The sex-specific association between autistic traits and eating behavior in childhood: An exploratory study in the general population

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ABSTRACT

Children with Autism Spectrum Disorder (ASD) often exhibit problematic eating behaviors, an observation mostly based on male dominated, clinical ASD study samples. It is, however, important to evaluate both children with an ASD diagnosis and children with subclinical autistic traits as both often experience difficulties. Moreover, considering the suggestion of a possible girl-specific ASD phenotype, there is a need to determine whether autistic traits are related with problematic eating behaviors in girls as well. This study explores the sex-specific association between autism (both autistic traits and diagnosed ASD) and eating behavior in middle childhood in Generation R, a prospective population-based cohort from fetal life onwards. We collected parental reports of autistic traits at six years (Social Responsiveness Scale) and of eating behavior at ten years (Children's Eating Behaviour Questionnaire). In this cohort of 3559 children, autistic traits at six years were associated with more Picky Eating, Emotional Eating and Food Responsiveness in later childhood (e.g. adjusted B for Picky Eating = 0.07; 95% CI: 0.03, 0.11). Stratified analyses showed that in girls, autistic traits were associated with more Emotional Overeating and Emotional Undereating (e.g. adjusted B for Emotional Undereating = 0.12; 95% CI: 0.04, 0.20), while no associations were found for boys. Results comparing children with and without an ASD diagnosis in the cohort largely confirm these associations (e.g. in girls, adjusted B for Emotional Undereating = 0.72; 95% CI: 0.01, 1.42). Our results point to a sex-specific association between autism and eating behavior in middle childhood. Also, our study is the first study to show that autistic traits are associated with emotionally based eating problems in girls and possibly represent part of a girl-specific ASD phenotype.

Keywords: Autism, autistic traits, eating behavior, sex, cohort

INTRODUCTION

Eating problems among children with Autism Spectrum Disorder

1 Eating problems such as picky eating and neophobia are seen in 46-89% of children with Autism Spectrum Disorder (ASD) (Ledford & Gast, 2006). The probability of eating problems among children with ASD is five times higher than in their typically developing peers (Sharp et al., 2013). Commonly seen problems among children with autism are aversive eating behaviors such as food refusal, choking, gagging and expulsion with no medical basis. Sensory-based feeding problems include textural aversion to specific kinds of foods (Schwarz, 2003). These eating problems are most likely the result of restricted interests combined with the sensory over-responsivity to texture, taste and smell associated with ASD (Ahearn, Castine, Nault, & Green, 2001; Cermak, Curtin, & Bandini, 2010; Chistol et al., 2018). In addition to restricted eating, the overlap of ASD with eating disorders and overweight suggests that obesogenic behaviors like external, binge and emotional 2 eating are present in the ASD population as well. Emotional eating might also be driven by sensory processing problems, which affect around 90% of individuals with ASD (Leekam, Nieto, Libby, Wing, & Gould, 2007). Although studies evaluating this association in the ASD population are lacking, this hypothesis is substantiated by research in healthy adults indicating that sensory processing styles characterized by low registration and sensory sensitivity were associated with more emotional and external eating (Hebert, 2018).

The described eating difficulties may have various health consequences. Children with autism are more likely to have either a low or high body weight (Matheson & Douglas, 2017; Sobanski, Marcus, Hennighausen, Hebebrand, & Schmidt, 1999), including a 40% higher chance of being obese than typically developing peers (Curtin, Anderson, Must, & Bandini, 2010). Also, children with ASD have an increased risk for gastrointestinal dysfunction like constipation, food allergy/intolerance and diarrhea (Bresnahan et al., 2015). The eating problems are also a serious concern for parents (Schreck, Williams, & Smith, 2004), causing behavioral problems in children and spousal stress during mealtime, and affecting families' food choices (Curtin et al., 2015).

Gender differences in ASD-symptomatology

Importantly, due to the overrepresentation of boys in the ASD population (4:1 ratio) (Baio et al., 2018), most of what we know about the relationship between autism and (eating) behavior is based on male study samples. Sex differences in the prevalence of ASD-symptomology are, however, a growing subject of debate in recent years. Genetic, epigenetic and environmental mechanisms are possibly responsible for the male preponderance in ASD prevalence, with some mechanisms presenting male-specific risk or female-specific protection (Ferri, Abel, & Brodkin, 2018). Recent

literature further suggests a girl-specific ASD phenotype, including less restricted interests and stereotypes than boys exhibit (Van Wijngaarden-Cremers et al., 2014). A large study using multiple data sources described differences in cognitive, adaptive and social abilities between boys and girls with ASD (Howe et al., 2015). Findings differed, however, per data source and depended on fluency of speech, making it difficult to draw conclusions regarding sex differences in clinical autistic traits. The diverse outcomes of this elaborate, novel study highlight the need to further explore sex differences in autistic traits, as sex-specific presentations might complicate the identification and diagnosis of autism in girls (Ratto et al., 2018; Van Wijngaarden-Cremers et al., 2014) and possibly contribute to their underdiagnosis.

In this light, potential sex differences in eating behavior among children with autistic traits and ASD should also be explored. A first hint for this comes from research showing elevated levels of autistic traits among girls with Anorexia Nervosa (Wentz et al., 2005; Westwood et al., 2016), suggesting that dietary restraint and other food control behaviors may co-occur with ASD-symptomatology. However, the Anorexia Nervosa population consists almost solely of girls making it difficult to examine sex differences. In other clinical studies on autism symptoms and eating behavior, sex differences were also not examined (Aponte & Romanczyk, 2016; Bresnahan et al., 2015; Curtin et al., 2010; Hill, Zuckerman, & Fombonne, 2015; Schreck et al., 2004; Tanner, Case-Smith, Nahikian-Nelms, Spees, & Darragh, 2013; Zobel-Lachiusa, Andrianopoulos, Mailloux, & Cermak, 2015), or sex was only adjusted for in the analyses (Curtin et al., 2015; McCoy, Jakicic, & Gibbs, 2016), partly driven by the low inclusion rates of females in these samples. General population studies may help elucidating sex differences in the association between ASD and behaviors as they have the benefit of including both boys and girls. Naturally, such analyses are focused on autistic traits, as the number of included children with a clinical ASD diagnosis is probably too low. The autism spectrum covers multiple symptoms which occur in varying degrees in both diagnosed and unaffected people. Studying autistic traits thus has the advantage to examine both clinical and subclinical symptoms, as several children with some symptoms do not reach the threshold for diagnosis, but may experience a burden.

Population-based studies on autistic traits and eating behaviors

Population-based studies showed that persistent picky eating across childhood predicted more autistic traits (n=3748) (Cardona Cano et al., 2016), that both clinical and subclinical autistic traits were associated with more food neophobia (n=4564) (Wallace, Llewellyn, Fildes, & Ronald, 2018) and that there is an association between ASD and eating disorder symptomology (Coombs, Brosnan, Bryant-Waugh, & Skevington, 2011). However, whether sex moderated the autism – eating behavior association was not specifically examined, despite observations of sex differences in eating behavior, e.g. boys exhibiting more food neophobia and having a lower body

mass index (BMI) than girls (Wallace et al., 2018). In their community-based study among 132 (46% male) 11-14 year old children, Coombs et al. (2011) even indicated sex differences in both autistic traits (lower imagination score among girls) and in eating behavior scores (higher dieting score among girls), but did not further explore these differences.

Thus, there is some evidence for an association between autistic traits and eating behavior in both clinical and population-based samples, but information about the possible sex specificity of this association is lacking. Potentially, eating difficulties are a sex-specific expression of autism – which is useful knowledge for the (early) detection and diagnostics of ASD. In this study, we evaluate the relationship between autistic traits and future eating behavior and between physician confirmed ASD diagnosis and eating behavior among boys and girls in a general population-based sample.

Based on previous clinical (Ledford & Gast, 2006; Leekam et al., 2007; Sharp et al., 2013) and general population (Cardona Cano et al., 2016; Coombs et al., 2011) studies, we hypothesized that autistic traits are associated with elevated levels of picky eating, food responsiveness and emotional eating. Based on previous studies indicating a high comorbidity between ASD and Anorexia Nervosa (Wentz et al., 2005; Westwood et al., 2016), we hypothesized that autistic traits are associated with elevated levels of dietary restraint. We had no specific hypotheses regarding any potential gender differences, given the rather exploratory nature of our study.

METHOD

Study design and population

This study was embedded in Generation R, a prospective population-based cohort from fetal life onwards. All pregnant women living in Rotterdam, the Netherlands, with an expected delivery date between April 2002 and January 2006, were invited to participate in the study (participation rate: 61 %) (Jaddoe et al., 2012). Written informed consent was obtained from all participants. The study was approved by the Medical Ethical Committee of the Erasmus Medical Center, Rotterdam.

Sample

Parents of 7295 children gave full consent for the postnatal phase of Generation R (Figure 1). Information on autistic traits at age six years and eating behavior at age ten years was available for 3559 children (48.8%).

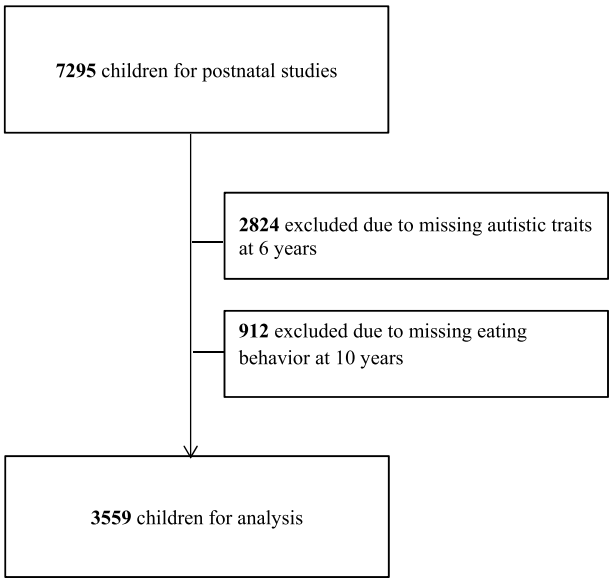

Figure 1. Flow diagram of the study population

Measures

Autistic traits

Autistic traits were assessed using maternal reports of the validated Social Responsiveness Scale (SRS) (Constantino, 2002) when children were six years old. The SRS is an autism screening questionnaire [3] providing a quantitative measure of (sub) clinical autistic traits including social deficits and autistic mannerisms. The instrument's psychometric properties are good with a test-retest reliability of 0.88 and a long-term stability correlation of 0.83 (Constantino et al., 2003). To minimize subject burden, the lengthy original questionnaire was reduced to an 18-item short-form SRS (total sample $\alpha = 0.77$; boys $\alpha = 0.81$; girls $\alpha = 0.67$) with selected items encompassing all DSM-IV autism domains (Román et al., 2013). Items assessed traits in the past three months and are scored on a 4-point scale (not true, sometimes true, often true, almost always true). As described in Blanken et al. (2015), the 18-item short-form SRS shows correlations of 0.93-0.99 with the full scale. Diagnostic validity studies comparing the SRS with the ADI-R and ADOS found sensitivity and specificity rates within the 70-80 % "acceptable" range.

ASD diagnosis

Children with a clinically confirmed ASD diagnosis were identified by examining medical records using a stepwise screening procedure (White et al., 2018). First, cut-off scores for the SRS were used to identify children with elevated autistic traits.

Second, to rule out false-negatives, children scoring in the top 15% of the total score of the Child Behavior Checklist (CBCL/1½-5) (Achenbach & Rescorla, 2001) at age six years were then screened using the 40-item Social Communication Questionnaire (SCQ), as reported by a parent (Berument, Rutter, Lord, Pickles, & Bailey, 1999). Additionally, psychiatric diagnoses and treatment were routinely assessed at all contact moments between ages 6–9 years (health center visits and questionnaires). If children scored positive in one or more of these three information sources (SRS, SCQ or report of diagnosis/treatment), their medical records at their general practitioner's office were examined. A child was regarded as a clinically confirmed case of ASD if an ASD diagnosis was confirmed through the medical records.

Eating behavior

A parent-report assessment of eating behavior was obtained when children were ten years old. Using the Children's Eating Behaviour Questionnaire (CEBQ), we evaluated Food Responsiveness (5 items, α = 0.86), Emotional Overeating (4 items, α = 0.91) and Emotional Undereating (4 items, α = 0.86) (Wardle, Guthrie, Sanderson, & Rapoport, 2001). Food Responsiveness reflects eating in response to the sight or smell of food. Emotional eating refers to the tendency to eat less or more when emotionally aroused. Food Fussiness is the rejection of particular foods which results in a restricted diet variety. Each item is scored on a 5-point Likert scale. The CEBQ has good psychometric properties, such as good internal consistency, concurrent validity with actual eating behavior and test-retest reliability, and stability over time (Dubois, Farmer, Girard, Peterson, & Tatone-Tokuda, 2007; Sleddens, Kremers, & Thijs, 2008; Viana, Sinde, & Saxton, 2008; Wardle et al., 2001).

We additionally assessed children's dietary restraint using the Restrained Eating scale of Dutch Eating Behavior Questionnaire (DEBQ) – parent version (Braet & Van Strien, 1997). The scale assesses the tendency to eat less than desired in order to lose or maintain body weight. Parents indicated on nine items whether the described behaviors occurred in their children, on a five-point Likert scale from 1=never to 5=always. We omitted one DEBQ-item (eating in the evening) as 10-year olds might generally not eat much in the evening. Cronbach alpha was 0.89 in our sample, indicating a good internal consistency (n = 3412). Finally, children's picky eating behavior was assessed with the Stanford Feeding Questionnaire (SFQ) (Jacobi, Agras, Bryson, & Hammer, 2003). Parents indicated the occurrence of four picky eating behaviors on a five-point Likert scale from 1=never to 5=always. The four SFQ items that were used to assess Picky Eating were; *'My child eats a limited number of types of food'*, *'My child only eats food if it was made in a specific way'*, *'My child has a strong preference or dislike for certain types of food'* and '*My child accepts new food easily'*. The SFQ was validated in a Danish population-based child cohort (Micali et al., 2011). In our sample, Cronbach alpha's was 0.83, indicating a good internal consistency.

Covariates

We included several child and family covariates based on previous studies (Blanken et al., 2015; Cardona Cano et al., 2016; Jansen et al., 2012). Information about child sex and birth weight was obtained from midwife and hospital registries. Child anxious-depressed symptoms were assessed at age six years using the Anxious-Depressed scale of the CBCL/1½ -5. Maternal education, maternal ethnicity and family income were assessed by postal questionnaires. We used the Brief Symptom Inventory (BSI) to assess maternal psychopathology during pregnancy. The BSI is a validated 53-item self-report questionnaire assessing diverse psychiatric problems (Derogatis & Melisaratos, 1983). Non-verbal intelligence quotient (IQ) of children was assessed at age six years with two subtest of the well-validated Dutch non-verbal intelligence test, the Snijders-Oomen Niet Verbale Intelligentie test, SON-R 2½-7 (Tellegen, Winkel, & Wijnberg-Williams, 2005). The two subtest used were mosaics (assesses spatial visualization abilities), and categories (assesses abstract reasoning abilities).

Statistical analyses

First, linear regressions were conducted to evaluate the prospective relationship between autistic traits measured with the SRS at six years and the different eating behavior scales at ten years, while correcting for confounding variables. In all linear regression analyses, we tested sex interactions and subsequently stratified the analyses by sex if the interaction was significant. Secondly, we performed linear regressions to evaluate the association between physician confirmed ASD diagnosis and eating behavior scales at ten years, also correcting for covariates.

We conducted a Bonferroni correction in all our linear regressions to protect from Type 1 Error. The new p-value is the original p-value (.05) divided by the number of comparisons (5); (new p-value = .05/5) =.01. The linear regressions are statistically significant if the *p*-value is $p < .01$.

We estimated missing values on confounding variables (ranging from 0% missing for sex to 20.9% for maternal psychopathology) using multiple imputation techniques. All variables included in the analyses were used to estimate the missing values (Graham, 2009). Regressions were conducted on the imputed dataset and reported estimates are the 4 pooled results of 20 imputed datasets. List-wise deletion was used if data was missing on eating behavior variables. All statistical analyses were performed with SPSS 21.

RESULTS

Non-response analyses

We compared the characteristics of the participating mother-child dyads (n=3559) with dyads excluded from the prospective analyses due to missing data on the SRS at six years or eating behavior at ten years (n=3736). Data was more often missing in mothers with a family income of <2000 euro per month, a low educational level, a non-Dutch background and a higher psychopathology score (all p-values < .01). Excluded children had a lower birth weight $p < .01$) than included children.

Sample Characteristics

Child and maternal characteristics are presented in Table 1. In total, half of the children were girls and about two-third (69.3%) of the mothers had a Dutch background. The study sample contained fifty-three children (1.5%) with a general practitioner confirmed ASD diagnosis, reflecting a boys : girls ratio of 5.6 : 1 (84.9% male, n = 45). Children with an ASD diagnosis had a higher score on the SRS (median = 0.83, range 0.06 to 2.50) than children without a diagnosis (median = 0.17, range 0.00 to 2.17, p-value <.01). There were no difference in non-verbal IQ score between children in the ASD (median = 102, range 74 to 140) and non-ASD (median=104, range 50 to 150) groups (p = 0.12). In total, 8.4% of the children in the prospective sample had an IQ score < 85. Boys had a higher level of autistic traits (median = 0.17, range 0.00 to 2.50) than girls (median = 0.12, range 0.00 to 1.78 (p < .01).

Prospective association between autistic traits and eating behavior

The prospective association of autistic traits at age six years with eating behavior at age ten years was examined. Adjusted analyses in Table 2 showed positive associations of autistic traits with Picky Eating, Emotional Eating and Food Responsiveness (e.g. B for Picky eating = 0.07; 95% CI, 0.03 to 0.11), which were significant after a Bonferroni correction. Significant sex interactions were found for Emotional Undereating and Emotional Overeating. Stratified analyses indicated that for girls, autistic traits were associated with more Emotional Undereating (B = 0.12; 95% CI, 0.04 to 0.20) and Emotional Overeating (B = 0.17; 95% CI, 0.10 to 0.25), while no associations were found for boys.

Association between ASD diagnosis and eating behavior

Table 3 shows the association between physician confirmed ASD diagnosis and the eating behavior scales, to determine the clinical relevance of our findings. Results comparing children with and without an ASD diagnosis showed associations in the same directions as for the continuous autistic trait scores. Some betas were slightly larger, although not significant, likely due to the small number of children with an ASD diagnosis. In sum, results showed that having an ASD diagnosis was

Table 1. Population characteristics of parent-child dyads

	n=3559	
	Percentage or median[a]	% missing
Child characteristic		
Sex		0.0
Girl, %	50.4	
Age at assessment(years)		
Social Responsiveness Scale	6.0 (5.0 to 8.9)	0.0
Children's Eating Behaviour Questionnaire (10 years)	9.7 (8.7 to 12.5)	0.0
Autistic traits	0.17 (0.00 to 2.50)	0.0
Birth weight (grams)	3470 (780 to 5610)	0.1
Anxious-depressed symptoms	0.0 (0.0 to 14.0)	2.9
Maternal characteristic		
Ethnicity		0.1
Dutch, %	69.3	
Moroccan, %	2.5	
Turkish, %	4.0	
Surinamese/ Antillean/ CapeVerdian, %	5.6	
Other Western, %	8.7	
Other non-Western, %	9.7	
Education		3.6
Higher vocational education/university, %	59.5	
Lower vocational education, %	25.8	
Less than high school, %	11.1	
Psychopathology	0.13 (0.0 to 2.4)	20.9
Family income, euro per month		6.6
≥2000, %	79.7	
<2000, %	13.7	

[a] Values are percentages for categorical variables and medians (range) for continuous non-normally distributed variables.

associated with higher scores on Picky Eating (B=0.40, 95% CI, 0.11 to 0.68) in the whole sample, and with Emotional Undereating (B=0.72, 95% CI, 0.01 to 1.42) in girls. Girls with an ASD diagnosis also depicted more Emotional Overeating (adjusted B=0.30, 95% CI, -0.38 to 0.98) but this result was not statistically significant.

DISCUSSION

5 This study shows that in the general population, autistic traits are associated with more food responsiveness and more picky eating among both boys and girls. Only among girls, autistic traits at six years were also associated with more

Table 2. Prospective relation between maternal reported autistic traits at 6 years and eating behavior at 10 years

	Food avoidant at age 10 years			Food approach at age 10 years	
Autistic traits (per 1 SD)[a] at age 6 years	Emotional Undereating[b] B (95%CI)[e]	Picky Eating[c] B (95%CI)[e]	Dietary Restraint[d] B (95%CI)[e]	Emotional Overeating[b] B (95%CI)[e]	Food Responsiveness[b] B (95%CI)[e]
All (n=3559)	0.02 (-0.02;0.06)[f]	0.07 (0.03;0.11)**	0.02 (-0.01;0.06)	0.07 (0.03;0.11)**[f]	0.09 (0.05;0.13)**
Boys (n=1766)	-0.02 (-0.07;0.03)	0.05 (0.00;0.11)	0.02 (-0.02;0.07)	0.02 (-0.03;0.07)	0.06 (0.02;0.11)**
Girls (n=1793)	0.12 (0.04;0.20)**	0.15 (0.07;0.22)**	0.04 (-0.03;0.11)	0.17 (0.10;0.25)**	0.10 (0.02;0.18)**

Sample size varied slightly per eating behavior scale.
** significant after Bonferonni correction, p-value <.01.
[a] Assessed with the total score of the Social Responsiveness Scale at 6 year, in z-score.
[b] Assessed with the Children's Eating Behaviour Questionnaire.
[c] Assessed with the Stanford Feeding Questionnaire.
[d] Assessed with the Dutch Eating Behavior Questionnaire.
[e] Adjusted for child sex, age, birth weight, anxious-depressed symptoms at 6 year, family income, and maternal ethnicity, education and psychopathology
[f] Significant interaction effect between sex and independent variable.

Table 3. Association between physician confirmed ASD and eating behavior at 10 years

	Food avoidant at age 10 years			Food approach at age 10 years	
	Emotional Undereating[b] B (95%CI)[e]	Picky Eating[c] B (95%CI)[e]	Dietary Restraint[d] B (95%CI)[e]	Emotional Overeating[b] B (95%CI)[e]	Food Responsiveness[b] B (95%CI)[e]
ASD (0=no / 1=yes)[a]					
All (n=3559)	0.02 (-0.27;0.31)	0.40 (0.11;0.68)**	-0.09 (-0.34;0.16)	0.01 (-0.27;0.29)	0.06 (-0.22;0.34)
Boys (n=1766)	-0.14 (-0.46;0.18)	0.45 (0.13;0.78)**	-0.08 (-0.34;0.18)	-0.05 (-0.36;0.26)	0.21 (-0.09;0.51)
Girls (n=1793)	0.72 (0.01;1.42)*	0.14 (-0.54;0.81)	-0.19 (-0.86;0.48)	0.30 (-0.38;0.98)	-0.60 (-0.13;0.10)

Sample size varied slightly per eating behavior scale.
* P < .05
** significant after Bonferonni correction, p-value <.01.
[a] Physician confirmed ASD diagnosis.
[b] Assessed with the Children's Eating Behaviour Questionnaire.
[c] Assessed with the Stanford Feeding Questionnaire.
[d] Assessed with the Dutch Eating Behavior Questionnaire.
[e] Adjusted for child sex, age, birth weight, anxious-depressed symptoms at 6 year, family income, and maternal ethnicity, education and psychopathology.

emotional under- and overeating at ten years. Analyses comparing children with and without an ASD diagnosis largely confirmed these associations.

We found an association of autistic traits with picky eating (i.e. selective in type, taste, structure, color of food) and food responsiveness (i.e. reactivity to food cues), both across the full spectrum of autistic traits and within the clinical range. These results are in line with previous research indicating a relationship of ASD symptomatology with feeding problems in the clinical population (Aponte & Romanczyk, 2016) and with persistent picky eating, food neophobia and overall eating disorder symptomology in non-clinical samples (Cardona Cano et al., 2016; Coombs et al., 2011; Wallace et al., 2018). The autism – picky eating association also corresponds with the frequently reported link of autism with underweight (Sobanski et al., 1999). However, other children with ASD have overweight (Curtin et al., 2010; Hill et al., 2015; Matheson & Douglas, 2017), which thus may be explained by high levels of food responsiveness in this group. Interestingly, Wallace et al. (2018) reported that particularly children with ASD traits *and* food neophobia have a higher BMI, suggesting a complex interplay between eating behaviors and a differential effect of food neophobia on health outcomes among children with autism features as compared to unaffected peers.

In girls, we found that autistic traits were associated with emotional overeating and emotional undereating. This finding was evident in the analyses with trait scores as well in the analyses on ASD diagnosis. Emotional eating is defined as eating more or less when emotionally aroused (e.g. being happy, irritated, worried, angry). Although emotional overeating is a rather uncommon type of eating behavior in childhood (Van Strien & Oosterveld, 2008), we found that it is clearly associated with autistic traits and an ASD diagnosis, especially in girls. To our knowledge, this has not been observed before and is an important addition to the literature. Our findings suggest that autism related eating problems can be behavioral/cognitive (e.g. eating no green food, specific amount) or sensory (e.g. non-sticky food, no particular smells) but also emotionally based eating problems.

Emotional eating patterns develop when self-regulating mechanisms are diminished or lost (Van Strien & Oosterveld, 2008) and when food is used for comfort (Bruch, 1973). Indeed, emotion regulation dysfunctions are common in children and adolescents with ASD (Samson, Hardan, Podell, Phillips, & Gross, 2015). Emotion regulation problems and emotional eating can also be symptoms of anorexia and bulimia nervosa (Harrison, Sullivan, Tchanturia, & Treasure, 2010; Ricca et al., 2012). Besides emotion regulation, there are more similarities between ASD and anorexia, including deficiencies in cognitive processing styles (Huke, Turk, Saeidi, Kent, & Morgan, 2013; Zucker, Losh, Bulik, Labar, & Piven, 2007), impairment in social functioning (Zucker et al., 2007), and a similar decrease of temporal gray matter volumes in areas connected to social cognition (Karjalainen, 2016). The prevalence of autism in the eating disorder population is estimated between 8-37% (Huke et

al., 2013) and autism features are more prevalent in girls with anorexia (Wentz et al., 2005; Westwood et al., 2016). One study reported that a substantial proportion of women with eating disorders had a pattern of autistic traits (e.g. social and flexibility difficulties) before the onset of their eating disorder (Mandy & Tchanturia, 2015). Furthermore, emotion dysregulation has shown to be a possible mediator in the relationship between autistic traits, body dissatisfaction and eating pathology in a general population (82% female) of university students (Mansour et al., 2016). Possibly, the developmental path between autistic traits and eating behavior is not only associated with sensory dysregulation but also mediated by emotional dysregulation, which is more common in girls. This would explain our result of an association between autistic traits and emotional eating for girls only.

In contrast to emotional eating and against our expectations, we found no association between autistic traits and Dietary Restraint. This may suggest that the previously shown comorbidity between ASD and AN (Wentz et al., 2005; Westwood et al., 2016) does not reflect a shared fear for gain weight, as measured by the Dietary Restraint scale of the DEBQ. We hypothesize that the comorbidity reflects similarities in other symptoms, including emotion regulation and restricted eating behaviors that arise from rigidity and a drive for control. Further studies are needed to test this hypothesis.

This link between autistic traits and eating disorder symptoms may be indicative of a general underlying vulnerability to psychopathology. Alternatively, parents' responses to a child's negative behaviors in mealtime situations, like pressuring a fussy child to eat, may also enhance the development and/or sustainability of emotional eating in children with ASD (Jansen et al., 2017; Kral et al., 2015). For instance, parental pressure to eat has been positively associated with emotional eating in 7-12 year old girls (Van Strien & Oosterveld, 2008).

Methodological considerations

Strengths of the current study are the large population-based cohort with prospective data on a range of behaviors and potential confounding factors. Moreover, information/measurement bias was limited due to the use of the SRS, a validated questionnaire specifically developed for screening of autistic traits. However, in our sample, the internal consistency of the SRS was slightly higher among boys than girls, reflecting that the SRS was developed and validated in the 6 male-dominated clinical ASD population. Further limitations of this study include a possible selection bias because the excluded mothers more often had a non-Dutch, lower socioeconomic background and more psychopathology, suggesting that particularly vulnerable families dropped out. Based on previous analyses of selection bias in a similar prospective cohort study, we expect the effects of drop out to be rather small (Nilsen et al., 2009). Our study was further limited by the sole reliance on parental reports of eating behavior instead of self-report, which could have

resulted in underreporting of distorted eating behaviors (Kalyva, 2009). Although parent reports of children's eating behaviors correlates substantially with actual food intake (Carnell & Wardle, 2007), it is possible that, due to the characteristics of ASD, it is difficult for parents to recognize particular emotional stages in children with ASD. However, the CEBQ asks parents about basic child emotions which are also observable in children with ASD traits.

Conclusions

In conclusion, autistic traits are associated with eating behavior problems in middle childhood, with results pointing to a possible sex-specific association. Our results add to previous studies in the field that the association is independent of a range of potential confounding factors, including children's anxious-depressed symptoms which are often hypothesized as an explanation for the autism – eating behavior link (Zucker et al., 2007). Moreover, our findings underline that the relationship extends beyond preschool years onto middle childhood. Further research should evaluate this relationship in the general population, including an even wider age range covering infancy to adolescence. Future clinical research in larger samples including sufficient numbers of girls with a clinically diagnosed ASD should also verify our observed emotional eating patterns among girls.

While more research is necessary, our findings may already have clinical implications. Mansour et al. (2016) stated that addressing abnormalities in emotion processes in individuals with higher scores on autistic traits could benefit the prevention and early detection programs for eating pathology. Our study suggests that this is possibly only beneficial in girls. Furthermore, current ASD diagnostic criteria as well as screening and observational instruments are probably unjustly biased towards males, given that they were mostly formulated on the basis of behaviors and features found in boys. We recommend that, if our findings regarding the sex-specific emotional eating behaviors in children with ASD are replicated, an eating behavior assessment is added to ASD diagnostic criteria and screening instruments. In this way, the girl ASD phenotype would probably be better represented, which may lower the under-diagnosis of autism among girls.

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CONFLICT OF INTEREST

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