

## Research Article

# Association between Temperament and Nutrition Risk in Pre-School Children

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- Effortful control
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- Pre-school children

## Abstract

**Objective:** To determine whether there is an association between parent reported child temperament and nutrition risk in preschool aged children.

**Methods:** This was a cross-sectional study. Healthy children aged between 3-5 years were recruited from community-based primary care practices. Temperament was assessed using the Children's Behavior Questionnaire Very Short Form (CBQ-VSQ) which identifies three domains: Negative Affectivity, Effortful Control, and Extraversion/Surgency. Nutrition risk was assessed using the Nutrition Screening Tool for Every Pre-schooler Questionnaire (NutriSTEP™). Adjusted logistic regression was used to measure the association between individual temperament domain and nutrition risk.

**Result:** 3468 children were included (mean age 3.75 years, 48 % female) in the study. The mean (SD) of Negative Affectivity, Effortful Control, and Extraversion/Surgency, were 3.79 (0.85), 5.46 (0.72) and 4.56 (0.79) respectively. About 14% (n=472) of the children had high nutrition risk. Children who scored high in Negative Affectivity and high in Effortful Control had an odds ratio of 1.47 (95% CI: 1.30, 1.66,  $p = <0.001$ ) and 0.73 (95% CI: 0.64, 0.84,  $p = <0.001$ ) respectively for high nutrition risk.

**Conclusion:** This study found children whose temperament is characterized by Negative Affectivity (discomfort, fear, anger/frustration, sadness and poor soothability) are more likely to be associated with high nutrition risk. These concepts can alert physicians to behavior patterns in children that may predispose them to poor nutrition and guide clinical decision making through laboratory testing for nutrition status, counseling and close monitoring.

## TARGET KIDS! COLLABORATION

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## ABBREVIATIONS

CBQ: Children's Behavior Questionnaire; SD: Standard Deviation; OR: Odds Ratio

## INTRODUCTION

Nutrition in early childhood has a significant impact on lifelong health and human development [1]. Nutrition experts

recommend systematic screening before children are school-aged, to identify risk factors and the need for preventive and early intervention services [2]. Nutrition risk is defined as the presence of characteristics or risk factors that can lead to negative nutritional outcomes [3]. The Nutrition Screening Tool for Every Pre-schooler (NutriSTEP<sup>®</sup>) is a short questionnaire that can be completed by parent or caregivers of preschoolers in the community [4]. It has been validated to assess nutrition risk in preschool children and has questions in five domains: eating behavior, dietary intake, parental concerns about food and activity, screen time duration, and the use of supplements [4,5]. This questionnaire has been used to identify high nutrition risk (10-20%) in Canadian children [6,7].

Non-nutritional factors, such as individual child behavior characteristics known as temperament have been found to be associated with negative nutritional behavior and outcomes in young children [8,9]. Temperament refers to constitutionally based, individual differences in reactivity and self-regulation [10, 11]. Empirical evidence from developed countries have found infant's with fussy-intense temperament to be associated with negative feeding behaviors such as shorter duration of breastfeeding, longer duration of bottle feeding and parent-reported feeding problems [12-14]. Furthermore, difficult temperament has also been found to be associated with nutritional disorders, such as obesity and iron deficiency in children and neonates [15-20].

During the last few decades, researchers have developed scales to measure child temperament across a range of ages using parent reported and validated questionnaires [21,22]. The Children's Behavior Questionnaire-Very Short Form (CBQ-VSF) is one such tool that provides a comprehensive assessment of reactive and self-regulative temperamental behavior patterns in pre-school children [11]. It identifies three highly differentiated temperament domains/constructs: Negative Affectivity, Effortful Control and Extraversion/Surgency. In light of the evidence indicating an association between child temperament and poor nutrition, we wanted to examine which of the temperament constructs identified by the CBQ-VSF are more likely to be associated with negative nutritional attributes identified as high nutritional risk in pre-school children.

Hence, the objective of our study was to examine whether an association exists between child temperament (measured using the CBQ) and higher nutrition risk (measured using the NutriSTEP<sup>™</sup>) in pre-school children [4,11]. Establishment of such association will shed insight into the multifactorial and complex etiology of the development of nutritional disorders in young children. We also intended to gain a deeper understanding of this association by investigating the influence of potential effect moderators such as age, sex and socio-economic status [18].

## MATERIALS AND METHODS

### Participants

Healthy children aged 3-5 years were recruited from the community-based primary care research network for children in Toronto, Ontario ([www.targetkids.ca](http://www.targetkids.ca)) [23]. There are currently 10 group practices in the network, each of which has between

3 and 10 practicing physicians. Children with acute illness, birth weight less than 2500 gm, major congenital anomaly, clinically identifiable neuromotor delay and weight and height less than 2SD below the reference standard were excluded.

### Study Design

In this cross-sectional study children attending their scheduled health supervision visits to participating TARGeT Kids! Practice swere approached by research assistants to partake in the study. Parents were asked to complete a standardized survey instrument which collects health, nutritional and socio-demographic data. Parents also completed the NutriSTEP<sup>™</sup> questionnaire and the CBQ-VSF [4,11,24]. Children and parents underwent anthropometric assessments using standardized instruments. All data generated from the TARGeT Kids! Research initiative was entered into a web-based data management system (Medidata Rave<sup>®</sup>). From this electronic data capture and repository we were able to access all data collected through the TARGeT Kids! Initiative.

### Measures

The outcome for this study was nutrition risk, which was assessed using the NutriSTEP<sup>™</sup> questionnaire [4]. This questionnaire consists of 17 items and each item has 2-5 response options. Responses are summed to provide an overall score (range of scores 0-68), where a higher score indicates increased nutrition risk. It has been recommended that a cut point of >25 for NutriSTEP<sup>™</sup> should be referred to a dietitian for further assessment and treatment. Based on this cutoff, we categorized nutrition risk into two groups: high (NutriSTEP<sup>™</sup>score >25) and low (NutriSTEP<sup>™</sup>score ≤ 25) [4]. The NutriSTEP<sup>™</sup> has been validated for use in a population of multicultural Canadian preschool-aged children, and found to have good correlation with nutrition risk assessed by a registered dietitian that included nutritional history and a 3-day dietary recall [4].

The main predictor, child temperament was assessed using the CBQ-VSF. This is a 36-item parent completed questionnaire developed for children aged 3-7 years [24]. The developers of the CBQ-VSF generated items to assess 15 selected temperament traits which were then factor analyzed to identify three broad temperament domains: Negative Affectivity, Effortful Control and Extraversion/Surgency. Table 1 describes the characteristics of the temperament domains. The CBQ-VSF has been validated in three different populations (US, Chinese and Japanese). All three populations showed similar reliability (mean 0.78) and internal consistency (0.68 to 0.93). Parental agreement on CBQ scales was substantial and consistent across samples. Comparison of parents' report of the CBQ with laboratory observations of children's behavior showed moderate correlation [11].

Important covariates which we considered as potential confounders included child age, sex and zBMI (calculated based on WHO growth standards), and maternal education. Evidence has shown child's age, sex and maternal education may act as effect moderators to the temperament-nutrition linkage [18,25,26]. A moderator/effect modifier is an independent variable that affects the strength and/or direction of the association between another independent variable and an outcome variable [27]. Hence,

**Table 1:** Description of the temperament domains identified using the CBQ [23].

Temperament domain	Description of the temperament domain
Higher score on Negative affectivity	<ul style="list-style-type: none"> <li>Negatively affected by the sensory qualities of stimulus, such as pain, suffering, disappointment and object loss</li> <li>Show worry or nervousness in anticipation of pain or distress and/or to potentially threatening situation</li> <li>Becomes upset by interruption of on-going task or goal blocking</li> <li>Very difficult to soothe after events causing distress or excitement</li> </ul>
Higher score on Effortful control	<ul style="list-style-type: none"> <li>Have pleasure or enjoy situation involving low stimulus intensity, rate, complexity or novelty.</li> <li>Have the capacity to suppress inappropriate response to novel or uncertain situation, that is they have inhibitory control</li> <li>Maintain attentional focus on task-related channels</li> <li>Show positive affect (such as smiling or laughter) in response to changes in stimulus</li> </ul>
Higher score on Extraversion/Surgency	<ul style="list-style-type: none"> <li>Impulsive</li> <li>Have pleasure or enjoy situation with high stimulus intensity, rate, complexity and novelty</li> <li>Have high level of activity involving gross motor movement</li> <li>Not shy, that is they do not show inhibited speed or discomfort to approach social situations</li> <li>Smile and laugh to appropriate social cues</li> </ul>

we have also assessed the effect-modifying influence of these variables on the temperament and nutrition risk association.

Ethics approval for the study was obtained from Research Ethics Boards of The Hospital for Sick Children and St. Michael's Hospital, Toronto, Canada.

### Statistical Methods

Data was analyzed using the SAS version 9.1 (SAS Institute, Cary NC) and R version 3.0.1. Descriptive statistics (mean±SD; percentage) were used to describe the outcome and predictor variables. Characteristics were compared using the independent t test for continuous variables or the chi-square test for categorical variables. An unadjusted logistic regression analysis was performed to examine the association between each of the three temperament domains individually and the level of nutrition risk.

The primary analysis was an adjusted logistic regression analysis which examined the association between each of the three temperament domains and nutrition risk after controlling for variables that were a priori specified to have clinical importance and not highly correlated with each other (verified using variance inflation factor). This method avoids biased high correlation coefficient ( $R^2$ ) as well as biased low standard errors [28].

In a secondary analysis, effect-modification was assessed using interactions between each of the three broad temperament domains and child's age, sex and maternal education in addition to all covariates included in the primary analysis model. Interactions were stated to be statistically significant both when tested simultaneously using a likelihood ratio test with a p-value of 0.3 as well as tested individually using a p-value of 0.05. In the multivariate analysis, multiple imputations were used to generate missing data (14%) using predictive mean matching with fifty datasets.

### RESULTS

A total of 3468 children aged 3-5 years, enrolled in the TARGet Kids! research initiative (July 2008 to August 2013) were assessed for their temperament and nutrition risk using the CBQ-VSF and NutriSTEP™ questionnaires. The sample had a mean (SD) age of 3.75 (0.56), zBMI of 0.29 (0.99), 52% were

male and 92% of the mothers had college/university degree. Three independent scores for each of the three temperament domains were assessed for each child. The mean (SD) of the temperament domains Negative Affectivity, Effortful Control, and Extraversion/Surgency were 3.79 (0.85), 5.46 (0.72) and 4.56 (0.79) respectively. The level of nutrition risk identified using the NutriSTEP™ questionnaire showed 2996 (86%) children in the low risk and 472 (14%) in the high risk group. Table 2 shows the distribution of the predictors within the two nutrition risk groups. Significant difference was identified in respect to the age, sex, zBMI of the children and maternal education. In case of temperament, children in the high nutrition risk group scored significantly higher in the Negative Affectivity domain ( $p < 0.0001$ ), whereas had significantly lower scores in Effortful Control ( $p < 0.0001$ ).

Table 3 shows the results of the unadjusted and adjusted logistic regression analyses. Model 1 shows children with higher Negative Affectivity have an odds ratio (OR) of 1.47 (95% CI: 1.30, 1.66,  $p < 0.0001$ ) for high nutrition risk after adjusting for child age, sex, zBMI and mother's education. Conversely, children with higher Effortful Control had an adjusted OR of 0.73 (95% CI: 0.64, 0.84,  $p < 0.0001$ ) for high nutrition risk (model 2). No significant association with Extraversion/Surgency and high nutrition risk was identified (model 3).

In a secondary analysis we included interaction between each of the three temperament domains and child's age, sex and maternal education in addition to all covariates used in the primary analysis. None of these models showed significant interaction between temperament and child's age, sex and maternal education.

### DISCUSSION

The data presented here suggest a significant link between child temperament and nutrition risk. Negative Affectivity and Effortful Control, two temperament domains/constructs identified by the CBQ-VSF, were found to have significant association with nutrition risk in pre-school children. An explanation for this type of association may be provided at a biochemical level, where dietary dependent neurotransmitters involved in mood regulation, such as serotonin, have been

**Table 2:** Distribution of clinically important variables within the two nutrition risk groups.

Predictors		Low nutrition risk N= 2996		High nutrition risk N= 472		p value
		Mean (SD)	Frequency (%)	Mean (SD)	Frequency (%)	
Age		3.74 (0.56)	-	3.86 (0.56)	-	<.0001
Sex	Female	-	1484 (49.53 )	-	194 (41.10)	0.0007
	Male	-	1512 (50.47 )	-	278 (58.90 )	
zBMI		0.32 (0.95)	-	0.13 (1.25)	-	0.0014
Negative Affectivity		3.74 (0.84)	-	4.09 (0.88)	-	<.0001
Effortful Control		5.49 (0.71)	-	5.28 (0.79)	-	<.0001
Extraversion/ Surgency		4.57 (0.80)	-	4.53 (0.79)	-	0.3224
Mothers education	Elementary school	-	15 (0.51)	-	7 (1.51)	<.0001
	High school	-	176 (6.04)	-	86 (18.53)	
	College/ university	-	2723(93.45)	-	371 (79.96)	

**Table 3:** Unadjusted and adjusted association between temperament domains and high nutrition risk in pre-school children.

	Predictor variable	Unadjusted p-value	Unadjusted OR (95% CI)	Adjusted p-value	Adjusted OR (95% CI)
Model 1	Negative Affectivity	<.0001	1.63 (1.45, 1.8)	<0.0001	1.47 (1.30, 1.66)
Model 2	Effortful Control	<.0001	0.68 (0.60, 0.78)	<.0001	0.73 (0.64, 0.84)
Model 3	Extraversion/ Surgency	0.3253	0.94 (0.83, 1.07)	0.2423	1.00 (0.81, 1.05)

shown to influence individual differences in the pattern of food consumption [10]. This evidence has led to the hypothesis that food preference patterns may reflect individuals' attempts to self-regulate their own mood states. Individual level mechanisms that may explain these associations include the possibility that highly negative infants may have disorderly feeding behaviors and be less resistant to unnecessary food and may be overfed by their parents in response to their more frequent expressions of distress ("feeding to soothe") [18].

We have also identified a differential effect of temperament on the development of nutrition risk in young children. Our results show children with a temperament that is consistent with Negative Affectivity are almost 1.5 times more at odds to have high nutrition risk. On the other hand, children displaying more of Effortful Control had 27% lower odds of having high nutrition risk. Temperament traits exhibited by Effortful Control such as positivity, able to control behavior, focus attention, follow parent requests and are pleasant to be with, may influence positive feeding behavior and environment and mitigate the development of high nutritional risk. In contrast, temperament traits displayed by Negative Affectivity, such as discomfort, fear, anger/frustration, sadness and poor soothability are conducive to the development of high level of nutrition risk in young children.

Our study proposes an association between individual differences in child temperament and high nutrition risk in young children. However, previous research has found that this association may also be moderated by specific child and family

characteristics [26,29]. Hence, we examined the effect of specific child and family characteristics (age, sex and maternal education) on the temperament and nutrition risk association. However, our study did not show any significant effect modifying influence of these factors. In comparison to previous studies different measures of nutritional status and different age group of children used in the current study may explain this negative finding. In our future research with child temperament and nutrition, we plan to examine the effect of these variables using more objective measures of nutritional status (such as BMI) in a range of age groups of children.

Limitations of the current study relate to its cross-sectional nature which requires caution in regard to causal inferences. Since temporality of the cause and effect cannot be established using this study design, further research is needed to investigate the temporality of the association between Negative Affectivity and nutrition risk. Both NutriSTEP™ and CBQ-VSF are parent-reported which induces a certain level of ascertainment bias to the nutrition risk and temperament data. However, both NutriSTEP™ and CBQ-VSF have been shown to have good correlation with other objective methods that assess the same concept or construct in children [4,11].

## CONCLUSION

Our study has identified the temperament trait of Negative Affectivity to have an increased likelihood of high nutrition risk in pre-school children. Even though more robust study design is

needed to strengthen these associations, however, these concepts can alert physicians in clinical practice settings to behavior patterns in children that may predispose them to poor nutrition. This may guide clinical decision making, for example laboratory testing for nutritional status, counseling interventions and close monitoring.

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