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## Childhood malnutrition and maltreatment are linked with personality disorder symptoms in adulthood: Results from a Barbados lifespan cohort

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### Abstract

Both childhood malnutrition and maltreatment are associated with mental health problems that can persist into adulthood. Previously we reported that in Barbados, those with a history of infant malnutrition were more likely to report having experienced childhood maltreatment. Few studies, however, address the long-term outcomes of those who have been exposed to both. We assessed the unique and combined associations of a history of early malnutrition and childhood maltreatment with personality pathology in mid-adulthood in participants of the 47-year longitudinal Barbados Nutrition Study. We used the Structured Clinical Interview for DSM-IV-TR Axis II Personality Disorders Personality Questionnaire (SCID-II-PQ) and NEO Personality Inventory-Revised derived Five-Factor Model (NEO PI-R FFM) personality disorder (PD) scores

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#### Statement of ethical standards

This study has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. All study participants provided written informed consent and were compensated for their time and travel expenses (IRB Protocol 2015P000329/MGH).

#### Conflict of interest

Paul T Costa, Jr. receives royalties from the NEO-PI\_R. The authors other authors declare that they have no conflict of interest.

#### Supplementary materials

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to assess personality pathology, the Childhood Trauma Questionnaire-Short Form (CTQ-SF) to assess childhood maltreatment, and clinical documentation of malnutrition in infancy. We tested the associations of malnutrition and maltreatment with PD scores using linear regression models, unadjusted and adjusted for other childhood adversities. We found increased scores for paranoid, schizoid, avoidant, and dependent PDs among those who had been malnourished and increased scores for paranoid, schizoid, schizotypal, and avoidant PDs among those with higher childhood maltreatment scores. Overall, those exposed to both adversities had even greater PD scores.

## Keywords

Early adversity; Early life stress; Child abuse; CTQ; Nutrition; Caribbean

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## 1. Introduction

Both childhood malnutrition and maltreatment (abuse and/or neglect) are associated with mental health problems that can persist into adulthood, including personality pathology (Battle et al., 2004; Johnson et al., 1999). Most studies on these early adversities, however, do not examine their unique and combined associations with mental health outcomes, despite evidence that these early adversities often co-occur (Dong et al., 2004).

In male survivors of the Dutch Famine who were exposed to undernutrition *in utero*, there was an increased prevalence of both schizoid (3.8–4.9/1000 vs 2.7/1000 for controls) and antisocial (1.8/1000 for severe vs 1.0 and 1.1 for moderate and no exposure) personality disorders (PD) (Hoek et al., 1996; Neugebauer et al., 1999). The diagnosis of PD in this series of studies was based on ICD-8, 9 criteria assessed as part of a standardized medical examination of 18-year-old male recruits at the time of military induction. The association between early growth and PD in adulthood was also documented in studies of the 1934–44 Helsinki Birth Cohort. In men, slower gain in BMI from birth to 6 months of age and later in childhood predicted an increased risk of hospitalization for PD (Lahti et al., 2011). Although the cause of growth failure was not available in this cohort, poor nutrition is known to be a leading contributor to impaired early growth (Kyle et al., 2015).

A history of childhood maltreatment also has been linked with increased risk of PD and maladaptive personality traits (Oshri et al., 2013) that can persist into adulthood (Anda et al., 2006; Carver et al., 2014; Hengartner et al., 2013; Johnson et al., 1999; Tyrka et al., 2009). These associations have been found both using measures of childhood maltreatment that were self-reported (Battle et al., 2004; Bernstein et al., 1998; Bierer et al., 2003; Hengartner et al., 2013; Lobbstaël et al., 2010; Tyrka et al., 2009) and publicly documented (Widom et al., 2009). Some studies have examined the relationship between childhood maltreatment and specific PD symptom profiles. Waxman et al. (2014) found associations between physical abuse and antisocial PD, as well as associations between emotional abuse and borderline PD. A population-based study using data from the National Epidemiological Survey on Alcohol and Related Conditions (NESARC, n = 34,653) reported that childhood adversity was associated with schizotypal, antisocial, borderline, and narcissistic PDs (Afifi et al., 2011). No consensus, however, has yet been reached about the specificity of links

between subtypes of childhood maltreatment and various categories or syndromes of personality pathology.

In addition to extending research on early adversities and personality development in general, it is important to increase the number of studies on this topic in non-Western populations and low resource settings. In fact, research supports that “people from Western, educated, industrialized, rich and democratic (WEIRD) societies—and particularly American undergraduates—are some of the most psychologically unusual people on Earth” (Henrich et al., 2010a; b). Meanwhile, in 2008, 96% of participants of studies in top psychology journals were from Western industrialized countries, which are home to only 12% of the world’s population (Arnett, 2008). For mental health research to be more broadly generalizable and beneficial, it is important to extend research to more diverse populations.

Some research on the topic of early life adversities and adult personality has been conducted in settings outside of the US. In a long-itudinal study in Mauritius (Raine et al., 2010, 2003; Venables and Raine, 2012) children who were malnourished at age 3 (and likely chronically) were followed to 23 years of age; a subgroup of these children was enrolled in an enrichment program at three to five years of age. The malnourished children who did not receive the intervention had a higher prevalence of schizotypal personality and criminal offending at age 23 than those children who received the intervention. In terms of maltreatment, a study in Togo examined the relationship between childhood abuse and neglect (using the Togo-adapted CTQ-SF) and PD symptoms (assessed with the Personality Diagnostic Questionnaire; Hyler, 1994 and the International Personality Item Pool; Goldberg, 1999) and documented associations between childhood physical abuse and schizoid, antisocial, narcissistic, obsessive compulsive, depressive, and negativist PDs (Kounou et al., 2015). A study in China with over 1,400 participants found strong correlations between retrospectively self-reported childhood maltreatment and Cluster B PDs (Zhang et al., 2012). Despite these advances, further research is needed on the independent and joint relations of childhood adversities with adult personality, particularly in populations outside of the US. Accordingly, the present study is conducted in a population in Barbados.

We recently evaluated the relationship between a clinically significant episode of malnutrition in the first year of life and adult personality in the context of the Barbados Nutrition Study (BNS), a 47-year longitudinal study that has followed survivors of malnutrition restricted to the first year of life. We reported that malnutrition in the first year of life was associated with an overrepresentation of adult personality trait scores outside the average range on the five broad factors, as assessed by the NEO-PI-R Five-Factor Model of Personality (FFM) (Costa and McCrae, 1992)—including higher neuroticism and lower extraversion, openness, agreeableness, and conscientiousness than healthy controls (Galler et al., 2013). The survivors of malnutrition in this cohort also showed differences from controls in 17 of the 30 lower-order NEO-PI-R facets, displaying a personality profile with heightened anxiety, depression, and vulnerability to stress, lowered interpersonal orientation, lowered intellectual curiosity as well as withdrawal and distrust and a lowered sense of self-efficacy or competence. The extent to which these differences in personality trait profiles might relate to clinically-defined personality symptoms or disorders, however, remained to

be demonstrated, although prior studies linking abnormal NEO-PI-R trait profiles to clinically significant problems in living and dysfunction in the social, work, and recreational domains suggest that there is merit to this hypothesis (Hopwood et al., 2009). Consideration of a profile of scores made up of multiple facet differences is not only likely to be more informative than focus on single traits one at a time, but also more likely to reflect the constellation of features that are included in the PD categories.

In addition, we have recently reported that Barbadian children who suffered from malnutrition in the first year of life were also more likely to report having experienced maltreatment in childhood, particularly physical and emotional neglect (Hock et al., 2017). Although many children worldwide are exposed to both malnutrition and maltreatment, the long-term consequences of these exposures have been for the most part studied separately. Investigating childhood malnutrition and maltreatment in the same population allows for assessment of both their unique contributions, as well as investigating potential increased risks from exposure to both conditions.

The Adverse Childhood Experiences (ACE) Study, conducted by Kaiser Permanente and the Centers for Disease Control, has been documenting the long-term consequences of exposure to multiple childhood adversities in the US. For instance, in a sample of 17,337 adults, ACE investigators found associations between the number of self-reported childhood adversities experienced and the risk of disorder in each of the domains they assessed: mental affective, somatic, substance abuse, memory, sexual, and aggression-related (Anda et al., 2006). Their results suggest that there may be an additive effect on risk for those exposed to multiple adversities (Anda et al., 2006). Unlike the BNS, the ACE study, however, does not include clinical observations of any adversity, such as malnutrition, during childhood.

The aim of the present study is to examine the unique and combined associations of exposures to early malnutrition and childhood mal-treatment with PD scores in middle adulthood, as measured by two different forms of assessment. We hypothesized that the two childhood exposures would be independently and jointly linked with increased PD scores on both measures in adulthood. The conceptual model for this investigation is presented in Fig. 1.

## 2. Methods

### 2.1. Participants

The study was conducted in Barbados, a Caribbean country with a population of approximately 260,000 persons. There is an average of 15.3 years of schooling and 4.7% of GDP is spent on public health. The country's ranking is 54 out of 187 nations on the UNDP Human Development Index (UNDP, 2016).

The BNS was originally implemented using a case-control design (Galler et al., 2010; Galler et al., 1983a). Briefly, 129 children born between 1967 and 1972 who had experienced moderate to severe (Grade II-III) protein-energy malnutrition (marasmus) in the first year of life were recruited in 1977 along with a group of 129 healthy ageand gender-matched controls, from the same classrooms and neighborhoods (Galler et al., 1983a, b; Ramsey,

1980). A group of children with histories of another form of protein-energy malnutrition, kwashiorkor, also diagnosed in the first year of life, was added in 1984 for a total of 312 study participants (Galler et al., 1987). All participants had normal birth weights (>2500 gs), no birth complications, and the absence of encephalopathic events during childhood. Because there were no differences between the outcomes of the marasmus and kwashiorkor groups (Galler et al., 1987a, b), data from the two groups were combined into a single malnourished group. After discharge from the hospital, the previously malnourished children were enrolled in a government-supported intervention program that followed them from infancy to 12 years of age, providing health monitoring and home visits, nutrition education, subsidized foods and a preschool program; this intervention ensured that there were no further episodes of malnutrition after the first year of life (Ramsey, 1980; 2006).

The present sample consists of 139 (56%) of 248 eligible individuals. Of the original 312 participants in the Barbados Nutrition Study, 64 were not eligible (as they were deceased or incarcerated, had moved out of Barbados or were lost and inaccessible to follow-up) leaving 248 participants for the present study. Due to funding limitations, 176/248 participants were randomly selected and tested in the current wave of data collection. A total of 139/248 participants with a mean age of 43.8 years ( $SD = 2.3$ ) had complete sets of data (CTQ, SCID-II and NEO-PI-R). Of these, 77 individuals were from the previously malnourished group and 62 from the control group.

## 2.2. Measures

**2.2.1. Childhood maltreatment (assessed at 40–45 years)**—The Childhood Trauma Questionnaire-Short Form (CTQ-SF) (Bernstein et al., 2003) is a 25-item retrospective self-report instrument that assesses the presence and severity of abuse and neglect in childhood. It contains five sub-categories with five questions each: physical abuse, sexual abuse, emotional abuse, physical neglect, and emotional neglect. Items are rated on a 5-point Likert scale (ranging from “never true” = 1 to “very often true” = 5), yielding scores ranging from 5 to 25 for each trauma sub-category, which are then added together to create a total CTQ score (ranging from 25 to 125). Items worded positively are reverse-coded so that higher scores reflect more maltreatment. For the regression analyses, total CTQ-SF scores were divided by 10 (approximate standard deviation) to ease interpretability of results. The CTQ-SF has been shown to have measurement invariance across diverse populations—both in the US and other high-, middle-, and low-income countries (e.g., Bernstein et al., 2003; Grassi-Oliveira et al., 2014; Hernandez et al., 2013; Rieder and Elbert, 2013). We found evidence for reliability and validity of the CTQ-SF in this population in a previous study (Hock et al., 2017).

**2.2.2. Structured interview for DSM-IV personality disorder – personality questionnaire (SCID-II-PQ) symptom counts (assessed at 40–45 years)**—Personality disorder symptom counts were ascertained using the Structured Clinical Interview for DSM-IV Personality Disorders -Patient Questionnaire (SCID-II-PQ) (First et al., 1997), a self-report questionnaire with 119 dichotomous (yes/no) items derived from DSM PD criteria. These items are used to generate component scores for each of the PDs.

SCID-II dimensional symptom scores were calculated for each PD diagnosis by summing the component scores (0 to 7 or 9).

**2.2.3. NEO FFM PD prototype scores (assessed at 40–45 years)**—We have previously applied the NEO-PI-R in Barbados (Galler et al., 2013). In the current study, the 30 facet scales of the NEO-PI-R were used to create the NEO FFM PD prototype scores (Costa and McCrae, 1992; Widiger et al., 2013b). Briefly, the personality facets considered prototypically low or high for each of the 10 PD categories have been identified both theoretically and empirically, and these are summarized in Table 6.1 of the 3rd Edition of Widiger et al. (2013a). Low facets are reverse keyed and then added to the high facets thus summing the scores in the same (high) maladaptive direction. Higher PD prototype scores derived in this way have shown highly significant agreement with more complex full prototype matching or similarity approaches.

**2.2.4. Covariates**—Low socioeconomic status has been reported as a risk factor for adult PD (Cohen, 1996; 2008) and was therefore included in the current study. Socioeconomic status was obtained from BNS archival data at three time points during childhood and adolescence (assessed at 5–11 years, at 9–15 years and at 11–17 years) and measured using the 50-item *Barbados Ecology Questionnaire* (Galler et al., 2012a; Galler and Ramsey, 1985), which elicited information on conditions in the home, and parent items including educational level and employment history. This questionnaire was administered to parents and supplemented by home visits. Factor analysis using varimax rotation yielded an independent factor that appeared to represent the *household standard of living* (e.g. household possessions, including refrigerator and television, bathroom in the home, type of toilet and running water, electricity, closet, gas or electric cooking fuel, number of bedrooms, number of rooms, weekly household food expenditure and household income), all salient discriminators among Barbadian households when these data were collected (Galler et al., 2010). This factor had good reliability established by tests of internal consistency for this factor, using Armor's theta ( $\theta = 0.86$ ) (Armor, 1973).

### 2.3. Statistical methods

Data analyses for this paper were generated using SAS software, Version 9.4 of the SAS System for Windows 7 (SAS Institute, 2013).

**2.3.1. Participant characteristics**—Demographic characteristics of the groups, including gender, age at the time of personality assessment, birth weight, mother's age at the time of their birth, and childhood SES (measured at three time points), were compared by Student's t-tests or chi-squared tests.

**2.3.2. Childhood malnutrition and maltreatment and adult personality pathology**—We examined relationships between the two early exposures (malnutrition and maltreatment) and adult personality pathology in several ways. First, we compared mean scores of personality pathology, using the SCID-II-PQ and NEO FFM PD prototypes, by malnutrition history group using Student's t-tests. We analyzed the relationships between

maltreatment and personality symptom scores using Pearson correlations (results not shown).

Next, we ran linear regression analyses with malnutrition and maltreatment histories as independent predictor variables and adult personality pathology in terms of SCID-II PD symptom scores and the NEO FFM PD prototypes as dependent variables. When including both malnutrition and maltreatment as independent variables in the same model, we did not find statistical evidence for an interaction effect between the two predictors (results not shown). Thus, we examined the unique associations with malnutrition and maltreatment histories using separate regression analyses, adjusting for the other childhood adversity variable and also household standard of living.

For the next series of regressions, median splits of the total CTQ scores were used to classify participants as having high or low/no exposure to maltreatment. We examined the independent and combined associations between malnutrition and maltreatment history with adulthood PD scores using an indicator variable that grouped study participants, as follows: (i) malnutrition and low CTQ score, (ii) no malnutrition and high CTQ score, (iii) both malnutrition and high CTQ score and (iv) a reference group with no malnutrition and low CTQ score. Regression analyses were performed showing the association of each of the first three groupings, compared with the reference group, with each of the 10 adulthood PDs.

**2.3.3. Correlations between SCID-II and NEO-PI-R scores**—Finally, we performed Pearson correlations ( $r$ ) to examine the interrelationships between the PD symptoms or trait scores, using the SCID-II and NEO-PI-R.

### 3. Results

#### 3.1. Participant characteristics

Table 1 summarizes the demographic characteristics of the participants. Previously malnourished and control groups did not differ significantly on birth weight, adult body mass index, or their mother's age at the time they were born. The mean age for the study sample was  $43.8 \pm 2.3$  years, and this did not differ significantly by malnutrition history. Previously malnourished and control groups did, however, differ significantly by childhood and adolescent household standard of living at all three assessment points that took place between 5 and 17 years of age (all  $p < 0.01$ ). The previously malnourished group consistently had lower standards of living than the control group at all three time points. This finding led us to adjust for childhood standard of living at the three time points in all multiple regression analyses.

#### 3.2. Childhood malnutrition and maltreatment and adult personality pathology

**3.2.1. Infant malnutrition as a predictor of adult PD**—Table 2 presents both the combined associations of childhood malnutrition and maltreatment (unadjusted models) and the unique associations of each childhood exposure (adjusted models) with SCID-II PD symptom scores and NEO FFM PD prototype scores as outcomes. Using the SCID-II-PQ, linear regressions showed significant associations between malnutrition history and paranoid personality disorder symptoms in both unadjusted and adjusted models. Malnutrition history

was also associated with schizotypal symptoms in the unadjusted model but not in the adjusted model. Using the NEO FFM PD prototype scores, we found that malnutrition was significantly associated with schizoid, avoidant, and dependent traits in both unadjusted and adjusted models. Malnutrition history was also associated with paranoid and borderline traits in the unadjusted models only.

**3.2.2. Childhood maltreatment as a predictor of adult PD**—Results from a parallel set of analyses that were performed for childhood maltreatment are presented in Table 3. Using the SCID-II-PQ, maltreatment history was significantly associated with paranoid, schizoid, and schizotypal traits in both unadjusted and adjusted models. Its associations with borderline, avoidant, and obsessive traits were significant only in unadjusted models. When using NEO FFM PD prototype scores to assess personality pathology, maltreatment history was found to have significant associations with schizoid, schizotypal and avoidant PDs in both unadjusted and adjusted models. Associations between maltreatment history and paranoid and borderline PD were present only in the combined, unadjusted models. Across the two assessment tools, CTQ scores were similarly and uniquely associated with both schizoid and schizotypal PDs.

**3.2.3. Childhood malnutrition and maltreatment vs. adult PD**—The next of set of analyses (Table 4) shows that, for both SCID-II PD symptom scores and NEO FFM clinician PD prototypes, a history of having both malnutrition and maltreatment was significantly associated with higher scores for paranoid, schizoid, schizotypal, borderline, and avoidant PDs. For most of these associations, a history of exposure to both malnutrition and maltreatment was linked with higher PD scores than was a history of either adversity alone (i.e., just malnutrition or just maltreatment).

#### 3.4. Correlations between the SCID-II and NEO FFM PD scores

Table 5 shows the agreement between the two different types of PD constructs and provides data relevant to the question of whether the DSM-IV based symptoms are correlated with dimensional PD scales by providing the unadjusted correlations between the SCID-II symptom scores and the NEO FFM PD prototype scores. Moderate to strong associations are observed for paranoid, avoidant, antisocial, borderline and schizoid PDs. There are small associations present for schizotypal, narcissistic and dependent PDs and no significant association in the case of histrionic and obsessive-compulsive PDs. That 8/10 SCID-II symptom scores correlate significantly with the NEO FFM PD prototype scores provides evidence of the convergent validity of the two different measures.

## 4. Discussion

In this study, we assessed the independent and combined associations between exposures to malnutrition and maltreatment in childhood and personality pathology in middle adulthood in a Barbadian cohort. As hypothesized, adults with histories of either infant malnutrition or childhood maltreatment showed an increase in mean SCID-II PD symptom counts and NEO FFM PD prototype scores when compared with study participants who had little or no exposure to either adversity. This finding remained for many of the PDs even after



adjustment for childhood standard of living and the other childhood adversity variable. Overall, those who were exposed to the combination of both malnutrition and maltreatment in childhood had higher PD scores than those exposed to neither or to either adversity alone.

Using the SCID-II, only one of the ten symptom categories, paranoid, had unique associations with both malnutrition and maltreatment history. Malnutrition history did not uniquely predict any of the other SCID-II PD scale scores after adjusting for covariates, while maltreatment status predicted two others: schizoid and schizotypal. When the NEO-FFM PD scores were used, schizoid and avoidant PDs had unique associations with both malnutrition and maltreatment history. A history of malnutrition also significantly and uniquely predicted dependent PD scores, while maltreatment history additionally uniquely predicted schizotypal symptom scores. A summary of unique associations for each of the two exposures, regardless of assessment tool, reveals that malnutrition history was linked with paranoid, schizoid, avoidant, and dependent PDs; while maltreatment history was linked with paranoid, schizoid, schizotypal, and avoidant PDs.

In terms of specific PD symptom profiles, previous studies have found links between early malnutrition or slow growth and the risk of schizoid, schizotypal, and/or antisocial PDs (Cohen, 2008; Hoek et al., 1998; Lahti et al., 2010; Neugebauer et al., 1999; Raine et al., 2003, 2010; Venables and Raine, 2012). We similarly found an association between early malnutrition and schizoid PD symptoms. Maltreatment history, on the other hand, has been linked with increased risk of symptoms for nearly every PD (Cohen, 2008; Bernstein et al., 1998; Bierer et al., 2003; Kounou et al., 2015; Lobbstaël et al., 2010; Widom et al., 2009; Zhang et al., 2012). However, further research is needed to confirm particular links between malnutrition or maltreatment history and specific PD subtypes. Given the complexity of the development of personality, involving biological and experiential influences over the first decades of life that “shape the nature of the individual’s schema regarding self, others, and the world they live in” (Cohen, 2008), there may be a range of PD outcomes that can stem from malnutrition and/or maltreatment exposures. Further studies in diverse populations should be conducted to confirm whether more specific patterns emerge.

The basis for the associations between early malnutrition, early maltreatment and PD symptoms merits comment. Preclinical data from our laboratory have demonstrated increased behavioral reactivity under stressful conditions in prenatally malnourished rats nutritionally rehabilitated after birth (Duran et al., 2006; Rosene et al., 2004; Tonkiss et al., 1998). Further, in our study of early immediate genes, exposure to restraint stress resulted in a significantly greater number of c-Fos positive neurons in the medial prefrontal and anterior cingulate cortices of adult rats with histories of early protein malnutrition relative to well-nourished controls (Rosene et al., 2004). Dysfunction in these brain regions has been implicated in posttraumatic stress disorder in humans (Shin et al., 2001; Zubieta et al., 1999). Therefore, it is plausible that children who experience a significant episode of malnutrition in the first year of life may be more reactive to childhood stressors and more vulnerable to developing maladaptive personality traits and personality pathology.

Childhood maltreatment also has been found to affect the developing brain in ways that increase risk for a variety of mental disorders, including personality pathology (Teicher and

Samson, 2016; Teicher et al., 2016). Maltreatment appears to affect the development of sensory systems, network architecture, and circuits involved in threat detection, emotion regulation, and reward anticipation. These altered developments may represent adaptations to the hostile environment of maltreatment (e.g., hypersensitivity to cues of threat) that then become maladaptive in the context of a healthy social environment (Choi et al., 2009; Tomoda et al., 2009). Altered threat detection, emotion regulation, and reward anticipation are also implicated in the development of personality pathology (Cohen, 2008).

Belsky et al. (2009) have proposed the possibility that genetics conferring greater vulnerability to psychopathology in adverse contexts might be better thought of as “plasticity” genes reflecting a higher level of responsiveness in adapting to environmental influences “for-better-and-for-worse.” Further research on early exposures such as malnutrition and maltreatment, as well as on nurturing exposures, will be important for assessing this concept and identifying the biological bases of several adult phenotypes including PD symptoms.

The present study is not without limitations. The CTQ-SF does not provide information about the specific ages of the child when the maltreatment occurred. Also, as indicated, retrospective reporting could be inaccurate or biased by other influences, including personality disorders. For ethical reasons, however, childhood maltreatment is often assessed retrospectively, so our approach is comparable to that of other studies (e.g., Kohrt et al., 2015; Teicher and Parigger, 2015). Since studies comparing retrospective to prospective reports of mal-treatment have found that, if anything, adults are more likely to minimize their degree of exposure on retrospective reporting (Shaffer et al., 2008), our use of a retrospective measure could have underestimated the association. Although we did adjust for standard of living during childhood and adolescence using a locally-developed and validated measure, we recognize that there may be other explanatory variables that were not accounted for. Finally, as with all longitudinal studies, there was attrition over time. There were, however, no significant differences between BNS participants and non-participants on key demographic variables (Galler et al., 2012b). Given that this is a 47-year longitudinal study, the ability to locate and enroll this number of the original cohort can be considered a strength.

Other strengths of this study include the detailed in-depth archival data available for each study participant and collected systematically over nearly 50 years. In addition, the current study used two different instruments to assess personality pathology. The agreement between these instruments was moderate-high, providing confidence in the validity of the observed findings.

In summary, we found that, in Barbadian adults, exposure to malnutrition or maltreatment early in life was associated with increased personality pathology. Participants who were exposed to both malnutrition and maltreatment tended to have even higher PD scores than those exposed to neither or to either adversity alone, suggesting a cumulative effect of the two adversities. Given the negative effects of personality disorders on social adjustment and adaptation, our findings have public health implications for populations exposed to early malnutrition and/or maltreatment and underscores the importance of prevention efforts.

Future research should help clarify the specificity of associations between these exposures and various PD symptom profiles as well as to elucidate potential mechanisms in the development of personality pathology.

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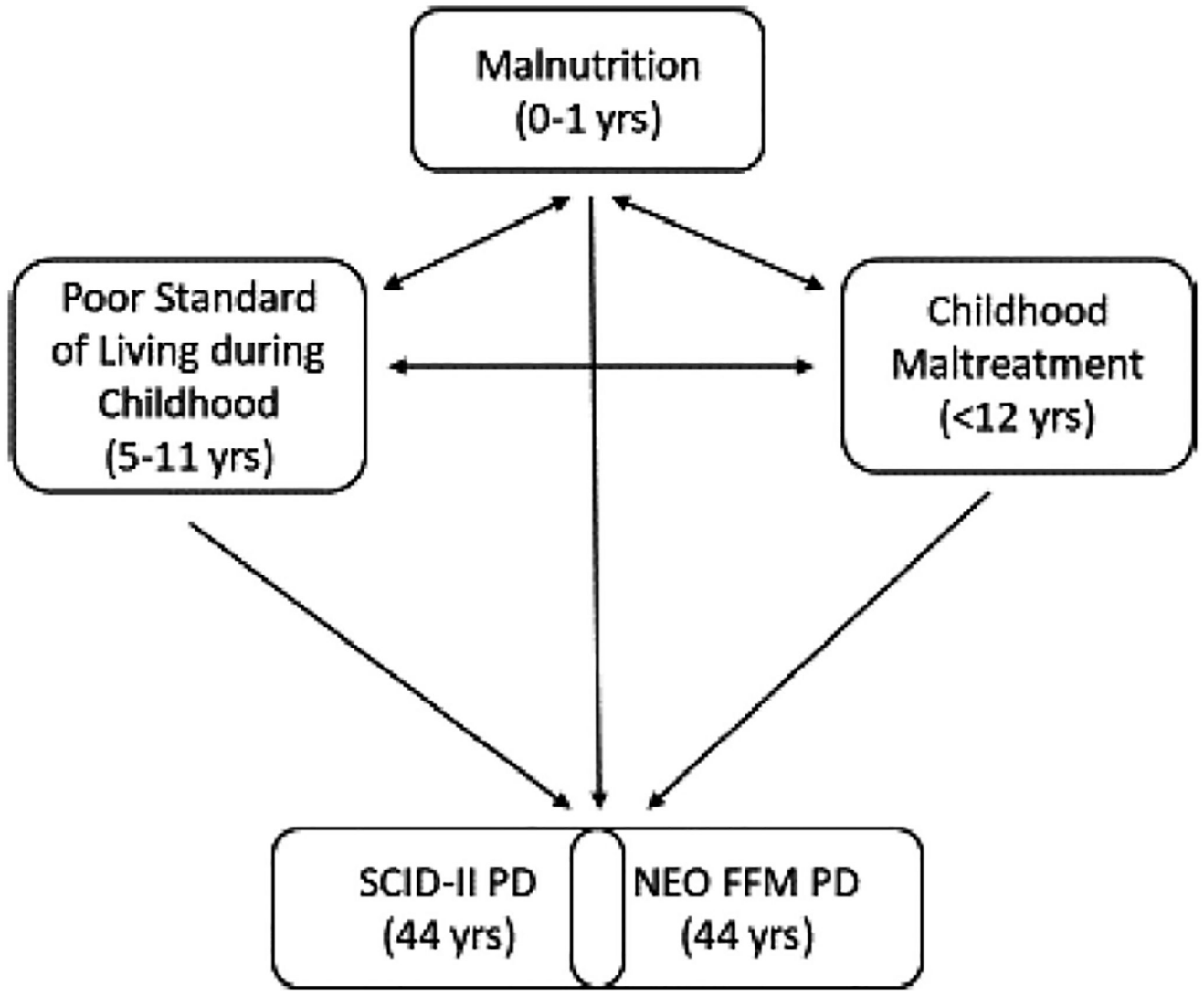
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**Fig. 1.** Model: Early malnutrition, childhood maltreatment and poor standard of living predict personality symptoms at adult ages.



Table 1

Participant characteristics (*n* (%) or mean  $\pm$  SD).

	Total sample N=139	Malnutrition N=77	Control N=62	<i>p</i> -value
Female	66 (47.5)	37 (48.1)	29 (46.8)	0.881
Age at CTQ-SF report (years)	43.8 $\pm$ 2.3	44.1 $\pm$ 2.1	43.4 $\pm$ 2.4	0.061
Birth weight (g)	2917.3 $\pm$ 430.9	2971.6 $\pm$ 444.0	2849.9 $\pm$ 407.6	0.098
Adult BMI (kg/m <sup>2</sup> )	27.8 $\pm$ 5.9	28.0 $\pm$ 5.6	27.5 $\pm$ 6.3	0.595
Maternal age at birth (years)	24.2 $\pm$ 7.2	24.5 $\pm$ 7.2	23.9 $\pm$ 7.1	0.679
Childhood Standard of Living (5–11 years)	-0.6 $\pm$ 0.9	-0.9 $\pm$ 0.9	-0.3 $\pm$ 0.5	< <b>0.001</b>
Childhood Standard of Living (9–15 years)	0.5 $\pm$ 0.9	0.2 $\pm$ 0.9	0.7 $\pm$ 0.8	< <b>0.01</b>
Childhood Standard of Living (11–17 years)	0.3 $\pm$ 0.7	0.1 $\pm$ 0.7	0.6 $\pm$ 0.6	< <b>0.01</b>

*P*-values obtained from t-tests and Wilcoxon rank-sum tests for continuous variables, Chi-square tests for categorical variables. Items bolded if *p* < 0.05.

Table 2

Early childhood malnutrition as a predictor of SCID-II PD symptom scores and NEO FFM clinician's PD prototypes in adulthood ( $N = 139$ ).

	SCID-II PD scores $\beta$ (95% CI)		NEO FFM PD Prototypes $\beta$ (95% CI)	
	Unadjusted	Adjusted <sup>a</sup>	Unadjusted	Adjusted <sup>a</sup>
Paranoid	1.0 (0.3, 1.6) $p = 0.006^{**}$	0.6 (0.0, 1.2) $p = 0.0499^*$	0.8 (0.1, 1.6) $p = 0.03^*$	0.6 (-0.2, 1.4) $p = 0.14$
Schizoid	0.2 (-0.5, 0.9) $p = 0.62$	0.03 (-0.7, 0.7) $p = 0.94$	0.8 (0.2, 1.4) $p = 0.01^*$	0.7 (0.1, 1.4) $p = 0.03^*$
Schizotypal	0.5 (0.0, 1.1) $p = 0.049^*$	0.3 (-0.2, 0.7) $p = 0.27$	0.3 (-0.2, 0.8) $p = 0.21$	0.2 (-0.3, 0.7) $p = 0.35$
Antisocial	0.2 (-0.1, 0.5) $p = 0.32$	0.1 (-0.2, 0.4) $p = 0.42$	-0.3 (-1.2, 0.6) $p = 0.55$	-0.5 (-1.4, 0.4) $p = 0.31$
Borderline	0.3 (-0.1, 0.7) $p = 0.096$	0.2 (-0.2, 0.5) $p = 0.39$	0.9 (0.2, 1.7) $p = 0.02^*$	0.7 (-0.1, 1.5) $p = 0.08$
Histrionic	-0.2 (-0.4, 0.1) $p = 0.13$	-0.2 (-0.5, 0.1) $p = 0.14$	-0.2 (-0.6, 0.3) $p = 0.47$	-0.3 (-0.8, 0.2) $p = 0.30$
Narcissistic	0.03 (-0.3, 0.3) $p = 0.86$	0.03 (-0.3, 0.3) $p = 0.86$	-0.01 (-0.7, 0.7) $p = 0.98$	-0.2 (-0.9, 0.6) $p = 0.63$
Avoidant	0.3 (-0.1, 0.8) $p = 0.16$	0.2 (-0.3, 0.7) $p = 0.38$	1.0 (0.4, 1.7) $p = 0.002^{**}$	1.0 (0.2, 1.7) $p = 0.009^{**}$
Dependent	-0.005 (-0.2, 0.2) $p = 0.96$	0.01 (-0.2, 0.2) $p = 0.95$	0.8 (0.2, 1.5) $p = 0.02^*$	0.7 (0.1, 1.4) $p = 0.04^*$
Obsessive	-0.02 (-0.5, 0.4) $p = 0.92$	-0.04 (-0.6, 0.5) $p = 0.87$	-0.2 (-0.7, 0.4) $p = 0.56$	-0.2 (-0.8, 0.4) $p = 0.46$

<sup>a</sup> Adjusted for maltreatment and childhood standard of living.

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

Child maltreatment (total CTQ score) as a predictor of SCID-II PD symptom scores and NEO FFM clinician's PD prototypes in adulthood ( $N = 139$ ).

**Table 3**

	SCID-II PD scores $\beta \pm SE$		NEO FFM PD Prototypes $\beta \pm SE$	
	Unadjusted	Adjusted <sup>a</sup>	Unadjusted	Adjusted <sup>a</sup>
Paranoid	0.6 (0.3, 0.8) $p < 0.0001$ ***	0.5 (0.2, 0.8) $p = 0.001$ **	0.4 (0.1, 0.7) $p = 0.01$ *	0.3 (-0.0, 0.7) $p = 0.05$
Schizoid	0.5 (0.2, 0.7) $p = 0.0007$ ***	0.5 (0.2, 0.7) $p = 0.002$ **	0.2 (0.0, 0.5) $p = 0.04$ *	0.2 (0.0, 0.4) $p = 0.046$ *
Schizotypal	0.4 (0.2, 0.6) $p < 0.0001$ ***	0.4 (0.1, 0.6) $p = 0.002$ **	0.3 (0.1, 0.5) $p = 0.004$ **	0.3 (0.0, 0.5) $p = 0.02$ *
Antisocial	0.1 (-0.0, 0.2) $p = 0.22$	0.04 (-0.1, 0.2) $p = 0.50$	0.2 (-0.2, 0.5) $p = 0.36$	0.2 (-0.2, 0.5) $p = 0.31$
Borderline	0.2 (0.1, 0.4) $p = 0.006$ **	0.2 (-0.0, 0.3) $p = 0.06$	0.3 (0.1, 0.6) $p = 0.02$ *	0.3 (-0.0, 0.6) $p = 0.08$
Histrionic	-0.04 (-0.1, 0.1) $p = 0.40$	-0.04 (-0.1, 0.0) $p = 0.30$	.003 (-0.2, 0.2) $p = 0.97$	-0.00 (-0.2, 0.2) $p = 0.98$
Narcissistic	-0.02 (-0.1, 0.1) $p = 0.71$	-0.03 (-0.1, 0.1) $p = 0.49$	0.2 (-0.1, 0.4) $p = 0.23$	0.2 (-0.1, 0.4) $p = 0.22$
Avoidant	0.2 (0.1, 0.4) $p = 0.01$ *	0.2 (-0.0, 0.3) $p = 0.11$	0.3 (0.1, 0.6) $p = 0.009$ **	0.3 (0.1, 0.6) $p = 0.02$ *
Dependent	-0.02 (-0.1, 0.1) $p = 0.56$	-0.03 (-0.1, 0.0) $p = 0.38$	0.2 (-0.0, 0.5) $p = 0.05$	0.2 (-0.0, 0.5) $p = 0.08$
Obsessive	0.2 (0.0, 0.4) $p = 0.02$ *	0.2 (-0.0, 0.5) $p = 0.07$	0.02 (-0.2, 0.2) $p = 0.83$	0.1 (-0.1, 0.3) $p = 0.27$

<sup>a</sup> Adjusted for malnutrition and childhood standard of living.

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$ .

**Table 4**

Regressions comparing PD scores among participants with malnutrition alone (high vs. low/no exposure)<sup>a</sup> (N=30), both malnutrition and maltreatment (high vs. low/no exposure) (N=37) with a reference group (N=32) that had neither exposure (i.e., no malnutrition and low/no maltreatment).

	SCID-II PD scores $\beta$ (95% CI)			NEO FFM PD Prototypes $\beta$ (95% CI)		
	Malnutrition	Maltreatment	Both	Malnutrition	Maltreatment	Both
Paranoid	0.6 (-0.3, 1.5) $p=0.18$	0.8 (-0.1, 1.8) $p=0.09$	2.1 (1.2, 3.1) $p<0.0001$ ***	1.2 (0.1, 2.2) $p=0.03$ *	0.9 (-0.3, 2.0) $p=0.14$	1.3 (0.3, 2.4) $p=0.02$ *
Schizoid	-0.2 (-1.2, 0.8) $p=0.69$	0.5 (-0.5, 1.6) $p=0.32$	1.1 (0.1, 2.1) $p=0.03$ *	1.2 (0.4, 2.1) $p=0.004$ **	0.8 (-0.1, 1.7) $p=0.08$	1.1 (0.3, 2.0) $p=0.01$ *
Schizotypal	-0.0 (-0.7, 0.7) $p=0.97$	0.1 (-0.7, 0.9) $p=0.76$	1.3 (0.5, 2.0) $p=0.001$ **	0.6 (-0.1, 1.3) $p=0.096$	0.8 (0.0, 1.5) $p=0.04$ *	0.8 (0.1, 1.5) $p=0.03$ *
Antisocial	-0.1 (-0.5, 0.3) $p=0.56$	-0.3 (-0.7, 0.2) $p=0.21$	0.2 (-0.3, 0.6) $p=0.45$	-0.2 (-1.4, 1.1) $p=0.80$	0.3 (-1.0, 1.7) $p=0.06$	-0.1 (-1.4, 1.2) $p=0.91$
Borderline	-0.0 (-0.6, 0.5) $p=0.89$	-0.0 (-0.6, 0.6) $p=0.95$	0.7 (0.2, 1.3) $p=0.01$ *	1.1 (0.0, 2.2) $p=0.047$ *	0.5 (-0.6, 1.7) $p=0.38$	1.3 (0.2, 2.4) $p=0.02$ *
Histrionic	-0.1 (-0.5, 0.2) $p=0.39$	0.1 (-0.3, 0.4) $p=0.64$	-0.1 (-0.5, 0.2) $p=0.41$	-0.3 (-0.9, 0.4) $p=0.44$	-0.2 (-0.9, 0.5) $p=0.6$	-0.2 (-0.9, 0.4) $p=0.47$
Narcissistic	-0.2 (-0.6, 0.2) $p=0.41$	-0.2 (-0.6, 0.2) $p=0.37$	0.0 (-0.4, 0.5) $p=0.87$	0.2 (-0.9, 1.2) $p=0.77$	0.4 (-0.7, 1.5) $p=0.43$	0.3 (-0.8, 1.3) $p=0.61$
Avoidant	0.3 (-0.3, 0.9) $p=0.40$	0.5 (-0.1, 1.2) $p=0.12$	0.9 (0.3, 1.5) $p=0.005$ **	1.2 (0.3, 2.1) $p=0.01$ *	0.5 (-0.5, 1.5) $p=0.35$	1.3 (0.4, 2.3) $p=0.006$ **
Dependent	-0.1 (-0.4, 0.2) $p=0.41$	-0.2 (-0.4, 0.1) $p=0.28$	-0.0 (-0.3, 0.2) $p=0.72$	0.8 (-0.1, 1.7) $p=0.09$	0.0 (-1.0, 1.0) $p=1.0$	0.8 (-0.1, 1.8) $p=0.08$
Obsessive	-0.1 (-0.7, 0.6) $p=0.80$	0.2 (-0.4, 0.9) $p=0.49$	0.3 (-0.4, 0.9) $p=0.40$	0.2 (-0.6, 0.9) $p=0.67$	0.6 (-0.2, 1.5) $p=0.14$	0.1 (-0.7, 0.9) $p=0.79$

\*  $p<0.05$ .

\*\*  $p<0.01$ .

\*\*\*  $p<0.001$ .

<sup>a</sup> Range for low/no exposure: 25–35; Range for high exposure: 36–95.

**Table 5**

Unadjusted Pearson  $r$ 's showing correlation between SCID-II PD symptom counts and NEO-PI-R PD prototypes (N = 149).

Personality disorder	$r$
Paranoid	0.59***
Avoidant	0.47***
Antisocial	0.42***
Borderline	0.44***
Schizoid	0.45***
Schizotypal	0.38***
Histrionic	0.14
Narcissistic	0.29***
Dependent	0.26**
Obsessive Compulsive	0.15

\*\*  
 $p < 0.01$ .

\*\*\*  
 $p < 0.001$ .