. Written informed consent was obtained from all subjects.

Dietary assessment

At the clinical examination, diet was assessed by using a validated, semi-quantitative 128-item food frequency questionnaire (FFQ) (16, 17). The FFQ was designed to measure the usual diet over the previous 12 months. There were 9 frequency categories ranging from never or seldom to ≥ 6 times/day. The subjects completed the FFQ during the day they attended the clinical examinations and it was checked by a study nurse. Exclusions were made because of incompletely filled FFQ or daily energy intake cut-off points corresponding to 0.5% at both ends of the daily energy intake distributions for men and women (n = 22) (15). The average daily intakes of foods and nutrients

were calculated using the National Food Consumption Database FINELI® (National Institute for Health and Welfare, Helsinki, Finland).

Temperament assessment

Temperament traits were assessed by using the Tridimensional Personality Questionnaire (TPQ) (18), a self-report questionnaire consisting of 100 true/false statements. The questionnaire was mailed to the subjects between 2004 and 2005, on average two years after the clinical examination, to those participants who were still traceable (n = 1975). Of these 1703 subjects returned the questionnaire. The TPQ measures temperament according to Cloninger´s psychobiological model of temperament, which originally defined three traits, NS, HA, and RD (3). Later a fourth trait, P, was added by means of separating it from RD (4), and therefore we preferred to use these four traits in this study. The temperament scales were standardized by sex and differences in temperament scores are expressed as standard deviations (SD). The internal consistency of the temperament scales was measured by Cronbach´s alpha and the values were as follows: 0.79 for NS, 0.89 for HA, 0.70 for RD and 0.46 for P.

Statistical analysis

In all, 1668 subjects (736 men, 932 women) had completed questionnaires regarding both temperament and diet. The associations of temperament traits and food and nutrient intake were tested by multiple linear regression analysis with temperament traits as independent variables and foods and nutrients as dependent variables and adjusted for sex, age, educational attainment, and total energy intake. When analysing nutrients, we additionally adjusted for total energy intake by applying the residual method (19). We calculated the individual results in food and nutrient intakes as continuous variables (g/d, mg/d, or μg/d) for 1 SD increase in each temperament score. In order

to attain normality, HA was square root transformed. Statistical tests were considered significant if $P < 0.05$. The statistical analyses were performed using IBM SPSS Statistics (version 23).

Results

The present analyses included 1668 participants, with a mean age of 61.6 years (ranging from 57 to 70 y) and 44% were men (**Table 1**). The associations between temperament traits and food and nutrient intakes are shown in **Table 2** and **Table 3**, respectively. After adjusting for sex, age, educational attainment, and total energy intake, HA was associated with higher consumption of cereals (4.7 g/d; 95% confidence interval (CI): 2.0, 7.4 for every 1 SD increase in the temperament score) and lower consumption of vegetables (-13.2 g/d; 95% CI: -22.2, -4.2), fruits (-15.5 g/d; 95% CI: -31.1, -0.1), and fish (-2.7 g/d; 95% CI: -5.0, -0.4) (**Table 2**). RD was positively associated with consumption of vegetables (10.5 g/d; 95% CI: 1.6, 19.4). Each SD increase in NS score was associated with higher consumption of fish (2.4g/d; 95% CI 0.1, 4.7) and lower consumption of cereals (-3.0 g/d; 95% CI: -5.7, -0.4) and milk products (-15.1 g/d; 95% CI: -30.1, -0.2). No statistically significant associations between P and food consumption were observed.

Concerning nutrients and after adjusting for sex, age, educational attainment, and total energy intake, HA was significantly associated with a lower intake of vitamins A, C, D and E (**Table 3**). NS was related to lower intake of carbohydrate and higher intake of total fat, alcohol, monounsaturated fatty acids, and vitamin D. RD was positively related to intake of vitamin E and inversely with alcohol intake. P was not significantly associated with nutrient intakes.

Discussion

We observed in this cross-sectional study that greater HA; the tendency to be pessimistic and fearful was associated with poorer diet quality, including lower consumption of vegetables, fruits,

fish and several vitamins. In contrast to HA, greater RD; the trait characterized as being warm and sociable, was related to healthier diet quality, including higher consumption of vegetables and lower intake of alcohol. NS, characterized by curiosity towards novelty, was associated with higher consumption of fish and intake of fat and alcohol and lower consumption of cereals, milk products and carbohydrates.

Because this study is to our knowledge the first one to explore the associations of temperament and foods and nutrients intake measuring the whole diet, the results are not fully comparable with the previous findings. However, our findings regarding HA being associated with poorer diet quality and RD being associated with healthier diet quality supports our original hypothesis and is also in line with previous findings (11, 12). A cross-sectional population-based study with 629 US subjects used a 90-item FFQ and identified three dietary patterns: healthy dietary pattern (including e.g. fruits and fresh vegetables, high fibre cereals, and baked fish), unhealthy dietary pattern (including e.g. processed meats, and foods high in fat or sugar), and frequent snacking/alcohol pattern (including e.g. typical snack foods and alcohol) (12). In that study, HA was related to the unhealthy dietary pattern, RD was related to the healthy dietary pattern, and NS was related to frequent snacking/alcohol pattern. Another cross-sectional study including 206 Spanish subjects, who explored the associations between temperament and the adherence to the Mediterranean diet (11) found that NS was negatively related to Mediterranean diet. Previous studies have also observed that temperament traits associate with the risk factors for cardiovascular disease. High NS (6-8, 10) and HA (8, 10) are positively and RD (7, 8, 10) inversely associated with several risk factors for cardiovascular disease, although in contrast findings also exist (6). Therefore, we suggest that temperament traits may influence dietary habits and thus explain at least partly previously observed associations between temperament traits and chronic disease risk factors. However, it should be noted that all studies, including our study, investigating relationships between temperament traits

and diet have been cross-sectional studies. Therefore, it is not possible to show causal pathway that temperament traits affect dietary habits and thus cause chronic diseases.

Cloninger´s temperament traits have been found to correlate with the personality traits assessed by the Five Factor Model (FFM) (20): HA has been found to correlate positively with neuroticism, RD and NS with extraversion and openness, and P with conscientiousness (21). Therefore it would be logical to expect similarity in the results in respect of these correlating traits. Previous studies have shown that neuroticism is related to poorer diet quality whereas extraversion and openness are related to health aware dietary patterns (22-24). Therefore, our finding that HA is associated with poorer diet quality and RD with healthier diet quality is also in line with these findings with personality traits and diet quality.

The strengths of the current study include a large study sample. Although health conscious subjects may always be more likely to participate in such studies, assessments of diet and temperament were only a part of an extensive health study making participation bias specific to these factors unlikely. The TPQ has been validated and is widely used. In future research adding character assessment to the temperament scales could bring more insight to the issue. The fact that RD was divided into two traits, RD and P, might have affected the results. Even though the Cronbach alpha for P was low, the alphas for the four temperament scales were similar to those found in another Finnish birth cohort (25). Also the FFQ has been validated (16, 17).

There are also limitations to this study. Firstly, the subjects completed the FFQ on average two years earlier than the TPQ. However, temperamental traits have high stability over time (2) and any inaccuracy would only be expected to increase random error and result in more conservative estimates of associations between temperament and diet. Also diets tend to remain relatively stable

from year to year (26, 27). Secondly, because of the cross-sectional nature of this study, we cannot make any causal inferences between temperament traits and food intake. Therefore, future longitudinal studies are especially needed to clarify the causal pathway between temperament traits and food intake. Thirdly, there is a possibility for measurement error as the subjects self-reported their food and nutrient intakes. Usually, FFQ overestimate nutrient intake and food consumption, especially subjects may overestimate intakes of foods considered healthy (17).

In conclusion, we observed that greater HA was related to unhealthier diet quality whereas greater RD was related to healthier diet quality. We also showed that greater NS associates with high intake of fat and alcohol. Therefore, food and nutrient intake may provide an additional explanation to why temperament is associated with risk factors of chronic diseases. However, the results should be treated with caution due to limited number of studies on this topic and a cross-sectional study design. Therefore, further studies in subjects from different age groups and cultural backgrounds and longitudinal study design are needed.

Acknowledgements

This study was funded by The Signe o. Ane Gyllenberg Foundation, The Juho Vainio Foundation, The Yrjö Jahnsson Foundation, The Academy of Finland, The Päivikki and Sakari Sohlberg Foundation, The Finnish Diabetes Research Foundation, The Finnish Foundation for Cardiovascular Research, Samfundet Folkhälsan, Liv och Hälsa and Finska Läkaresällskapet. None of the funders had any role in the design, analysis or writing of this article.

Conflict of interest

The authors declare no conflict of interest.

References

1. Thomas A, Chess S. Temperament and personality. In: Kohnstamm GA, Bates JE, MK. R, editors. Temperament in Childhood: Wiley1989. p. 249-69.
2. Caspi A, Harrington H, Milne B, Amell JW, Theodore RF, Moffitt TE. Children's behavioral styles at age 3 are linked to their adult personality traits at age 26. J Pers 2003; 71: 495-513.
3. Cloninger CR. A systematic method for clinical description and classification of personality variants. A proposal. Arch Gen Psychiatry 1987; 44: 573-88.
4. Cloninger CR, Svrakic DM, Przybeck TR. A psychobiological model of temperament and character. Arch Gen Psychiatry 1993; 50: 975-90.
5. Keltikangas-Järvinen L, Ravaja N, Viikari J. Identifying Cloninger's temperament profiles as related to the early development of the metabolic cardiovascular syndrome in young men. Arterioscler Thromb Vasc Biol 1999; 19: 1998-2006.
6. Hintsanen M, Pulkki-Råback L, Juonala M, Viikari JS, Raitakari OT, Keltikangas-Järvinen L. Cloninger's temperament traits and preclinical atherosclerosis: the Cardiovascular Risk in Young Finns Study. J Psychosom Res 2009; 67: 77-84.
7. Rosenström T, Jokela M, Cloninger CR, Hintsanen M, Juonala M, Raitakari O et al. Associations between dimensional personality measures and preclinical atherosclerosis: the cardiovascular risk in Young Finns study. J Psychosom Res 2012; 72: 336-43.
8. Sovio U, King V, Miettunen J, Ek E, Laitinen J, Joukamaa M et al. Cloninger's Temperament dimensions, socio-economic and lifestyle factors and metabolic syndrome markers at age 31 years in the Northern Finland Birth Cohort 1966. J Health Psychol 2007; 12: 371-82.

9. Etter JF, Pélissolo A, Pomerleau C, De Saint-Hilaire Z. Associations between smoking and heritable temperament traits. Nicotine Tob Res 2003; 5: 401-9.

10. Puttonen S, Elovainio M, Kivimäki M, Koskinen T, Pulkki-Råback L, Viikari JS et al. Temperament, health-related behaviors, and autonomic cardiac regulation: the cardiovascular risk in young Finns study. Biol Psychol 2008; 78: 204-10.

11. Jurado D, Burgos-Garrido E, Diaz FJ, Martinez-Ortega JM, Gurpegui M. Adherence to the Mediterranean dietary pattern and personality in patients attending a primary health center. J Acad Nutr Diet 2012; 112: 887-91.

12. van den Bree MB, Przybeck TR, Cloninger CR. Diet and personality: associations in a population-based sample. Appetite 2006; 46: 177-88.

13. Barker DJ, Osmond C, Forsén TJ, Kajantie E, Eriksson JG. Trajectories of growth among children who have coronary events as adults. N Engl J Med 2005; 353: 1802-9.

14. Ylihärsilä H, Kajantie E, Osmond C, Forsén T, Barker DJ, Eriksson JG. Body mass index during childhood and adult body composition in men and women aged 56-70 y. Am J Clin Nutr 2008; 87: 1769-75.

15. Meltzer HM, Brantsaeter AL, Ydersbond TA, Alexander J, Haugen M. Methodological challenges when monitoring the diet of pregnant women in a large study: experiences from the Norwegian Mother and Child Cohort Study (MoBa). Matern Child Nutr 2008; 4: 14-27.

16. Männistö S, Virtanen M, Mikkonen T, Pietinen P. Reproducibility and validity of a food frequency questionnaire in a case-control study on breast cancer. J Clin Epidemiol 1996; 49: 401-9.

17. Paalanen L, Männistö S, Virtanen MJ, Knekt P, Räsänen L, Montonen J et al. Validity of a food frequency questionnaire varied by age and body mass index. J Clin Epidemiol 2006; 59: 994-1001.

18. Cloninger CR, Przybeck TR, Svrakic DM. The Tridimensional Personality Questionnaire: U.S. normative data. Psychol Rep 1991; 69: 1047-57.

19. Willett W, Stampfer MJ. Total energy intake: implications for epidemiologic analyses. Am J Epidemiol 1986; 124: 17–27.

20. McCrae RR, Costa PT Jr. Personality trait structure as a human universal. Am Psychol 1997; 52: 509-16.

21. De Fruyt F, Van De Wiele L, Van Heeringen C. Cloninger's Psychobiological Model of Temperament and Character and the Five-Factor Model of Personality. Pers Individ Dif 2000; 29: 441-52.

22. Mõttus R, McNeill G, Jia X, Craig LCA, Starr JM, Deary IJ. The associations between personality, diet and body mass index in older people. Health Psychol 2013; 32: 353-60.

23. Mõttus R, Realo A, Allik J, Deary IJ, Esko T, Metspalu A. Personality traits and eating habits in a large sample of Estonians. Health Psychol 2012; 31: 806-14.

24. Tiainen AM, Männistö S, Lahti M, Blomstedt PA, Lahti J, Perälä MM et al. Personality and dietary intake - findings in the Helsinki birth cohort study. PLoS One 2013; 8: e68284.

25. Miettunen J, Kantojarvi L, Ekelund J, Veijola J, Karvonen JT, Peltonen L et al. A large population cohort provides normative data for investigation of temperament. Acta Psychiatr Scand 2004; 110: 150-7.

26. McNaughton SA, Mishra GD, Stephen AM, Wadsworth ME. Dietary patterns throughout adult life are associated with body mass index, waist circumference, blood pressure, and red cell folate. J Nutr 2007; 137: 99-105.

27. Mishra GD, McNaughton SA, Bramwell GD, Wadsworth ME. Longitudinal changes in dietary patterns during adult life. Br J Nutr 2006; 96: 735-44.

Table 1. Characteristics of the study subjects.

	Men		Women	
	Mean	SD	Mean	SD
n	736		932	
Age (y)	61.6	2.8	61.6	3.1
Body mass index (kg/m^2)	27.5	4.3	27.7	5.0
High education (%) [a]	51.7		45.7	
Novelty seeking (score)	13.4	5.2	14.5	5.6
Harm avoidance (score)	10.7	6.5	13.1	6.6
Reward dependence (score)	14.4	4.5	16.4	4.2
Persistence (score)	3.6	1.8	3.7	1.8
Energy intake (MJ)	10.4	3.6	8.6	3.0
Alcohol [b] (E%)	4.4	4.9	1.9	2.6
Carbohydrate (E%)	46.3	6.7	48.6	6.7
Sucrose (E%)	8.9	3.6	9.9	3.6
Fibre (g/day)	23.6	7.5	28.5	8.7
Protein (E%)	16.7	2.5	17.4	2.5
Fat (E%)	32.7	5.4	32.2	5.2
SFA (E%)	11.7	2.5	11.7	2.5
MUFA (E%)	11.0	2.1	10.6	2.1
PUFA (E%)	5.2	1.2	5.2	1.2

Abbreviations: E%, percent of energy intake; SFA, saturated fatty acids; MUFA, mono-unsaturated fatty acids; PUFA, poly-unsaturated fatty acids.

[a] Number of years in school 12 or more. [b] Calculated as ethanol.

Table 2. Multiple linear regressions on the associations of foods and temperament traits according to Cloninger´s psychobiological model of temperament in men (*n*= 736) and women (*n*=932).

Foods (g/d)	Novelty seeking Regression coefficient (95% CI) [a]	Harm avoidance Regression coefficient (95% CI) [a]	Reward dependence Regression coefficient (95% CI) [a]	Persistence Regression coefficient (95% CI) [a]
Vegetables [b]	7.8 (-1.3, 16.8)	**-13.2 (-22.2, -4.2)**	**10.5 (1.6, 19.4)**	2.8 (-6.2, 11.8)
Fruits [c]	-0.9 (-16.5, 14.6)	**-15.5 (-31.1, -0.1)**	3.8 (-11.6, 19.3)	3.8 (-11.8, 19.4)
Cereals	**-3.0 (-5.7,-0.4)**	**4.7 (2.0, 7.4)**	0.6 (-2.0, 3.3)	0.7 (-2.2, 3.1)
Fats	-0.1 (-0.8, 0.7)	-0.2 (-0.9, 0.5)	0.3 (-0.5, 1.0)	-0.1 (-0.9, 0.6)
Milk and dairy products	**-15.1 (-30.1, -0.2)**	10.5 (-4.5, 25.5)	-7.4 (-22.3, 7.5)	-6.7 (-21.7, 8.3)
Fish and fish products	**2.4 (0.1, 4.7)**	**-2.7 (-5.0, -0.4)**	1.3 (-1.1, 3.6)	-0.3 (-2.6, 2.0)
Meat and meat products	2.7 (-1.5, 6.8)	-1.9 (-6.0, 2.3)	0.4 (-3.7, 4.5)	0.6 (-3.5, 4.8)
Red and processed meat	1.3 (-2.5, 5.0)	-1.1 (-4.8, 2.7)	0.1 (-3.6, 3.8)	0.2 (-3.6, 3.9)
Sugar and confectionery	0.2 (-1.0, 1.4)	0.1 (-1.2, 1.2)	0.3 (-0.9, 1.5)	0.2 (-1.0, 1.4)

Abbreviations: 95% CI, 95% confidence interval

[a] Regression coefficient for change in food consumption (g/d) for 1 SD increase in the temperament scale, adjusted for sex, age, educational attainment, and total energy intake, statistically significant values are bolded (P<0.05).

[b] Potatoes not included.

[c] Berries and fruit juices included.

Table 3. Multiple linear regressions on the association between nutrients and temperament traits according to Cloninger´s psychobiological model of temperament in men (*n*=736) and women (*n*=932).

	Novelty seeking Regression coefficient (95% CI) [a]	Harm avoidance Regression coefficient (95% CI) [a]	Reward dependence Regression coefficient (95% CI) [a]	Persistence Regression coefficient (95% CI) [a]
Protein (E%)	0.12 (-0.01, 0.24)	-0.12 (-0.25, 0.01)	0.06 (-0.06, 0.19)	-0.04 (-0.16, 0.08)
Carbohydrate (E%)	**-0.46 (-0.78, -0.15)**	**0.34 (0.03, 0.66)**	-0.11 (-0.42, 0.21)	-0.12 (-0.44, 0.20)
Sucrose (E%)	0.01 (-0.17, 0.18)	-0.05 (-0.23, 0.12)	0.14 (-0.04, 0.31)	0.14 (-0.04, 0.31)
Dietary fibre (g/d) [b]	-0.08 (-0.48, 0.33)	-0.10 (-0.50, 0.31)	0.37 (-0.02, 0.77)	0.09 (-0.31, 0.50)
Fat, total (E%)	**0.34 (0.08, 0.60)**	-0.22 (-0.48, 0.04)	0.05 (-0.21, 0.30)	0.16 (-0.10, 0.42)
SFA (E%)	0.11 (-0.01, 0.24)	-0.08 (-0.20, 0.04)	-0.01 (-0.13, 0.11)	0.11 (-0.01, 0.23)
MUFA (E%)	**0.11 (0.01, 0.22)**	-0.06 (-0.17, 0.04)	-0.01 (-0.11, 0.10)	0.02 (-0.09, 0.12)
PUFA (E%)	0.06 (-0.01, 0.12)	-0.04 (-0.10, 0.02)	0.03 (-0.03, 0.09)	0.01 (-0.05, 0.06)
Alcohol (E%)	**0.19 (0.01, 0.38)**	-0.12 (-0.31, 0.07)	**-0.23 (-0.41, -0.04)**	-0.13 (-0.32, 0.05)
Vitamin A (μg/d) [b]	19.71 (-20.94, 60.36)	**-42.04 (-82.68, -1.40)**	18.87 (-21.45, 59.19)	-3.59 (-44.40, 37.22)
Vitamin D (μg/d) [b]	**0.24 (0.02, 0.46)**	**-0.29 (-0.51, -0.06)**	0.03 (-0.19, 0.25)	-0.13 (-0.36, 0.09)
Vitamin E (mg/d) [b]	0.13 (-0.01, 0.28)	**-0.22 (-0.37, -0.07)**	**0.17 (0.02, 0.32)**	0.02 (-0.13, 0.17)

Vitamin C (mg/d) [b]	3.04 (-2.04, 8.11)	**-11.22 (-16.26, -6.17)**	3.70 (-1.34, 8.74)	1.53 (-3.55, 6.61)
Calcium (mg/d) [b]	-5.55 (-24.16, 13.05)	-6.84 (-25.46, 11.78)	1.59 (-16.91, 20.08)	-1.18 (-19.76, 17.40)
Sodium (mg/d) [b]	25.90 (-1.15, 52.94)	0.77 (-26.30, 27.83)	21.72 (-5.17, 48.60)	-6.24 (-33.28, 20.80)

Abbreviations: 95% CI, 95% confidence interval; E%, percent of energy intake; SFA, saturated fatty acids; MUFA, mono-unsaturated fatty acids; PUFA, poly-unsaturated fatty acids

[a] Regression coefficient for change in nutrient intake for 1 SD increase in the temperament scale, adjusted for sex, age, educational attainment, and total energy intake (energy was excluded when testing energy-yielding nutrients), statistically significant values are bolded ($P<0.05$).

[b] Nutrients adjusted for total energy using the residual method.