Functional defecation disorders in children

Associated comorbidity and advances in management

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Chapter two

ADHD AND FUNCTIONAL DEFECATION DISORDERS IN CHILDREN

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Submitted

ABSTRACT

Objectives

To assess the prevalence of attention deficit hyperactivity disorders (ADHD) in children presenting with functional defecation disorders (FDDs) and to assess the prevalence of FDDs in children with ADHD.

Methods

A cross-sectional cohort study was carried out between September 2014 and May 2016, in which two groups of patients were included. Group 1: Parents of children with FDDs according to the Rome III criteria completed the Child Behavior Checklist (CBCL) and the VvGK (Dutch questionnaire based on the American Disruptive Behavior Disorder rating scale). Patients with ADHD subarea scores ≥70 on the CBCL and/or ≥16 on the VvGK were referred for further psychiatric evaluation. Group 2: Parents of children treated for ADHD at a specialized ADHD-outpatient clinic completed a standardized questionnaire regarding their child's defecation pattern.

Results

In group 1, 282 children were included and concomitant ADHD was diagnosed in 10.3 (7.1 – 13.5% BCaCI). Group 2 consisted of 198 children and 22.7% (17.6-28.8 BCaCI) fulfilled the Rome III criteria for a FDD. Children with both a FDD and ADHD reported urinary incontinence significantly more often compared to children with a FDD or ADHD alone: 57.1% in FDD+ADHD vs. 22.8% in FDD alone ($p<0.001$) and 31.1% in ADHD+FDD vs. 7.8% in ADHD alone ($p<0.001$).

Conclusion

10.3% of children with FDDs had ADHD and 22.7% of children with a known diagnosis of ADHD fulfilled the Rome criteria for a FDD. This observation suggests that screening for behavioral disorders and FDDs should be incorporated into the diagnostic workup of these groups of children.

INTRODUCTION

Functional defecation disorders (FDDs) are common in childhood and comprise of functional constipation (FC) and functional non-retentive fecal incontinence (FNRFI)[1]. The estimated worldwide prevalence of FC in children ranges from 0.7 to 29.6%[2], while FNRFI is estimated to occur in less than 1% of children in the general population[3]. In children with FC, fecal impaction may lead to overflow fecal incontinence, while in children with FNRFI fecal incontinence occurs without signs of fecal retention.

Behavioral problems are frequently reported in children with FDDs[4-6]. Likewise, gastrointestinal problems like abdominal pain and constipation, are common in children with behavioral disorders, such as attention deficit hyperactivity disorder (ADHD) and autism spectrum disorders (ASD)[7-9]. ADHD is defined as a persistent pattern of inattention, hyperactivity and/or impulsivity that causes impairment, with an onset before the age of 7 years[10]. The estimated prevalence of ADHD among school-aged children and adolescents is 5%[10,11]and this condition is more common in boys and gender ratios range from 1:3 to 1:16[12]. The etiology is multifactorial and largely unknown, but genetic factors, environmental and social factors are thought to play a role[13].

Reliable data on the prevalence of ADHD in children presenting with FDDs are scant. In a retrospective cohort study using a database of the military health system in the US, children with ADHD had an increased prevalence rate of FC (4.1% vs. 1.5%) and fecal incontinence (FI) (0.9% vs. 0.15%) compared with children without ADHD[8]. More reliable prospective studies on the prevalence of ADHD in children presenting with FDDs and vice versa are needed to further clarify the possible association between these two disorders. Novel insights could contribute to optimizing diagnostic and therapeutic strategies in these children. The aim of this study was to prospectively assess 1) the prevalence of ADHD in children presenting with FDDs, and 2) the prevalence of FDDs in children with a known diagnosis of ADHD.

METHODS

A cross-sectional cohort study was carried out between September 2014 and May 2016 in two groups of patients.

GROUP 1 CHILDREN WITH FDD

Children (6-16 years), who met the Rome III criteria for FC or FNRFI and who were treated at the specialized outpatient clinic of a tertiary center and a secondary hospital, were eligible for enrollment[1,14]. Patients were included regardless of previous treatments for FDDs or previously diagnosed behavioral health problems. Patients were excluded if they had an organic cause for their defecation disorder. After informed consent was obtained, parents or care-givers were asked to complete two ADHD-screening questionnaires; patients were only included if both questionnaires were returned.

ADHD screening questionnaires

1) The Child Behavior Checklist (CBCL/4-18)[15] is a validated parent-report questionnaire to evaluate various behavioral and emotional problems. We used a validated Dutch translation of the CBCL[16]. The CBCL assesses internalizing (i.e., anxious, depressive, and over-controlled) and externalizing (i.e., aggressive, hyperactive, noncompliant, and under-controlled) behaviors. It measures several subareas, including attention problems. Questions are answered on a 3-point Likert scale (0= not true, 1=somewhat or sometimes true, 2= very true or often true). Total raw scores are transformed into age- and gender-normed T-scores.

   For this study, we only referred children for further behavioral evaluation based on the CBCL if they had clinical scores in the subarea "attention problems". For this subarea, we used a T-score of ≥70 (98th percentile) as clinical scores, and T-scores between 65-69 as subclinical scores (93-97th percentile)[15]. Furthermore, the "Total CBCL T-score", as well as the total scores for internalizing and externalizing problems were calculated (clinical score: ≥64, subclinical score: 60-63).

2) The VvGK[17] is a validated Dutch questionnaire based on the 'American Disruptive Behavior Disorder rating scale'. The VvGK assesses externalizing behavior and screens for symptoms of ADHD, oppositional defiant disorder (ODD) and conduct disorder (CD). The questions are divided into four subscales: attention-deficit, hyperactivity/impulsiveness, ODD and CD. Parental responses are recorded on a 4-point Likert scale (0= not at all, 1=

a little, 2=quite a lot, 3=very much). Total raw scores are transformed into age- and gender-normed T-scores. A T-score on the attention-deficit and/or hyperactivity/impulsiveness-subscales of ≥16 (98th percentile) was used to identify children with behavioral problems, with a T-score of 15 as subclinical score (95th percentile)[17].

GROUP 2 CHILDREN WITH ADHD

Parents of children (6-16 years) with a known clinical based diagnosis of ADHD (according to the DSM-IV classification) treated at a specialized ADHD-outpatient clinic, received a letter by mail. This letter contained information about the study, an informed consent form and a questionnaire regarding the child's bowel habits. We used a standardized defecation questionnaire, developed by the specialized pediatric gastroenterology outpatient clinic of our tertiary center and consisted of questions about medical history, bowel habits, urinary problems and (previous) laxative usage. The questionnaire addresses all Rome III criteria for FC and FNRFI[1]. Parents were asked to complete the questionnaire and return it anonymously by mail.

Positive testing policy

GROUP 1 FDD-GROUP

Children with clinical scores exceeding the pre-established cut off values for the CBCL and/or VvGK were referred to a specialized ADHD outpatient clinic for a comprehensive psychiatric diagnostic assessment, this to evaluate whether they met the DSM-IV criteria for ADHD or other behavioral disorders.

GROUP 2 ADHD-GROUP

Parents were given the opportunity to contact one of the investigators (SKW) with any questions regarding the completed defecation questionnaire. If necessary, parents were referred to their general health practitioner or seen at the specialized outpatient gastroenterology clinic. Due to the anonymous nature of the questionnaires, children fulfilling the Rome III criteria were not actively approached for an evaluation at the gastroenterology clinic.

Outcomes

The primary outcomes were 1) the prevalence of ADHD in children with FDDs, according to the DSM-IV criteria based on a clinical evaluation and 2) the prevalence of FDDs in children with ADHD, according to the Rome III criteria, based on the questionnaire.

Statistical analyses

For all statistical analyses SPSS version 23 (IBM, Amsterdam, The Netherlands) was used. A maximum of 10 percent missing values was considered acceptable. Parametric data were compared using independent t-tests. For the comparison of non-parametric data, Mann-Whitney U tests were performed. For the comparison of proportions, Chi square analyses were performed. Fisher exact tests were performed to compare proportions with an observed or expected frequency of less than 5. P <.05 was considered statistically significant. Bias-corrected and accelerated bootstrapping, drawing 100 samples of the same size as the original sample with replacement, was performed to generate 95% bias-corrected and accelerate confidence intervals (BCaCI).

Ethical considerations

The medical ethics committee of the Academic Medical Center of Amsterdam approved the study protocol. All parents gave written informed consent.

RESULTS

FDD-GROUP

Demographics

The baseline characteristics of the 282 included FDD patients are shown in Table 1. Twenty-four patients (8.5%) had been diagnosed with ADHD previous to this study, all of them received treatment; 17/24 used psychopharmacological medication for ADHD.

ADHD screening questionnaires

The outcomes of the CBCL and VvGK questionnaires are summarized in Table 2. A total of 32 patients (11.3%) scored in the clinical range of either the CBCL or the VvGK or both; 17 patients (6.0%) on the CBCL and 25 patients (8.9%) on the VvGK; with 10 children (3.5%) scored in the clinical range on both questionnaires. Of the 24 patients with a prior DSM-IV diagnosis of ADHD, 11 patients had clinical scores on one or both screening questionnaires. Of the remaining 13 children diagnosed with ADHD, 5 patients had subclinical scores and 8 patients had normal scores on both questionnaires.

Psychiatric evaluation

Out of the 32 patients with positive ADHD-screening questionnaires, 25 parents waived the referral for a comprehensive psychiatric evaluation: 5 parents

Table 1 Demographics of FDD group

n= 282	
Male, *n (%)*	171 (60.6)
Age in years, *median (IQR)*	9.5 (7.3-11.8)
Center of recruitment, *n (%)*	
Emma Children's hospital/AMC, Amsterdam	270 (95.7)
Maasstad, Rotterdam	12 (4.3)
FDD diagnosis, *n (%)*	
Diagnosis FC without FI	175 (62.1)
Diagnosis FC with FI	82 (29.1)
Diagnosis FNRFI	25 (8.9)
Duration of symptoms in months, *median (IQR)*	60.0 (36.0-84.0)
Treated by general practitioner only, *n (%)*	120 (35.8)
Behavior problems, *n (%)*	
Known diagnosis of ADHD	24 (8.5)
Known DSM-diagnosis other than ADHD	48 (17.0)[1]
Use of psychopharmacologic medication for ADHD, *n (%)*	17 (6.0)

ADHD = attentive deficit/hyperactivity disorder, FC= functional constipation, FI = fecal incontinence, FNRFI = functional nonretentive fecal incontinence, IQR=interquartile range [1] *Autism spectrum disorders=25; anxiety disorder, n=10; PTSS, n=3; Tic disorder, n=4; eating disorder, n=2; pica, n=1; dysthymic disorder, n=1.*

argued that their children were not experiencing problems in daily life and 20 children were currently receiving (non)pharmacological treatment for their behavioral problems elsewhere. Ten out of these 20 children had a diagnosis of ADHD (Table 2); with 4 children having a concomitant DSM-IV diagnosis (ASD or Tic disorder). DSM-IV diagnoses in the remaining patients included ASD (n=4), anxiety disorder (n=3), developmental coordination disorder (n=1).
Thus, 7 patients were referred for a psychiatric evaluation. One patient had previously been diagnosed with ADHD, and this diagnosis was confirmed. Five out of seven patients were diagnosed with ADHD, according to the DSM-IV. One was diagnosed with Asperger's.
As ADHD was previously known in 24 patients and 5 new ADHD diagnoses were made after psychiatric evaluation, the total number of patients with a diagnosis of ADHD in the FDD-group was 29, resulting in a prevalence of 10.3% (7.1 – 13.5% BCaCI).

Table 2 ADHD-screening questionnaires and behavior health evaluation

ADHD screening questionnaires	
CBCL n=282	
Median attentional subarea score, *median (IQR)*	53.00 (51.0-59.0)
Attentional subarea clinical range (T-score ≥70), *n (%)*	17 (6.0)
Attentional subarea subclinical range (T-score 65-69), *n (%)*	23 (8.2)
Total positive scores, *(T-score ≥64), n (%)*	86 (30.5)
Internalizing behavior problems, *(T-score ≥64), n (%)*	121 (43)
Externalizing behavior problems, (T-score ≥64), *n (%)*	46 (16.3)
VvGK n=282	
Median VvGK-A score, *median (IQR)*	11.0 (10.0-13.0)
VvGK-A clinical range (score ≥16), *n (%)*	24 (8.5)
Median VvGK-HI score, *median (IQR)*	10.0 (10.0-12.0)
VvGK-HI clinical range (score ≥16), *n (%)*	11 (3.9)
VvGK-A or VvGK-HI clinical range (score ≥16), *n (%)*	25 (8.9)
VvGK-A or VvGK-HI subclinical range (score =15), *n (%)*	17 (6.3)
Patients with clinical scores n=32	
Cases with scores in clinical range on CBCL **or** VvGK, *n (%)*	32 (11.3)
Cases with both scores in clinical range of CBCL **and** VvGK, *n (%)*	10 (3.5)
Psychiatric evaluation n=32	
Parents approached for a referral, *n (%)*	32 (11.3)
Previously known DSM-diagnosis, *n (%)*	18 (54.5) [a,b]
Waived referral, *n (%)*	25 (78.1) [b]
Completed psychiatric evaluations	7 (21.8) [b]
DSM-diagnosis based on psychiatric evaluation n=7	
ADHD, *n (%)*	6 (18.8) [b, c]
Attention deficit disorder – NOS, *n (%)*	1 (3.1) [b]
Asperger's, *n (%)*	1 (3.1) [b]

ADHD= attentive deficit/hyperactivity disorder, CBCL= Child Behavior Checklist, IQR=interquartile range, NOS= not otherwise specified, VvGK-A= attention deficit subscale on VvGK, VvGK-HI= hyperactivity/impulsiveness subscale on VvGK

[a] *ADHD, n=7; ADHD+Autism spectrum disorder, n=3; ADHD+Tic disorder, n=1; autism spectrum disorder n=4; anxiety disorder, n=3; and developmental coordination disorder, n=1.* [b] *n (% of the parents approached for a referral for psychiatric evaluation),* [c] *5/6 new diagnosis of ADHD, and 1/6 diagnosis of ADHD was previously known and confirmed*

Table 3 Clinical characteristics of patients in the FDD group with and without ADHD according to the DSM-IV criteria

	FDD	FDD + ADHD	p-value
N	254	28	
Male, n (%)	154 (60.1)	17 (60.7)	0.99 [a]
Age in years, median (IQR)	9.3 (7.3 – 11.4)	10.9 (8.3 – 12.5)	0.09 [b]
FDD subtypes, n (%)			
Diagnosis of FC without FI	76 (29.9)	6 (21.4)	0.24 [a]
Diagnosis of FC with FI	156 (61.4)	19 (67.9)	0.33 [a]
Diagnosis of FNRFI	22 (8.7)	3 (10.7)	0.46 [a]
Duration of symptoms in months, median (IQR)	60 (36 – 84)	72 (36 – 96)	0.28 [b]
Psychiatric comorbidity other than ADHD, n (%)	39 (15.4)	9 (32.1)	0.03 [a] *
Urinary incontinence, n (%)			
Nighttime	51 (20.1)	9 (32.1)	0.12 [a]
Daytime	58 (22.8)	16 (57.1)	<0.001 [a] *

*ADHD = attentive deficit/hyperactivity disorder, FC= functional constipation, FDD= functional defecation disorder, FI = fecal incontinence, FNRFI = functional nonretentive fecal incontinence, IQR=interquartile range. [a] Fisher's exact test, [b] Mann-Witney U test, *statistically significant*

Clinical characteristics of patients with and without ADHD symptoms

Table 3 shows the clinical characteristics of children in the FDD-group, comparing patients with and without a diagnosis of ADHD. Patients with FDD+ADHD reported daytime urinary incontinence (UI) significantly more often compared to children with FDD alone (57.1% vs 22.8%, p < 0.001).

ADHD GROUP

Demographics

Baseline characteristics of the 198 included ADHD patients are shown in Table 4. The majority (n=153, 77.3%) of patients with ADHD used psychopharmacological medication; 23 patients (11.6%) had ≥1 other concomitant psychiatric disorders.
The prevalence of FDDs in the ADHD-group was 22.7 (17.6-28.8 BCaCI); 42 patients met criteria for FC and 3 patients met criteria for FNRFI. Six out of 45 children (13.3%) had previously been diagnosed with a FDD and 5 of these patients still used laxatives at the moment of enrollment in this study.

Clinical characteristics of patients with and without FDD symptoms

Clinical characteristics of patients in the ADHD-group were compared between those with and without FDDs (Table 5). Abdominal pain (60.0% vs 30.1%, p< 0.001) and UI (31.1% vs 7.8%, p < 0.001) were reported significantly more often in children with ADHD+FDD compared to children with ADHD alone.

Table 4 Demographics ADHD group

n=198	
Male, *n (%)*	144 (72.7)
Age in years, *median (IQR)*	11.6 (9.8 – 13.7)
Center of recruitment, *n (%)*	
De Bascule, Amsterdam	118 (59.6)
Maasstad Hospital, Rotterdam	80 (40.4)
Previously diagnosed with FDD, *n (%)*	6 (3.0)
Patients with other psychiatric comorbidity, *n (%)*	23 (11.6)[1]
Using psychopharmacologic medication, *n (%)*	153 (77.3)
Meet criteria for FDD, *n (%)*	
Total	45 (22.7)
FC without FI	29 (64.4)
FC with FI	13 (28.8)
FNRFI	3 (6.7)

FC= functional constipation, FDD= functional defecation disorder, FI = fecal incontinence, FNRFI = functional nonretentive fecal incontinence, IQR=interquartile range

[1] *Psychiatric comorbidity in patients from the ADHD-group: Autism spectrum disorder, n=10; ODD, n=4; anxiety disorder, n=4; dysthymic disorder, n=3, trichotillomia, n=1*

DISCUSSION

This is the first study to prospectively assess the prevalence of ADHD (based on the DSM-IV criteria) in children with functional defecation disorders (FDDs) (based on the internationally accepted Rome III criteria), and vice versa. In our study, 10.3% children presenting with FDDs had a confirmed diagnosis of ADHD and 22.7% of children with a known diagnosis of ADHD fulfilled the Rome III criteria for a FDD. Children with FDDs+ADHD and ADHD+FDDs reported urinary incontinence (UI) significantly more often compared to children with ADHD and FDDs alone.

The prevalence of concomitant ADHD in children with FDDs (10.3%) found in our sample is higher than the reported prevalence of 5% in the general population[18]. Our results corroborate previous studies showing a higher prevalence of ADHD in children with FDD. In a study by Niemczyk et al., 1,676 parents of German schoolchildren completed a questionnaire regarding FI, UI and ADHD symptoms. ADHD was diagnosed based on DSM-IV items and incontinence was defined based on occurrence of at least once per month. They reported a prevalence of 10.3% of ADHD in children with FI[19]. These results were corroborated by another population-based study, in which parents of 8,242 children aged 7-8 years, completed questionnaires regarding FI and common behavioral problems. In this study, 9.2% of children with frequent FI had ADHD[20]. The limitation of these studies was that ADHD diagnoses were based on questionnaire-scores, and not confirmed by clinical evaluation. Recently, our group showed that positive ASD-screening questionnaires did not always correctly identify children with ASD[21]. After psychiatric evaluation, the majority of children with positive screening questionnaires were diagnosed with other DSM-IV diagnoses than ASD. Together with the results from our current study, this emphasizes the need for referral in case of positive screening questionnaires.

We found that the prevalence of coexistent FDDs in children with ADHD was 22.7% (FC 64.4%, FC+FI 28.8%), which is higher than the median prevalence of FC reported in a systematic review (12%)[2] and higher than the prevalence of FDDs in children with ADHD reported by McKeown et al (FC 4.1% and FI 0.9%)[8]. In the latter study, ICD-codes were used to identify children with ADHD, FC and FI in a military health system database. However, this study did not involve a clinical evaluation and it is unclear if standardized criteria, like the Rome III and DSM-IV criteria, were used to diagnose these disorders. Differences between our findings and those from other studies may rely on methodological factors, especially differences in definitions.
Although multiple studies have described an association between FC, FI and ADHD, the pathophysiology of these disorders has not been clarified yet. FDDs and ADHD are heterogeneous disorders in which genetic factors are thought to play a role[13,22]. Another factor could be an altered communication between the central nervous system (CNS) and the enteric nervous system, resulting in disturbed gastrointestinal motility[8]. Others hypothesized that ADHD leads to FDDs, as children with ADHD ignore their urge to defecate or experience difficulties taking the time to complete bowel movements[19]. Children with ADHD are also less compliant to incontinence treatment[23] and this could also causes problems with toilet training.

Urinary incontinence has been described to be associated with both ADHD and FDDs[20,24,25] and psychological problems have been shown to be associated with both UI and FI[26]. Approximately one third of children with FDDs has coexistent daytime and nighttime UI[27,28]. Moreover, successful treatment of constipation resulted in resolution of UI[28]. In children with ADHD, nighttime UI is one of the most common reported comorbidities[29,30]. Clinical studies have consistently shown that children with ADHD have high rates of nighttime UI, but much less data is available on daytime UI. In a small study, children with ADHD (n=28) had significantly more nighttime and daytime UI than controls (n=22)[31]. In our study, children with FDD+ADHD and ADHD+FDD also reported symptoms of UI. The connection between these disorders and UI is unknown, but some hypothesize that FDDs and UI are related to maturational disorders of the CNS, resulting in difficulties with responding to urge[5]. Other possible factors include fecal impaction leading to bladder obstruction and detrusor hyperactivity, or abnormal pelvic floor function[32]. It is hypothesized that patients with ADHD frequently have coexisting UI because they share CNS-abnormalities[33-35], but the incontinence may also be due to ADHD-associated inattentiveness[33].

The major strengths of our study are the prospective design, the large patient samples and that diagnoses of FDDs and ADHD were made according to the internationally accepted criteria; the Rome III and the DSM-IV criteria. Nevertheless, there are limitations that should be taken into account when interpreting our results. Firstly, our study is at risk of selection bias towards more severe cases of FDD and ADHD as most of the patients were recruited from tertiary referral centers and patients/parents may have been more willing to participate if they believed that their child may have been suffering from these disorders. This could have resulted in a higher overall prevalence of ADHD in children with FDD, or FDD in children with ADHD. Secondly, it is possible that children with positive screening-questionnaires, who waived their referral for behavior health evaluation, have ADHD or meet criteria for another DSM-diagnosis. This could have resulted in an underestimation of the prevalence of ADHD in children with FDDs. The same goes for children who had a clinical total CBCL-score, these children may have been referred for evaluation outside the study, for clinical reasons. The outcome of these referrals was not available to our research team. Lastly, patients in the ADHD-group were not subjected to a physical and rectal examination, which are necessary to determine the presence of a large fecal mass in the rectum, one of the Rome III criteria. It is therefore possible that we have underestimated the prevalence of FDDs in children with ADHD.

Our findings may have several implications for clinical practice as well as research concerning childhood FDDs. Although the majority of children with behavior problems in the current study were already diagnosed, the use of screening-questionnaires resulted in 6 new DSM-diagnoses. Moreover, 11/24 children that were diagnosed with and received treatment for ADHD still had clinical scores on the ADHD-screening questionnaires at time of the survey. In addition, we identified children with symptoms of internalizing (43%) and externalizing (16.3%) disorders. Since unrecognized behavior problems may interfere with the treatment of FDDs, children with FDDs should be screened for behavior problems (like ADHD) routinely. If behavior problems or FDDs are present, referral for and treatment of both disorders is recommended. Especially since treatment outcomes are less successful in children with ADHD[36]. Niemczyk et al., showed that treatment of ADHD had positive effects on the prevalence of incontinence[23], and van Dijk et al showed that CBCL-scores decreased after a combination of conventional treatment and behavioral therapy[37]. Vice versa, healthcare providers should be aware of the high prevalence of FDDs and UI in children with ADHD and these children should be identified at an early stage to initiate proper care.

The high CBCL total, internalizing and externalizing scores in the FDD-group show that these children are not only impaired by attentional and hyperactive problems, but possibly also by other comorbid behavior problems, which can negatively affect treatment outcome and compliance as well. Screening of children with FDDs should therefore be done using broadband screening questionnaires (such as the CBCL), rather than ADHD-specific questionnaires alone. In order to better understand the relationship between both disorders and to select adequate treatment methods, future research should focus on whether children with FDD and ADHD would benefit from targeted treatment strategies. In addition, future research could potentially benefit from further investigating the link between FDDs and ADHD, e.g. gastrointestinal motility testing in children with FDDs with and without ADHD.

CONCLUSION

In this study, 10.3% of children with FDDs had ADHD and 22.7% of children with a known diagnosis of ADHD fulfilled the Rome criteria for a FDD. This suggests that screening for behavioral disorders and defecation disorders should be incorporated into the diagnostic workup of these groups of children. Further research is necessary to further unravel the possible joint pathophysiology of FDDs and ADHD and to assess whether these children would benefit from targeted treatment strategies.

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REFERENCES

1 Hyams JS, Di Lorenzo C, Saps M, et al. Functional Disorders: Children and Adolescents. *Gastroenterology*. 2016.

2 Mugie SM, Benninga MA, Di Lorenzo C. Epidemiology of constipation in children and adults: a systematic review. *Best Pract Res Clin Gastroenterol*. 2011;25(1):3–18.

3 Koppen IJN, von Gontard A, Chase J, et al. Management of functional nonretentive fecal incontinence in children: Recommendations from the International Children's Continence Society. *J Pediatr Urol*. 2016;12(1):56–64.

4 van Dijk M, Benninga MA, Grootenhuis MA, et al. Chronic childhood constipation: a review of the literature and the introduction of a protocolized behavioral intervention program. *Patient Educ Couns*. 2007;67(1-2):63–77.

5 van Dijk M, Benninga MA, Grootenhuis MA, et al. Prevalence and associated clinical characteristics of behavior problems in constipated children. *Pediatrics*. 2010;125(2):e309–17.

6 Benninga MA, Voskuijl WP, Akkerhuis GW, et al. Colonic transit times and behaviour profiles in children with defecation disorders. *Arch Dis Child*. 2004;89(1):13–6.

7 Ibrahim SH, Voigt RG, Katusic SK, et al. Incidence of gastrointestinal symptoms in children with autism: a population-based study. *Pediatrics*. 2009;124(2):680–6.

8 McKeown C, Hisle-Gorman E, Eide M, et al. Association of constipation and fecal incontinence with attention-deficit/hyperactivity disorder. *Pediatrics*. 2013;132(5):e1210–5.

9 Peeters B, Noens I, Philips EM, et al. Autism spectrum disorders in children with functional defecation disorders. *J Pediatr*. 2013;163(3):873–8.

10 Diagnostic and statistical manual of mental disorder – Fifth Edition (DSM 5). American Psychiatric Association (APA). Washington, D.C.:American Psychiatric Association 2013.

11 Niemczyk J, Equit M, Hoffmann L, et al. Incontinence in children with treated attention-deficit/hyperactivity disorder. *J Pediatr Urol*. 2015;11(3):141.e1–6.

12 Nøvik TS, Hervas A, Ralston SJ, et al. Influence of gender on attention-deficit/hyperactivity disorder in Europe--ADORE. *Eur Child Adolesc Psychiatry*. 2006;15 Suppl 1:115–24.

13 Thapar A, Cooper M. Attention deficit hyperactivity disorder. *Lancet*. 2016;387(10024): 1240–1250.

14 Rasquin A, Di Lorenzo C, Forbes D, et al. Childhood functional gastrointestinal disorders: child/adolescent. *Gastroenterology*. 2006;130(5):1527–37.

15 Achenbach T. Manual for the Child Behavior Checklist/4-18 and 1991 Profiles. Burlingtong, VT: Univeristy of Vermont Department of Psychiatry; 1991.

16 Verhulst F, van der Ende J, Koot H. Manual for the Child Behavior Checklist/4-18 and 1991 Profiles [in Dutch]. Rotterdam, Netherlands; Afdeling Kinder- en JEugdpsychiatrie, Sophia Kinderziekenhuis/Academisch Ziekenhuis Rotterdam/Erasmus Universiteit van Rotterdam; 1996.

17 Oosterlaan J, Baeyens D, Scheres A, et al. Manual vor behavior problems in children 6-16 years, Manual [In Dutch]. Amsterdam, The Netherlands; 2008.

18 Le HH, Hodgkins P, Postma MJ, et al. Economic impact of childhood/adolescent ADHD in a European setting: the Netherlands as a reference case. *Eur Child Adolesc Psychiatry*. 2014;23(7):587–98.

19 Niemczyk J, Equit M, Braun-Bither K, et al. Prevalence of incontinence, attention deficit/hyperactivity disorder and oppositional defiant disorder in preschool children. *Eur Child Adolesc Psychiatry*. 2015;24(7):837–43.

20 Joinson C, Heron J, Butler U, et al. Psychological differences between children with and without soiling problems. *Pediatrics*. 2006;117(5):1575–84.

21 Kuizenga-Wessel S, Di Lorenzo C, Nicholson

LM, et al. Screening for autism identifies behavioral disorders in children functional defecation disorders. *Eur J Pediatr*. 2016. doi:10.1007/s00431-016-2775-x.

22 Benninga MA, Büller HA, Heymans HS, et al. Is encopresis always the result of constipation? *Arch Dis Child*. 1994;71(3):186–93.

23 Niemczyk J, Equit M, Hoffmann L, et al. Incontinence in children with treated attention-deficit/hyperactivity disorder. *J Pediatr Urol*. 2015;11(3):141.e1–6.

24 Loening-Baucke V. Prevalence rates for constipation and faecal and urinary incontinence. *Arch Dis Child*. 2007;92(6):486–9.

25 Nurko S, Scott SM. Coexistence of constipation and incontinence in children and adults. *Best Pract Res Clin Gastroenterol*. 2011;25(1):29–41.

26 von Gontard A, Baeyens D, Van Hoecke E, et al. Psychological and psychiatric issues in urinary and fecal incontinence. *J Urol*. 2011;185(4):1432–6.

27 Loening-Baucke V. Functional fecal retention with encopresis in childhood. *J Pediatr Gastroenterol Nutr*. 2004;38(1):79–84.

28 Loening-Baucke V. Urinary incontinence and urinary tract infection and their resolution with treatment of chronic constipation of childhood. *Pediatrics*. 1997;100(2 Pt 1):228–32.

29 von Gontard A, Moritz AM, Thome-Granz S, et al. Association of attention deficit and elimination disorders at school entry: a population based study. *J Urol*. 2011;186(5):2027–32.

30 von Gontard A, Equit M. Comorbidity of ADHD and incontinence in children. *Eur Child Adolesc Psychiatry*. 2015;24(2):127–40.

31 Duel BP, Steinberg-Epstein R, Hill M, et al. A survey of voiding dysfunction in children with attention deficit-hyperactivity disorder. *J Urol*. 2003;170(4 Pt 2):1521–3; discussion 1523–4.

32 Burgers R, Liem O, Canon S, et al. Effect of rectal distention on lower urinary tract function in children. *J Urol*. 2010;184(4 Suppl):1680–5.

33 Crimmins CR, Rathbun SR, Husmann DA. Management of urinary incontinence and nocturnal enuresis in attention-deficit hyperactivity disorder. *J Urol*. 2003;170(4 Pt 1):1347–50.

34 Franco I. New ideas in the cause of bladder dysfunction in children. *Curr Opin Urol*. 2011;21(4):334–8.

35 Shreeram S, He J-P, Kalaydjian A, et al. Prevalence of enuresis and its association with attention-deficit/hyperactivity disorder among U.S. children: results from a nationally representative study. *J Am Acad Child Adolesc Psychiatry*. 2009;48(1):35–41.

36 van Everdingen-Faasen EQ, Gerritsen BJ, Mulder PGH, et al. Psychosocial co-morbidity affects treatment outcome in children with fecal incontinence. *Eur J Pediatr*. 2008;167(9):985–9.

37 van Dijk M, Bongers MEJ, de Vries G-J, et al. Behavioral therapy for childhood constipation: a randomized, controlled trial. *Pediatrics*. 2008;121(5):e1334–41.