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Temperament in preadolescence is associated with weight and eating pathology in young adulthood

Annelies E. van Eeden MD[1,2] | Hans W. Hoek MD, PhD[1,2,3] | Daphne van Hoeken PhD[1] | Mathijs Deen MSc[1] | Albertine J. Oldehinkel PhD[2]

[1]Parnassia Psychiatric Institute, The Hague, The Netherlands

[2]University of Groningen, University Medical Center Groningen, Department of Psychiatry, Groningen, The Netherlands

[3]Columbia University, Mailman School of Public Health, Department of Epidemiology, New York, New York

Correspondence
Annelies E. van Eeden, Parnassia Psychiatric Institute, Kiwistraat 43, 2552 DH The Hague, the Netherlands.
Email: annelies.vaneeden@parnassiagroep.nl

Abstract

Objective: Few longitudinal studies have investigated the role of temperament traits on weight and eating problems thus far. We investigated whether temperament in preadolescence influences body weight and the development of eating pathology in adolescence and young adulthood.

Method: This study used data from TRAILS (Tracking Adolescents' Individual Lives Survey), a Dutch community cohort study (N = 2,230) from preadolescence into adulthood. At age 11, the temperament dimensions negative affectivity and effortful control were measured with the Early Adolescent Temperament Questionnaire-Revised. Body mass index (BMI) was measured at all assessment waves. At age 19, the prevalence of eating disorders was investigated by two-stage screening including interviews by eating disorder experts. At age 22 and 26, the Eating Disorder Diagnostic Scale was used to assess the level of eating pathology.

Results: Higher negative affectivity in preadolescence was associated with higher BMI and eating pathology in young adulthood. Lower effortful control in preadolescence was found to be a risk factor for the development of obesity in young adulthood. No association was found between effortful control in preadolescence and eating pathology in later life.

Discussion: Both negative affectivity and effortful control play a role in the development of weight or eating problems during adolescence.

KEYWORDS
adolescence, body weight, eating disorders, effortful control, negative affectivity, obesity, temperament

1 | INTRODUCTION

The etiology of weight and eating pathology is complex and not fully understood, and many diverse factors may play a role in the development of these disorders (Culbert, Racine, & Klump, 2015; Gortmaker et al., 2011; Jacobi, Hayward, de Zwaan, Kraemer, & Agras, 2004; Keel & Forney, 2013). Recently, there has been an increasing interest in psychological factors. We therefore investigated whether temperament in preadolescence influences body weight and the development of eating pathology in adolescence and young adulthood. It has been argued that certain temperamental traits, such as negative affectivity and effortful control (Bergmeier, Skouteris, Horwood, Hooley, & Richardson, 2014; Graziano, Kelleher, Calkins, Keane, & Brien, 2013; Martin et al., 2000), are potential risk factors for the development of obesity or disordered eating. Adolescence is a highly informative period to investigate the role of temperament traits on weight and eating problems, because these problems often have their origins in this life phase.

Temperament refers to individual differences in emotional and behavioral reactivity and self-regulation. Temperament traits are already evident early in childhood and are assumed to have a biological foundation (Goldsmith et al., 1987). In general, temperament is rather stable over the course of an individual's development, while changes due to psychiatric disorders have been reported (Abrams et al., 2004; Atiye, Miettunen, & Raevuori-Helkamaa, 2015). Temperament has been implicated in the development of an individual's personality. Most temperament models distinguish between three major constructs: negative affectivity, effortful control, and surgency (Rothbart, Ahadi, & Evans, 2000; Rothbart & Putnam, 2002).

According to the model proposed by Rothbart et al. (Rothbart et al., 2000; Rothbart & Putnam, 2002), *negative affectivity* reflects both fearfulness and frustration. Fearfulness is defined as negative affect associated with worrying and anticipation of distress. Frustration refers to unpleasant affect related to an obstructed goal or interruption of an ongoing task. In other words, negative affectivity represents how easily individuals get upset. Broadly speaking, negative affectivity is comparable to the personality trait of neuroticism. *Effortful control* denotes an individual's ability to voluntarily regulate behavior and attention. It is a combination of activation control (the ability to perform an action despite a strong tendency to avoid it), inhibitory control (the capacity to anticipate and suppress inappropriate responses), and attentional control (the ability to focus and shift attention when desired). By and large, effortful control equals the personality trait of conscientiousness. *Surgency* denotes the pleasure resulting from activities with a high intensity or novelty. Research findings into surgency have been inconsistent and contradictory (Jokela et al., 2013; Leung et al., 2016; Sutin, Kerr, & Terracciano, 2017). Since previous studies suggest that negative affectivity and effortful control are of particular interest within the field of weight and eating pathology (Atiye et al., 2015; Gerlach, Herpertz, & Loeber, 2015; Martin et al., 2000; Sutin et al., 2017), we will focus on these two concepts.

In adults, the personality trait of neuroticism has been consistently related to higher body mass index (BMI) (Gerlach et al., 2015; Sutin, Ferrucci, Zonderman, & Terracciano, 2011), but findings concerning the temperament trait of negative affectivity and BMI in childhood and adolescence have been mixed. Higher negative affectivity has been associated with weight gain over time in some studies (age range 0–24 years) (Niegel, Ystrom, & Vollrath, 2007; Pulkki-Raback, Elovainio, Kivimaki, Raitakari, & Keltikangas-Jarvinen, 2005), while other results (age range 0–8 years) showed no relation (Anzman-Frasca, Stifter, Paul, & Birch, 2013; Wright, Cox, & Le Couteur, 2011). Recently, Sutin et al. (2017) found that negative affectivity at age 4–5 predicted more weight gain at age 14–15. These results seem to indicate that weight becomes increasingly susceptible to the effects of negative affectivity during adolescence. Furthermore, it is possible that the relation between negative affectivity and weight is not linear, but that negative affectivity is a predictor of the development of obesity in particular. This hypothesis needs further investigation. Higher effortful control appears to protect against obesity. Higher conscientiousness has been found to predict less weight gain in adults (Gerlach et al., 2015; Jokela et al., 2013; Sutin et al., 2011; Terracciano et al., 2009), and aspects of effortful control have been associated with lower BMI in childhood and early adolescence (age range 1–15 years) (Duckworth, Tsukayama, & Geier, 2010; Faith & Hittner, 2010; Graziano et al., 2013; Sutin et al., 2017). This raises the question whether the relation of effortful control with weight outcomes persists in adolescence. During adolescence, the growth spurt takes place: a rapid increase in height, which also influences the BMI.

In comparison with the number of reports on temperament and weight problems, the literature on prospective studies of temperament and eating disorders (EDs) is scarce (Atiye et al., 2015; Brown, Hochman, & Micali, 2019; Stice, South, & Shaw, 2012). Higher negative affectivity was found to be associated with all EDs (anorexia nervosa [AN], bulimia nervosa [BN], binge-eating disorder [BED], and eating disorders not otherwise specified [EDNOS]) in a 2015 meta-analysis of cross-sectional studies (Atiye et al., 2015). Negative affectivity also predicted ED symptoms in longitudinal studies (age range 3–16 years), but it should be noted that these studies did not cover the whole age range of adolescence, did not evaluate ED diagnoses, and did not correct for initial symptoms (Brown et al., 2019; Martin et al., 2000; Sutin et al., 2017). This requires further research. The role of effortful control is rather equivocal; although all ED groups except BED scored higher on effortful control in a meta-analysis (Atiye et al., 2015), longitudinal studies found that lower effortful control in childhood (age 2–5 years) was associated with more ED symptoms at age 12–15 years (Martin et al., 2000; Sutin et al., 2017). These findings suggest that both relatively high and relatively low effortful control are associated with eating pathology, which could reflect the forced control in AN and loss of control in BED. More research is needed to investigate this.

Currently, few large longitudinal studies have investigated whether preadolescent temperamental characteristics predict weight gain and/or disordered eating in later life (Atiye et al., 2015; Brown et al., 2019; Stice et al., 2012; Sutin et al., 2017). To extent the current knowledge base, we investigated the role of temperament in weight and eating pathology in a prospective population-based cohort study covering preadolescence through young adulthood. We hypothesized that higher

negative affectivity and lower effortful control in preadolescence are associated with a disproportionate increase in BMI during adolescence. In addition to BMI trajectories, we also examined the association of pre-adolescent temperament with the development of obesity in young adulthood. Furthermore, we hypothesized that higher negative affectivity and both relatively low and relatively high effortful control (U-shaped relation) predict eating pathology in young adulthood.

2 | METHODS

2.1 | Study population

This study used data from TRAILS (Tracking Adolescents' Individual Lives Survey), a Dutch prospective community cohort study that has followed participants from preadolescence into adulthood. A detailed description of the cohort is available elsewhere (de Winter et al., 2005; Oldehinkel et al., 2015). Briefly, the TRAILS target sample comprised 10- to 11-year-old children living in five municipalities in the north of the Netherlands, including both urban and rural areas. The children were selected through community registers and through their primary schools. Exclusion criteria were nonparticipation of the school, lack of parental or child informed consent, severe mental or physical handicap, or not having a Dutch-, Turkish-, or Moroccan-speaking parent or parent-surrogate available. In 2001, TRAILS enrolled 2,230 (76.0% of eligible children in the participating schools) predominantly Caucasian children and their parents (first assessment wave [T1]: mean age 11.1 years, SD = 0.6). Follow-up waves of data collection took place approximately every third year: second assessment wave (T2): N = 2,149, response 96.4%, mean age 13.6 years, SD = 0.5; third assessment wave (T3): N = 1,816, response 81.4%, mean age 16.3 years, SD = 0.7; fourth assessment wave (T4): N = 1,881, response 84.3%, mean age 19.1 years, SD = 0.6; fifth assessment wave (T5): N = 1,782, response 79.9%, mean age 22.3 years, SD = 0.7; and sixth assessment wave (T6): N = 1,618, response 72.6%, mean age 25.7 years, SD = 0.6. If participants had missed an assessment, they were nevertheless contacted for subsequent assessments. The proportion of female participants ranged from 50.8% (T1) to 54.5% (T6). We used data from all six measurement waves. Informed consent was obtained from the participants themselves at each assessment wave and from their parent(s) or parent-surrogate at T1, T2, and T3. The Dutch Central Committee on Research Involving Human Subjects approved the TRAILS study. Our analyses included participants for whom measures of temperament (T1) and BMI (T1–T6) or eating pathology (T4, T5, or T6) were available, resulting in sample sizes per analysis that ranged from 1,142 to 2,230.

2.2 | Measures

2.2.1 | Temperament

At T1, temperament was measured by the parent- and the self-report versions of the Dutch translation of the Early Adolescent Temperament Questionnaire-Revised (EATQ-R; Ellis, 2002; Hartman, 2000; Putnam, Ellis, & Rothbart, 2001). The EATQ-R is based on the temperament model proposed by Rothbart et al. (Rothbart et al., 2000; Rothbart & Putnam, 2002). The scales they introduced had not, at that stage, been verified empirically in large population samples. Principal components analyses in the TRAILS sample led to some minor alterations to their scales. A full description of these scales is available elsewhere (Oldehinkel, Hartman, De Winter, Veenstra, & Ormel, 2004). We used the dimensions negative affectivity (composed of the scales for fearfulness and frustration) and effortful control. Negative affectivity contains 10 items (α = .72) in the parental version and 13 items (α = .80) in the children's version (r = .16). Effortful control includes 11 items (α = .87) in the parental version and 13 items (α = .69) in the children's version (r = .39). Each item could be rated on a 5-point scale ranging from 1 (hardly ever true) to 5 (almost always true). For both the parental and children's versions, the mean scores for negative affectivity and effortful control were constructed when at least half of the items of the corresponding scale had been answered. They were then converted to a z-score.

2.2.2 | Body mass index

Trained research assistants measured participants' weight and height using calibrated scales at T1–T5. At T6, the participants reported their own weight and height. For participants aged 18 years or younger (T1–T3), age-standardized BMI z-scores per sex were calculated according to the BMI WHO growth reference data for 5–18 year olds (de Onis et al., 2007; World Health Organization [WHO], 2007). From T4 (mean age 19.1), BMI (determined by dividing weight by the square of height [kg/m^2]) was converted to WHO BMI z-scores for ages 19 and older, so that they could be compared to BMI at T1–T3. In addition, participants' weights were categorized as obese, using cut-offs for ages 19 and older (WHO, 2000). A BMI z-score of >2 corresponds with the cutoff for obesity (a BMI of 30 kg/m^2).

2.2.3 | Eating pathology – DSM-5 diagnoses

At T4, the prevalence of EDs (AN, BN, BED, other specified feeding and eating disorder [OSFED], and unspecified feeding and eating disorder [UFED]) was estimated by a two-stage screening approach. The methods have been described elsewhere (Smink, van Hoeken, Oldehinkel, & Hoek, 2014). In the first stage, participants at high risk for an ED were identified. Selection criteria for the high-risk group were based on the core features of an ED: low or high BMI, binge eating, compensatory behaviors, and a distorted body image (American Psychiatric Association [APA], 2000). In the second stage, participants at high risk for an ED (n = 312) were selected for an additional interview with the ED module of the Structured Clinical Interview for DSM disorders (SCID-I; First, Spitzer, Gibbon, & Williams, 1995; Groenestijn, Akkerhuis, Kupka, Schneider, & Nolen, 1998) with adjusted skip rules and parts of the Eating Disorder Examination

(EDE; Fairburn, Cooper, & O'Connor, 2008). The interviews were conducted by a resident in psychiatry or a psychologist, both clinically experienced in diagnosing EDs, and yielded current and lifetime diagnoses of EDs according to DSM-5 criteria. All possible and probable ED cases were discussed in a consensus meeting with an ED expert and member of the DSM-5 EDs Work Group (coauthor H.W.H.). For more detailed information on the selection criteria and subsequent diagnostic procedure, see Smink et al. (2014).

2.2.4 | Eating pathology – Dimensional scores

To assess the level of eating pathology, the validated Dutch translation of the Eating Disorder Diagnostic Scale (EDDS) was administered at T5 and T6. This self-report questionnaire consists of 22 items and generates an overall symptom composite score that indicates the level of eating pathology, not the specific type of ED problems (Krabbenborg et al., 2012; Stice, Fisher, & Martinez, 2004; Stice, Telch, & Rizvi, 2000). When at least half of the required items had been answered, standardized item scores (excluding items regarding height, weight, amenorrhea, and use of birth control) were summed to construct the EDDS standardized score, ranging from 0 to 100. The EDDS score has been shown to have satisfactory reliability and validity (Stice et al., 2004), and to correlate strongly ($r = .85$, $p < .001$) with the symptom composite score of the EDE (Fairburn et al., 2008; Krabbenborg et al., 2012), the most commonly used questionnaire for assessing EDs. The test-retest stability of the Dutch translation of the EDDS over a 2-week interval was 0.81 for female ED patients ($N = 59$) and 0.69 for healthy controls (Krabbenborg et al., 2012). Eating problems at T1 could be a confounder for the prediction of eating pathology in later life by temperament at T1. The EDDS was not administered at T1. To check for potential eating pathology, we constructed a T1 proxy measure of core features of EDs: distorted body image and overeating accompanied by compensatory behaviors (APA, 2000). Distorted body image refers to a discrepancy between self-reported and objective body weight, as assessed by a combination of "very true" or "often true" on the "overweight" item of the youth self-report (YSR, item 55) and an objective BMI below average (BMI z-score <0). Compensatory behaviors for overeating were operationalized as a combination of "very true" or "often true" on the "overeating" item of the YSR (item 53) or child behavior checklist (CBCL, item 53) and on the "vomiting" item of the YSR (item 56g). The test-retest stability of YSR and CBCL items is moderate to good (Achenbach & Rescorla, 2001).

2.3 | Statistical analysis

Hierarchical Linear Modeling (HLM) was used to determine the trajectory of age- and sex-standardized BMI z-scores from T1 to T6 (the primary weight outcome). We tested both linear and quadratic slopes. To keep the results interpretable, we did not add higher-order polynomials; these are assumed to be unrealistic in real data (Field, 2013). Subsequently, we used HLM to examine whether each temperament

dimension at T1 was associated with BMI z-score on average (intercept) and with the change in BMI z-score over time (interaction between time and temperament dimension; linear slope). When the extension of a model showed no significant improvement, this extension was excluded from further analysis.

Logistic regression analysis was used to assess whether each temperament dimension at T1 was associated with the development of obesity at T5 or T6 (the secondary weight outcome), after controlling for obesity at T1 and for sex. Logistic regression models were also used to test whether effortful control and negative affectivity predicted the development of an ED as assessed at T4, controlling for sex. In line with our hypothesis of a U-shaped relation, we checked for a quadratic effect of effortful control in addition to the linear effect. The different ED groups were analyzed together because the small number of cases in each group did not allow disorder-specific analyses. Since our study was set up to investigate whether temperament at T1 predicts the incidence of EDs, participants ($n = 3$) whose age of onset preceded or was equal to their age at T1 were excluded from the analysis.

Since the EDDS score is not normally distributed and does not exist of counts, the assumptions for linear and negative binomial regression models, respectively, were not met. To examine the association between each temperament dimension at T1 and the level of eating pathology (EDDS score) at T5 and T6, we therefore calculated Spearman correlations. For effortful control, these correlations involved both linear and quadratic effects, in line with our hypothesis of a U-shaped relation. Furthermore, weighted correlations by sex were calculated and a subgroup analysis was performed in participants without eating pathology at T1.

All analyses were performed separately for parent-reported and child-reported temperament. All analyses were carried out using SPSS version 25, and significance levels were set at .05.

3 | RESULTS

3.1 | Descriptive statistics

Table 1 presents the descriptive statistics of variables used in this study. At all waves, the mean BMI was in the range of normal weight (18.5≤ BMI <25). The percentage of participants with obesity (BMI ≥30) increased between T1 and T6 from 5.5 to 8.5%. The lifetime and point prevalence of DSM-5 EDs ($n = 58$ and 36) were respectively 5.7 and 3.7% among women, and 1.2 and 0.5% among men. The mean age of onset (defined as the age at which first symptoms of the ED occurred as reported in the diagnostic interview) was 14.7 years ($SD = 2.5$). At T4, 46 females and 9 males were diagnosed with an ED that had developed between T1 and T4: 15 AN, 8 BN, 23 BED, 7 OSFED, and 2 UFED. The mean EDDS score was higher at T6 than at T5 (mean difference 1.7 [$SD = 14.7$], $p < .001$). Females had significantly higher EDDS scores, indicating higher levels of eating pathology than males at both T5 (females: mean 16.0 [$SD = 16.9$]; males: mean 7.0 [$SD = 11.0$], $p < .001$) and T6 (females: mean 18.4 [$SD = 18.1$]; males:

TABLE 1 Descriptive statistics

Variable	N	Mean (SD) or percentage
Sex (female) T1	2,230	50.8%
Age		
T1	2,230	11.1 (0.6)
T2	2,149	13.6 (0.5)
T3	1,816	16.3 (0.7)
T4	1,881	19.1 (0.6)
T5	1,782	22.3 (0.7)
T6	1,618	25.7 (0.6)
T1 child-reported temperament[a]		
Negative affectivity	2,047	2.7 (0.7)
Effortful control	2,051	3.6 (0.5)
T1 parent-reported temperament[a]		
Negative affectivity	1,984	2.6 (0.6)
Effortful control	1,985	3.2 (0.7)
BMI WHO z-scores[b]		
T1	2,161	0.04 (1.2)
T2	2,028	−0.04 (1.1)
T3	1,593	0.06 (1.0)
T4	1,574	0.2 (1.1)
T5	1,443	0.4 (1.0)
T6	1,276	0.5 (1.0)
BMI[c]		
T4	1,574	22.9 (3.9)
T5	1,444	23.6 (4.1)
T6	1,278	24.1 (4.4)
Obesity		
T1	2,161	5.5%
T5	1,444	7.1%
T6	1,278	8.5%
Eating pathology		
T4 DSM-5 eating disorder diagnoses	1,597	3.6%
T5 EDDS score[d]	1,497	12.1 (15.3)
T6 EDDS score[d]	1,298	14.2 (16.2)

[a]T1 temperament: Early Adolescent Temperament Questionnaire-Revised (EATQ-R); scale scores could range between 1 (low) and 5 (high).
[b]BMI WHO z-scores, body mass index; T1–T3, z-score standardized for age according to BMI WHO growth reference data for 5–19 year olds; T4–T6, z-score for ages 19 and older according to BMI WHO growth reference data 5–19 year olds.
[c]T4–T6, absolute BMI (kg/m^2).
[d]EDDS, Eating Disorder Diagnostic Scale; EDDS standardized scores could range between 0 (no eating pathology) and 100 (high level of eating pathology).

mean 8.1 [SD = 10.3], p <.001]. At T1, a distorted body image was found in eight participants. Two participants displayed perceived overweight in combination with vomiting.

3.2 | Temperament and BMI

Table 2 shows the results of the extended HLM analyses to model the course of BMI z-scores from T1 to T6 and the associations with temperament dimensions at T1. The quadratic slopes for time and z-BMI were significant, indicating a curvilinear course with more rapidly increasing BMI in late adolescence and young adulthood than in early adolescence. For child-reported temperament, negative affectivity and effortful control were unrelated to the intercept, but both were associated with the linear slope. Participants with higher scores on negative affectivity at T1 gained more weight across adolescence and young adulthood; and participants with higher effortful control scores at T1 gained less weight later on. In the analyses on parent-reported temperament, negative affectivity was positively associated with the intercept, indicating that participants with higher negative affectivity scores at T1 had a higher BMI on average. Participants who scored higher on effortful control weighed less on average. Adding associations with the linear slope showed no improvement, hence these effects were excluded from the models.

Next, we investigated whether temperament at T1 was associated with obesity at T5 or T6 after controlling for obesity at T1 and sex. The results are shown in Table 3. Child-reported negative affectivity at T1 was significantly associated with an increased risk of obesity at T5 and T6. This relation was not found in analyses using parent-reported negative affectivity. Finally, effortful control at T1 was consistently associated with a decreased risk of obesity at T5 and T6.

3.3 | Temperament and eating pathology

Logistic regression analysis was used to investigate whether temperament predicts the development of an ED. As shown in Table 4, negative affectivity at T1 was associated with lifetime ED diagnoses assessed at T4. For child-reported negative affectivity, the association lost significance after correction for sex, but the adjusted association of parent-reported negative affectivity remained significant. Effortful control was neither linearly nor quadratically associated with lifetime ED diagnoses.

Spearman correlations between temperament and EDDS are presented in Table 5. The correlations between negative affectivity and EDDS scores at T5 and T6 were positive and significant. For effortful control, no consistent evidence was found for either a linear or a U-shaped relation (higher EDDS scores for both relatively low and relatively high effortful control) with EDDS scores. The weighted correlations by sex and the correlations of analyses with participants without eating pathology at T1 (results available in Supplementary File) were comparable to those presented in Table 5.

4 | DISCUSSION

We investigated whether temperament in preadolescence influences body weight and the development of eating pathology in adolescence

and young adulthood. We used data from TRAILS (Oldehinkel et al., 2015), which follows a general population cohort from preadolescence into young adulthood.

In accordance with our hypothesis, we found that both higher negative affectivity and lower effortful control in preadolescence were generally associated with higher BMI in young adulthood. Lower effortful control also predicted, fairly consistently, the development of obesity in adolescence. Furthermore, positive relationships were found between negative affectivity in preadolescence with the development of clinical eating disorders in adolescence and with the level of eating pathology in young adulthood. Contrary to our expectations, effortful control in preadolescence was not associated with eating pathology in adolescence or young adulthood.

Our findings suggest that both negative affectivity and effortful control play a role in the development of weight or eating pathology during adolescence. It should be noted that the observed effects were not large, but the directions of the effects were quite consistent.

The observed curvilinear course of BMI, with more rapidly increasing BMI in late adolescence and young adulthood, is comparable to reference growth curves for community studies (de Onis et al., 2007). The curvilinear course can be explained by the growth spurt in adolescence, during which a rapid increase in the rate of growth in height precedes weight gain. Both negative affectivity and effortful control were associated with BMI. The observed relation between higher negative affectivity and higher BMI in adolescence is comparable to previous studies (Pulkki-Raback et al., 2005; Sutin et al., 2017). In investigations in early childhood, this association was not found (Anzman-Frasca et al., 2013; Wright et al., 2011). Combined, these results suggest that BMI is more susceptible for the effect of negative affectivity during (pre)adolescence than during childhood. The transitional period between childhood and adulthood can be stressful; adolescents are faced with complex emotions and need to develop coping mechanisms. It has been argued that individuals with higher levels of negative affectivity are more likely to regulate their negative emotions with food (Sutin et al., 2017; Vollrath, Stene-Larsen, Tonstad, Rothbart, & Hampson, 2012; Vollrath, Tonstad, Rothbart, & Hampson, 2011), which could lead to weight gain. Furthermore, children become

more independent during adolescence and it is likely that parents have less control over the eating patterns of their adolescents. These explanations could clarify the suggested higher susceptibility of BMI for the effect of negative affectivity during (pre)adolescence. In contrast to previous findings (Pulkki-Raback et al., 2005; Sutin et al., 2017), our results are ambiguous about the predictive value of preadolescent negative affectivity with regard to weight gain and obesity, since the analyses with negative affectivity, as measured by child and parent responses, differed slightly. The results were in the same direction, but the analyses with parent-reported negative affectivity were not significant. More research is needed to clarify this. Previously reported relations between effortful control and weight gain were based on younger samples than ours (Duckworth et al., 2010; Graziano et al., 2013; Sutin et al., 2017), but the nature of the associations is the same in all studies: higher effortful control is a protective factor against obesity. Our findings thus add to the existing literature that the protective effect of effortful control persists into at least young adulthood. This supports the development of early interventions that increase self-control in childhood (Diamond, Barnett, Thomas, & Munro, 2007; Duckworth et al., 2010).

TABLE 3 Association between temperament at T1 and obesity at T5–T6

Temperament T1	Obesity T5		Obesity T6	
	OR	*p* value	OR	*p* value
Negative affectivity				
Child-reported	**1.342**	**.02**	**1.498**	**.001**
Parent-reported	1.143	.26	1.199	.12
Effortful control				
Child-reported	**0.780**	**.04**	**0.779**	**.04**
Parent-reported	0.806	.08	**0.644**	**<.001**

Notes: Models are adjusted for obesity at T1 and sex. At T5, N = 1,310 for child-reported temperament and N = 1,289 for parent-reported temperament. At T6, N = 1,155 for child-reported temperament and N = 1,142 for parent-reported temperament. Bold: *p* <.05.

TABLE 2 Association between temperament at T1 and the course of body mass index (BMI) between T1 and T6 (N = 2,230)

	Course of body mass index T1–T6					
	Child-reported temperament			Parent-reported temperament[a]		
	Intercept	Linear slope	Quadratic slope	Intercept	Linear slope	Quadratic slope
z-BMI[b]	0.023 (.37)	−0.014 (.17)	**0.026 (<.001)**	−0.005 (.85)	−0.003 (.76)	**0.025 (<.001)**
Negative affectivity T1	−0.020 (.44)	**0.013 (.02)**		**0.079 (<.001)**		
z-BMI[b]	0.022 (.38)	−0.014 (.18)	**0.026 (<.001)**	−0.004 (.89)	−0.004 (.71)	**0.025 (<.001)**
Effortful control T1	−0.020 (.42)	**−0.013 (.01)**		**−0.064 (.01)**		

Notes: Results of four extended models with different temperament dimensions: child-reported negative affectivity, child-reported effortful control, parent-reported negative affectivity, and parent-reported effortful control. *p* value in brackets. Bold: *p* <.05.

[a]In the analyses with parent-reported temperament, models extended with the association of temperament dimension with the linear slope showed no improvement.

[b]z-BMI: age-standardized BMI z-scores per sex according to the BMI WHO growth reference data.

TABLE 4 Association between temperament at T1 and lifetime eating disorder diagnoses till T4

Temperament T1	Lifetime eating disorder diagnoses	
	OR	p value
Negative affectivity		
Child-reported	1.314	.07
Parent-reported	**1.383**	**.02**
Effortful control		
Child-reported	0.862	.31
Parent-reported	0.748	.06
Effortful control – quadratic		
Child-reported	1.004	.97
Parent-reported	0.941	.61

Notes: Models are adjusted for sex. N = 1,479 for child-reported temperament and N = 1,456 for parent-reported temperament. Bold: p <.05.

TABLE 5 Spearman's rho correlations of temperament at T1 and Eating Disorder Diagnostic Scale (EDDS) at T5–T6

Temperament T1	Eating Disorder Diagnostic Scale	
	T5	T6
Negative affectivity		
Child-report	**0.137 (<.001)**	**0.104 (<.001)**
Parent-report	**0.083 (.002)**	**0.067 (.02)**
Effortful control		
Child-report	−0.048 (.07)	**−0.059 (.04)**
Parent-report	0.023 (.40)	0.016 (.59)
Effortful control – quadratic		
Child-report	**−0.059 (.03)**	−0.044 (.13)
Parent-report	0.028 (.30)	−0.005 (.86)

Notes: p value in brackets. Bold: p <.05. At T5, N = 1,391 for correlations with child-reported temperament (female n = 781 and male n = 610). At T5, N = 1,372 for correlations with parent-reported temperament (female n = 776 and male n = 596). At T6, N = 1,199 for correlations with child-reported temperament (female n = 707 and male n = 492). At T6, N = 1,188 for correlations with parent-reported temperament (female n = 707 and male n = 481).

In accordance with previous studies (Atiye et al., 2015; Brown et al., 2019; Martin et al., 2000; Sutin et al., 2017), we found an association of higher negative affectivity in early adolescence and the later development of eating pathology. Despite the low number of formal eating disorder diagnoses in our study, the associations were generally robust. As suggested by the findings in Table 2, preadolescents with higher levels of negative affectivity tend to have higher weights and may gain even more weight during adolescence. This could induce unhealthy compensating strategies in order to manage the weight, and consequently lead to the development of disordered eating and eating disorders, especially in adolescents with a tendency to experience negative emotions. In contrast to negative affectivity, we found no relation between effortful control in preadolescence and eating pathology in later life. This result was unexpected, as previous findings suggested both relatively high (Atiye et al., 2015) and relatively low effortful control to be associated with eating pathology (Martin et al., 2000; Sutin et al., 2017). These contrasting findings could be explained by the fact that the temperament measures used covered partly different elements of effortful control than the measures used before. Previous studies focused on persistence, which relates mostly to attentional control (Mägi, Kikas, & Soodla, 2018). Although the broader concept of effortful control that we used (i.e., the regulation of both attention and behavior) seems more suitable for eating pathology, our study still revealed no association. Furthermore, the small number of eating disorder cases did not allow disorder-specific analyses, which might have yielded other results (Bulik, Sullivan, Weltzin, & Kaye, 1995). Future research into temperament and eating pathology should focus on negative affectivity and the different aspects of effortful control: activation control, inhibitory control, and attentional control.

Our results based on child-reported temperament differed somewhat from the results based on parent-reported temperament. Previous research showed that data from different informants tend to correlate only weakly (Achenbach, McConaughy, & Howell, 1987), which was confirmed in our study. These discrepancies reflect, among other things, differences in the context of the measurement and in the perspectives of informants (Harkness, Tellegen, & Waller, 1995; Kraemer et al., 2003). For example, emotions that are not expressed clearly can be difficult to observe. Between-informant discrepancies have been found especially for preadolescents and adolescents (Achenbach et al., 1987). In our study, the correlation between child- and parent-reported negative affectivity was smaller than the correlation between the two measures of effortful control. It is possible that effortful control is more evident for other informants than negative affectivity. Previous studies often preferred to use parent-reported temperament in childhood. We consider temperament reported by the child valuable and important as well, especially as the child grows older, because it involves feelings that are not easily observed by parents. We have shown that the results based on children's reports were largely in line with those of their parents. To learn more about the specific predictive value of reports by different informants, we recommend to include self-reported temperament in future studies in preadolescents and adolescents.

4.1 | Strengths and limitations

The strengths of our study are its large sample size, the population-based cohort, and the longitudinal design covering the whole period from preadolescence to young adulthood. The response rates remained relatively high over the 15 years of follow-up. We used formal eating disorder diagnoses, assessed by experts who administered diagnostic interviews. Moreover, we prospectively assessed whether temperament is related to the development of formal diagnoses of eating disorders. To our knowledge, this has not been investigated before. Furthermore, temperament was scored by different

informants. The child and parent versions of the EATQ-R (Hartman, 2000) differ slightly: the negative affectivity scale of the child version contains proportionately more items on frustration, and the effortful control scale contains more items on inhibitory control than the parent version. That most effects were comparable between child- and parent-reported temperaments suggests that our findings are robust and not dependent on specific measures or informants.

There are also some limitations to our study. In this population-based sample, the number of participants with an eating disorder diagnosis was low, which limited the power in the statistical analysis to detect small differences. The observed numbers for AN and BED among the adolescents in our community sample are comparable to other studies among adolescents. In comparison with studies among US adolescents, participants with BN were rare in our sample and less common than AN and BED. Possible explanations include the relatively young age of our sample, who was in the middle of the high-risk period for incidence of BN, and an overall decreasing trend in the occurrence of BN over time (Keel, Heatherton, Dorer, Joiner, & Zalta, 2006; Keski-Rahkonen & Mustelin, 2016). For a detailed discussion of the cohort, see Smink et al. (2014). Furthermore, the small number of eating disorder cases did not allow analyses per eating disorder diagnostic group, and the EDDS measures reflect the overall level of eating pathology, not specific types of problems. It was thus not possible to investigate differences between specific eating disorders with regard to associations with temperament characteristics. However, in light of the transdiagnostic view that eating disorders share the same psychopathology (Fairburn & Cooper, 2011), we feel that our combined analyses of symptoms and eating disorder groups are still valid. Another limitation is that height and weight at T6 were self-reported, while trained research assistants measured participants' weight and height at T1 to T5. Previous studies among young adults suggest that, despite some evidence of under- and overestimation, self-reported height and weight are accurate enough to generate a valid BMI in the majority of cases (Olfert et al., 2018; Quick et al., 2015). In addition, it should be noted that we only included participants with complete data in each analysis. Compared to subjects who participated at all data collection waves, those who missed one or more follow-up waves were more likely to be male, to come from low socioeconomic position families, and to have more parent-reported externalizing problems at baseline (Nederhof et al., 2012; Oldehinkel et al., 2015). We think it is unlikely that this population-level type of nonrandom attrition would bias the associations between temperament, weight-, and eating-pathology measured in our study. Furthermore, due to varying data collection budgets over time, different eating pathology measurements were used at T5 and T6 (questionnaire) compared to T4 (interview). Finally, we did not use a validated measure of eating pathology at T1, which limited the possibilities to correct for initial eating problems. This could have led to both overestimation and underestimation of the actual association between T1 temperament and later eating pathology in the case of undercorrection or overcorrection for eating pathology at T1. We would advise including a single, reliable, and valid eating disorder measure for all measurement points in future longitudinal studies.

5 | CONCLUSIONS

Our study suggests that (a) higher negative affectivity in preadolescence increases the risks of higher BMI and of eating pathology in young adulthood, and (b) higher effortful control in preadolescence decreases the risk of obesity in young adulthood.

CONFLICT OF INTEREST
The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available on reasonable request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ORCID
Annelies E. van Eeden 🅘 https://orcid.org/0000-0002-7847-296X
Hans W. Hoek 🅘 https://orcid.org/0000-0001-6353-5465

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