Eur J Pediatr (2015) 174:897–902
DOI 10.1007/s00431-014-2474-4

ORIGINAL ARTICLE

Periodic limb movements during sleep are associated with a lower quality of life in children with monosymptomatic nocturnal enuresis

Charlotte Van Herzeele · Karlien Dhondt · Sanne Patrick Roels · Ann Raes · Luitzen-Albert Groen · Piet Hoebeke · Johan Vande Walle

Received: 11 August 2014 / Revised: 25 November 2014 / Accepted: 9 December 2014 / Published online: 9 January 2015

Abstract The study investigates whether cortical arousals and periodic limb movements during sleep are related to daytime psychological functioning in children with monosymptomatic nocturnal enuresis with associated nocturnal polyuria. Psychological functioning is evaluated on five domains: attention deficit hyperactivity disorder—inattentive problems, quality of life, internalizing problems, externalizing problems, and executive functioning. This multi-informant (parents, teachers, and children) and multi-method study included overnight video-polysomnography, questionnaires, and neuropsychological testing. Thirty children (7 girls) 6 to 16 years (mean 10.43 years, SD 3.08) were selected in a tertiary enuresis center. A high index of periodic limb movements during sleep was associated with a lower quality of life, according to the child. No significant correlations were found with attention deficit hyperactivity disorder—inattentive problems, internalizing problems, externalizing problems, and executive functioning.

Conclusion: This study clarifies the relationship between sleep parameters and psychological functioning of the children with monosymptomatic nocturnal enuresis and associated nocturnal polyuria according to the child, the parents, and the teachers. Periodic limb movements during sleep are associated with a lower quality of life of the child.

Keywords Child · Psychology · Quality of life · Sleep · Enuresis

Abbreviations

AASM	American Academy of Sleep Medicine
ADHD	Attention deficit hyperactivity disorder
BRIEF	Behavior Rating Inventory of Executive Function
CANTAB	Cambridge Neuropsychological Test Automated Battery
CBCL	Child Behavior Checklist
DBDRS	Disruptive Behavior Disorder Rating Scale
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, 4th Edition
ICCS	International Children's Continence Society
MNE	Monosymptomatic nocturnal enuresis
NE	Nocturnal enuresis
NP	Nocturnal polyuria
PinQ	Pediatric incontinence quality of life
PLMS	Periodic limb movements during sleep
PSG	Polysomnography
QoL	Quality of life

Communicated by Jaan Toelen

C. Van Herzeele (✉) · A. Raes · L.-A. Groen · P. Hoebeke · J. Vande Walle
Department of Pediatric Nephrology/Urology, University Hospital Ghent, De Pintelaan 185, 9000 Ghent, Belgium
e-mail: charlotte.vanherzeele@ugent.be

A. Raes
e-mail: ann.raes@uzgent.be

L.-A. Groen
e-mail: luitzenalbert.groen@uzgent.be

P. Hoebeke
e-mail: piet.hoebeke@uzgent.be

J. Vande Walle
e-mail: johan.vandewalle@ugent.be

K. Dhondt
Pediatrics, Department of Child Neurology & Metabolism, Pediatric Sleep Center, University Hospital Ghent, De Pintelaan 185, 9000 Ghent, Belgium
e-mail: karlien.dhondt@ugent.be

S. P. Roels
Department of Data Analysis, Ghent University, Henri Dunantlaan 1, 9000 Ghent, Belgium
e-mail: sanne.roels@ugent.be

TRF	Teacher Report Form
WISC-III-NL	Flemish version of the Wechsler Intelligence Scale for children, 3rd edition

Introduction

Monosymptomatic nocturnal enuresis (MNE) is a heterogeneous disorder, caused by various pathogenic factors: a mismatch of the increased nocturnal diuresis rate and the functional bladder volume together with a failure to awaken in response to a full bladder. Several comorbidities probably play a part in the pathogenesis. Most common comorbidities are bladder dysfunction [47], disturbed circadian rhythm [38], sleep problems [13], and psychological problems, especially attention deficit hyperactivity disorder (ADHD) [5, 42].

The most common psychological disorder in children with enuresis is ADHD [5, 27], especially the ADHD-inattentive subtype [4, 32]. Children with the ADHD-inattentive subtype have a low ability to concentrate; they have no hyperactivity and impulsivity problems. The high comorbidity is observed in different study populations [44]: a pediatric setting [5], a child psychiatry setting [7, 14, 35], and in epidemiological studies [22, 43].

Children with enuresis are difficult to arouse from sleep compared to controls [46]. Subjectively, parents of children with nocturnal enuresis (NE) confirm this and often consider their child to be a "deep" sleeper. However, Yeung et al. suggested in a letter that children with enuresis, mostly due to an overactive bladder, have fragmented sleep associated with frequent cortical arousals but an inability to awaken completely [48]. The presence of increased arousals is confirmed by Dhondt et al. in a heterogeneous group of children with NE [12, 13].

Children with enuresis experience higher levels of daytime sleepiness [11]. Daytime sleepiness is associated with internal and external behavior problems [1]. Daytime dysfunction due to lower sleep quality is associated with a lower quality of life (QoL) in terms of physical and social well-being [16].

The majority of the above-mentioned studies have some limitations. Studies investigating sleep in children with NE are performed in therapy-resistant children [12, 13, 46] or in patients with bladder dysfunctions [48]. Furthermore, studies investigating psychological functioning of children with NE are performed in heterogeneous patient groups, not differentiating between MNE and non-MNE. Non-MNE is associated with a higher incidence of psychological problems [21, 43, 44]. Therefore, children with non-MNE are excluded from this study.

This is the first study investigating the association between sleep and ADHD-inattentive symptoms in a homogeneous group of patients with MNE associated with nocturnal polyuria (NP). Not only ADHD-inattentive symptoms are studied but also broad psychological functioning, including QoL, internalizing problems, externalizing problems, and executive functioning.

This explorative study investigates in children with MNE associated with NP, if specific sleep parameters, i.e. cortical arousals and periodic limb movements (PLMS) are related to the psychological functioning of the child. Psychological functioning is evaluated on five domains: ADHD-inattentive problems, QoL, internalizing problems, externalizing problems, and executive functioning. It is expected that a disturbed sleep is associated with worse psychological functioning.

Material and methods

Study population

Thirty children (7 girls) 6 to 16 years (mean 10.43 y, SD 3.08) suffering from MNE associated with NP, referred to a tertiary enuresis center, were included. NP was defined in this study as a nocturnal diuresis exceeding the expected bladder capacity according to the formula of Hjälmas [(age+1)*30]. Patient characteristics were demonstrated in Table 1. Exclusion criteria were daytime incontinence resistant to therapy, dysfunctional voiding, urgency, diuretics, antihypertensives, uropathy, renal abnormalities, poor therapy compliance, and intelligence quotient below 75. Children who were on desmopressin stopped treatment at least 2 weeks for the start of the study. This substudy was part of a larger study investigating the influence of desmopressin on sleep, MNE, and psychology.

Procedure

The study was approved by the Institutional Ethics Board of the Ghent University Hospital (B670201212). Written consent was obtained from all patients and their parents.

All subjects participated in one overnight standardized video-polysomnography (PSG). PLMS and cortical arousals

Table 1 Patient characteristics

	N of patients with available data	Mean	SD
Age (years)	30	10.43	3.08
MVV (ml)	30	383	132
Number of wet nights a week	29	5.2	1.9
Nocturnal diuresis on PSG (ml)			
Wet + dry nights	29	753	355
Wet nights only	26	767	372
Dry nights only	3	633	115

MVV maximum voided volume, *PSG* polysomnography were the main PSG parameters investigated in this study. PLMS were defined as rhythmic extensions and dorsiflexions of the ankle, occasionally of the knee and hips. Scored according to the American Academy of Sleep Medicine (AASM) criteria, PLMS were calculated per hour of sleep (PLMS index). A PLMS index greater than five was considered as pathologic [26]. PLMS usually cluster into episodes and could co-occur with cortical arousals.

Cortical arousals could be short (micro-arousals of 3 to 15 s) or longer (>15 s), resulting in awakening. The number of arousals during the night was manually scored according to the AASM criteria and also calculated as arousal index (number of arousals over total sleep time). Awakening index was also calculated (number of awakenings over total sleep time).

The psychological measurements were multi-method and multi-informant. Parents, children, and the teachers filled in questionnaires, and neuropsychological testing of the child was performed.

Parents provided socio-demographic information. Parents and teachers completed the Child Behavior Checklist/Teacher Report Form (CBCL/TRF), the Disruptive Behavior Disorder Rating Scale (DBDRS), and the Behavior Rating Inventory of Executive Function (BRIEF). The CBCL/TRF measured emotional, social, and behavioral problems in 6 to 18-year-old children. Problems were grouped into internalizing and externalizing problems [2, 20, 40, 41]. The DBDRS measured behavior problems in terms of DSM-IV [3] criteria in 6 to 16-year-old children [17, 29, 30]. It contained four scales: inattention, hyperactivity/impulsivity, oppositional defiant disorder, and conduct disorder. The BRIEF measured executive function behaviors for children and adolescents ages 5–18 years [18, 19, 37].

Parents and children completed two questionnaires measuring QoL of the child. The pediatric quality of life inventory measured health related QoL in children aged 2 to 18-year old [15, 39] Scores ranged from 0 to 100 with higher scores indicating better QoL. The pediatric incontinence quality of life (PinQ) was originally developed to measure QoL in children with bladder dysfunction [8, 9]. Scores ranged from 0 to 84, with higher scores on the PinQ indicating worse QoL concerning the wetting problem.

The child performed three neuropsychological tests. First, the digit span subtest of the Flemish version of the Wechsler Intelligence Scale for children, third edition (WISC-III-NL) was used to measure auditive memory [23, 45]. Second, two subtests of the Test of Everyday Attention for children were used to measure sustained attention: score double task and code transmission [24, 25]. Third, the child underwent several subtests of the Cambridge Neuropsychological Test Automated Battery (CANTAB) [10, 36]. Motor screening and Big/little circle were two mandatory screening subtests to screen for visual, movement, comprehension, learning and reversal difficulties. Four subtests assessed executive function, working memory and planning. More specifically, Intra/Extra Dimensional set shift assessed rule acquisition and attentional set shifting. The Stockings of Cambridge assessed spatial planning and motor control. Spatial Span and Spatial Recognition Memory tested working memory capacity. Visual sustained attention was measured by the subtest Rapid Visual information Processing.

Statistical analyses

The relationship between psychological and specific sleep parameters (cortical arousals and PLMS index) was explored by pairwise correlations using R version 3.0.2 [33]. Variables with more than 20 % missing observations were excluded from the correlation analyses. Correlations were corrected for multiple testing per psychological domain and per physical measure using false discovery rate control [6]. False discovery rate control examines the expected number of false discoveries among all discoveries.

Results

Mean PLMS index was 10.83 (SD 4.99; min 3.6–max 23.3). Arousal index ranged between 1.2 and 13.9 (mean 6.433; SD 3.31) and awakening index between 1.8 and 15.2 (mean 8.720; SD 3.76).

Scores on the pediatric quality of life inventory in children and parents ranged, respectively, between 51.41 and 97.50 (mean 72.87; SD 12.08) and between 42.97 and 100 (mean 79.96; SD 14.75). Mean scores on the PinQ for children and parents were, respectively, 26.17 (SD 12.07; min 8–max 54) and 23.1 (SD 14.86; min 3–max 63).

Normscores on the Test of Everyday Attention for Children on the score double task and the code transmission task ranged, respectively, between 2 and 14 (mean 9.03; SD 2.65) and between 2 and 15 (mean 8.83; SD 3.36). The mean z-score on the CANTAB Rapid Visual information Processing was 0.45 (SD 1.06; min −1.86–max 1.69). According to the parents, 5 of the 30 children had a (sub)clinical score on the DBDRS inattentive scale, compared to 1 of the 25 children with available teacher data.

Overall, 11/30 children had a (sub)clinical score on the CBCL on internalizing problems. The same number of children had a (sub)clinical score on externalizing problems. According to the teachers, 4/26 and 5/26 children had a (sub)clinical score on internalizing and externalizing problems, respectively.

The behavioral regulation index scores were (sub)clinical for 6/30 children according to the parents. Of the 25 children with evaluable data, none of them had a (sub)clinical score on the behavioral regulation index. The mean z-scores on the

CANTAB Intra/Extra Dimensional set shifting and Stockings of Cambridge were 0.40 (SD 1.03; min −1.25–max 3.88) and −0.22 (SD 0.99; min −3.21–max 1.24), respectively. The *z*-scores on the CANTAB Spatial Recognition Memory and Spatial Span ranged, respectively, between −0.88 and 1.79 (mean 0.52; SD 0.67) and between −2.84 and 2.77 (mean 0.23; SD 1.32). Finally, normscores on the WISC-III-NL Digit Span ranged between 2 and 17 (mean 9.4; SD 3.5).

A high PLMS index was associated with a high score on the PinQ, indicating a lower QoL according to the child. The association between a high arousal index and a lower QoL was only marginally significant. There were no correlations found between the sleep parameters (i.e., PLMS and cortical arousals) and ADHD-inattentive problems, internalizing problems, externalizing problems, and executive functioning. Details were demonstrated in Table 2.

Discussion

This study investigates whether specific sleep parameters, i.e., cortical arousals and PLMS are related to the psychological

Table 2 Sleep parameters, pairwise correlations with psychological domains

Psychological domain	Measurement	PLMS	Cortical arousals	
		PLMS index	Arousal index	Arousal—awakening index
Quality of life	Pediatric incontinence Questionnaire			
	Children	0.517*	0.431[a]	0.317
	Parents	0.048	0.012	0.014
	Pediatric quality of life inventory			
	Children	0.065	0.231	0.325
	Parents	−0.078	0.118	0.208
ADHD-inattentive symptoms	CANTAB Rapid Visual information Processing	0.270	0.138	0.068
	Test of everyday attention for children			
	Score double task	0.388	0.320	0.240
	Code transmission	0.256	0.133	0.154
	DBDRS inattentive subscale			
	Parents	−0.107	−0.195	−0.148
	Teachers	−0.103	−0.207	−0.229
Internalizing problems	Child behavior checklist/teacher report form			
	Parents	0.078	−0.153	−0.199
	Teachers	−0.120	−0.145	−0.219
Externalizing problems	Child behavior checklist/teacher report form			
	Parents	0.140	−0.054	−0.149
	Teachers	0.095	−0.050	−0.203
Executive functioning	CANTAB			
	Spatial Recognition Memory	−0.030	0.150	0.035
	Spatial Span	0.016	−0.035	−0.056
	Intra/Extra Dimensional set shift	0.167	0.267	0.340
	Stockings Of Cambridge	0.013	0.020	0.149
	WISC-III-NL Digit Span	0.361	0.233	0.180
	BRIEF			
	Parents (total score)	0.016	0.017	−0.045
	Teachers (total score)	Missing	Missing	Missing

ADHD attention deficit hyperactivity disorder, *BRIEF* Behavior Rating Inventory of Executive Function, *CANTAB* Cambridge Neuropsychological Test Automated Battery, *DBDRS* Disruptive Behavior Disorder Rating Scale, *PLMS* periodic limb movements during sleep, *WISC-III-NL* Flemish version of the Wechsler Intelligence Scale for children, 3rd edition

*Corrected $p<0.05$

[a] $p<0.1$ ~ marginally significant

functioning of the child in a homogeneous group of children with MNE associated with NP. Psychological functioning is evaluated on five domains: ADHD-inattentive problems, QoL, internalizing problems, externalizing problems, and executive functioning.

The study demonstrates a high incidence of disrupted sleep and an association between a high PLMS index and a low QoL of the child. More specific, a high PLMS index is associated with a high score on the PinQ, indicating a lower QoL associated with the wetting problem, according to the child, not according to the parents. This confirms previous literature based on questionnaires that a low quality of sleep is associated with a lower QoL [16].

Our pilot study demonstrated previously an increased PLMS index and cortical arousability in children with refractory nocturnal enuresis [12]. PLMS are infrequent in normal children, a PLMS index higher than five is considered as pathologic [26]. Of the thirty children in the pilot study, all except one had a pathological PLMS index. These findings were confirmed in our case–control study, where it was demonstrated that children with NE displayed higher sleep fragmentation (more cortical arousals) and PLMS than the control children with a possible sleep disorder without NE [13].

The results of the present study confirm the findings of our pilot [12] and case–control study [13] in a more benign population of enuresis with NP: a high incidence of PLMS and cortical arousals and an increased comorbidity with psychological problems. However, this study only finds a significant correlation with QoL. ADHD-inattentive problems, internalizing problems, externalizing problems, and executive functioning are not associated with PLMS and cortical arousals.

The first advantage of the study is the carefully selected group of children with MNE associated with nocturnal polyuria without daytime symptoms. Second, this study is the first using objective sleep parameters by video-polysomnography while investigating the association with psychological functioning. Third, previous studies in children with enuresis investigated only 1 or 2 domains of psychological functioning [5, 42], assuming that children with enuresis only have problems on the investigated domains. This study investigates extensively the psychological functioning in a homogeneous group of children with MNE in an explorative way.

However, this study has some limitations. First, the lack of a control group of children without enuresis and without sleep problems. Due to financial and ethical reasons, this was not achievable. Second, the definition of NP of >100 % expected bladder capacity does not follow the International Children's Continence Society (ICCS) standardization paper and may be subject for criticism [28]. To our defence, we want to emphasize that the ICCS definition of >130 % is an expert opinion-based definition. The recent data from the Aarhus group in a control population demonstrates that the 100 % definition is more relevant in defining NP and/or desmopressin response [34]. These recent data are not yet incorporated in the ICCS paper [28]. Patients with NP of >130 % expected bladder capacity are at the end of the spectrum. This would neglect a major proportion of the population with a mismatch between an increased nocturnal diuresis and a normal bladder volume.

Third, the male-to-female ratio is not according to literature. During inclusion period, more male children were eligible for the study. This selection bias could influence the results. Finally, the sleep is not measured in the natural environment of the children. The possible influence of a first night can be a limitation, a bias that was also present in the reference population. An individual night-to-night variability of PLMS in children is demonstrated. However, it is random and not likely to skew the group-level analysis [31]. Moreover, our study group investigated previously children with NE and controls; both groups have a possible first night effect. Even though, children with NE have a higher PLMS index and a more fragmented sleep than controls [13].

This study identifies in children with MNE associated with NP the relationship between sleep parameters and psychological functioning of the child according to the child, the parents, and the teachers. In children with MNE associated with NP, PLMS index is associated with a lower QoL of the child. Further research should elucidate the association between sleep and psychological functioning.

Ethical standards The study was approved by the Institutional Ethics Board of the Ghent University Hospital (B670201212). Therefore, it has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Written consent was obtained from all patients and their parents prior to their inclusion in the study.

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Abou-Khadra MK, Amin OR, Ahmed D (2013) Association between sleep and behavioural problems among children with enuresis. J Paediatr Child Health 49:E160–E166
2. Achenbach TMR LA (2001) Manual for the ASEBA school-age forms & profiles. University of Vermont, Research Center for Children, Youth, & Families, Burlington
3. American Psychiatric Association (2000) Diagnostic and statistical manual of mental disorders. 4th ed. edn, Washington, DC
4. Baeyens D, Roeyers H, Hoebeke P, Verte S, Van Hoecke E, Walle JV (2004) Attention deficit/hyperactivity disorder in children with nocturnal enuresis. J Urol 171:2576–2579
5. Baeyens D, Roeyers H, Van Erdeghem S, Hoebeke P, Vande Walle J (2007) The prevalence of attention deficit-hyperactivity disorder in children with nonmonosymptomatic nocturnal enuresis: a 4-year followup study. J Urol 178:2616–2620

6. Benjamini Y, Hochberg Y (1995) Controlling the false discovery rate—a practical and powerful approach to multiple testing. J Roy Stat Soc B Met 57:289–300
7. Biederman J, Santangelo SL, Faraone SV, Kiely K, Guite J, Mick E, Reed ED, Kraus I, Jellinek M, Perrin J (1995) Clinical correlates of enuresis in ADHD and non-ADHD children. J Child Psychol Psychiatry Allied Discip 36:865–877
8. Bower WF, Sit FK, Bluyssen N, Wong EM, Yeung CK (2006) PinQ: a valid, reliable and reproducible quality-of-life measure in children with bladder dysfunction. J Pediatr Urol 2:185–189
9. Bower WF, Wong EM, Yeung CK (2006) Development of a validated quality of life tool specific to children with bladder dysfunction. Neurourol Urodyn 25:221–227
10. Cambridge Cognition Ltd (2006) CANTABeclipse test administration guide. Manual version 3.0.0. Cambridge, United Kingdom
11. Cohen-Zrubavel V, Kushnir B, Kushnir J, Sadeh A (2011) Sleep and sleepiness in children with nocturnal enuresis. Sleep 34:191–194
12. Dhondt K, Raes A, Hoebeke P, Van Laecke E, Van Herzeele C, Vande Walle J (2009) Abnormal sleep architecture and refractory nocturnal enuresis. J Urol 182:1961–1965
13. Dhondt K, Baert E, Van Herzeele C, Raes A, Groen LA, Hoebeke P, Vande Walle J (2014) Sleep fragmentation and increased periodic limb movements are more common in children with nocturnal enuresis. Acta Paediatr 103:e268–e272
14. Duel BP, Steinberg-Epstein R, Hill M, Lerner M (2003) A survey of voiding dysfunction in children with attention deficit-hyperactivity disorder. J Urol 170:1521–1523, discussion 1523–1524
15. Engelen V, Haentjens MM, Detmar SB, Koopman HM, Grootenhuis MA (2009) Health related quality of life of Dutch children: psychometric properties of the PedsQL in the Netherlands. BMC Pediatr 9:68
16. Ertan P, Yilmaz O, Caglayan M, Sogut A, Aslan S, Yuksel H (2009) Relationship of sleep quality and quality of life in children with monosymptomatic enuresis. Child Care Health Dev 35:469–474
17. Friedman-Weieneth JL, Doctoroff GL, Harvey EA, Goldstein LH (2009) The Disruptive Behavior Rating Scale-Parent Version (DBRS-PV): factor analytic structure and validity among young preschool children. J Atten Disord 13:42–55
18. Gioia GA, Isquith PK, Guy SC, Kenworthy L (2000) Behavior rating inventory of executive function. Child Neuropsychol J Normal Abnorm Dev Child Adolesc 6:235–238
19. Gioia GAIPK, Guy SC, Kenworthy L (2000) Behavior rating inventory of executive function BRIEF. Professional manual. Psychological Assessment Resources, Lutz
20. Gomez R, Vance A, Gomez RM (2014) Analysis of the convergent and discriminant validity of the CBCL, TRF, and YSR in a clinic-referred sample. J Abnorm Child Psychol 42:1413–1425
21. Joinson C, Heron J, von Gontard A (2006) Psychological problems in children with daytime wetting. Pediatrics 118:1985–1993
22. Joinson C, Heron J, Emond A, Butler R (2007) Psychological problems in children with bedwetting and combined (day and night) wetting: a UK population-based study. J Pediatr Psychol 32:605–616
23. Kort W, Schittekatte M, Bosmans M, Compaan EL, Dekker PH, Vermeir G, Verhaeghe P (2005) [Handleiding Wechsler Intelligence Scale for children –III (WISC-III-NL)]. Pearson Assessment and Information B.V., Amsterdam
24. Manly T, Roberston IH, Anderson V, Nimmo-Smith I (2007) [Handleiding] Test of everyday attention for children, Nederlandse vertaling]. Pearson Assessment and Information B.V., Amsterdam
25. Manly T, Roberston IH, Anderson V, Nimmo-Smith I (1999) Manual of the test of everyday attention for children. Thames Valley Test Company, United Kingdom
26. Marcus CL, Traylor J, Gallagher PR, Brooks LJ, Huang J, Koren D, Katz L, Mason TB, Tapia IE (2014) Prevalence of periodic limb movements during sleep in normal children. Sleep 37:1349–1352
27. Mellon MW, Natchev BE, Katusic SK, Colligan RC, Weaver AL, Voigt RG, Barbaresi WJ (2013) Incidence of enuresis and encopresis among children with attention-deficit/hyperactivity disorder in a population-based birth cohort. Acad Pediatr 13:322–327
28. Neveus T, Eggert P, Evans J, Macedo A, Rittig S, Tekgul S, Vande Walle J, Yeung CK, Robson L, International Children's Continence S (2010) Evaluation of and treatment for monosymptomatic enuresis: a standardization document from the International Children's Continence Society. J Urol 183:441–447
29. Oosterlaan JBD, Scheres A, Antrop I, Roeyers H, Sergeant JA (2008) [Handleiding Vragenlijst voor Gedragsproblemen bij Kinderen (VvGK 6–16)] Pearson Assessment and Information B.V., Amsterdam
30. Pelham WE Jr, Gnagy EM, Greenslade KE, Milich R (1992) Teacher ratings of DSM-III-R symptoms for the disruptive behavior disorders. J Am Acad Child Adolesc Psychiatry 31:210–218
31. Picchietti MA, Picchietti DL, England SJ, Walters AS, Couvadelli BV, Lewin DS, Hening W (2009) Children show individual night-to-night variability of periodic limb movements in sleep. Sleep 32:530–535
32. Raghavan S, Mahadevan S, Kattimani S (2013) Enuresis among children with inattentive ADHD—a potential marker for a distinct sub-group. Asian J Psychiatry 6:83–84
33. RCoreTeam (2013) R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna
34. Rittig S, Kamperis K, Siggaard C, Hagstroem S, Djurhuus JC (2010) Age related nocturnal urine volume and maximum voided volume in healthy children: reappraisal of International Children's Continence Society definitions. J Urol 183:1561–1567
35. Robson WL, Jackson HP, Blackhurst D, Leung AK (1997) Enuresis in children with attention-deficit hyperactivity disorder. South Med J 90:503–505
36. Sahakian BJ, Owen AM (1992) Computerized assessment in neuropsychiatry using CANTAB: discussion paper. J R Soc Med 85:399–402
37. Smidts DHM (2009) [Handleiding BRIEF executieve functies gedragsvragenlijst (BRIEF)]. Hogrefe Uitgevers B.V., Amsterdam
38. Vande Walle J, Rittig S, Bauer S, Eggert P, Marschall-Kehrel D, Tekgul S (2012) Practical consensus guidelines for the management of enuresis. Eur J Pediatr 171:971–983
39. Varni JW, Seid M, Kurtin PS (2001) PedsQL 4.0: reliability and validity of the Pediatric Quality of Life Inventory version 4.0 generic core scales in healthy and patient populations. Med Care 39:800–812
40. Verhulst FvdE J (2001) [Handleiding Child Behavior Checklist (CBCL)] Achenbach system of empirically based assessment (Aseba). Erasmus MC Sophia Kinderziekenhuis, Rotterdam
41. Verhulst FvdE J (2001) [Handleiding Teacher Report Form (TRF)] Achenbach system of empirically based assessment (Aseba). Erasmus MC Sophia Kinderziekenhuis, Rotterdam
42. von Gontard A, Baeyens D, Van Hoecke E, Warzak WJ, Bachmann C (2011) Psychological and psychiatric issues in urinary and fecal incontinence. J Urol 185:1432–1436
43. von Gontard A, Moritz AM, Thome-Granz S, Freitag C (2011) Association of attention deficit and elimination disorders at school entry: a population based study. J Urol 186:2027–2032
44. von Gontard A, Equit M (2014) Comorbidity of ADHD and incontinence in children. Eur Child Adolesc Psychiatry
45. Wechsler D (1991) The Wechsler intelligence scale for children, 3rd edn. The Psychological Corporation, San Antonio
46. Wolfish NM, Pivik RT, Busby KA (1997) Elevated sleep arousal thresholds in enuretic boys: clinical implications. Acta Paediatr 86: 381–384
47. Yeung CK, Sreedhar B, Sihoe JD, Sit FK, Lau J (2006) Differences in characteristics of nocturnal enuresis between children and adolescents: a critical appraisal from a large epidemiological study. BJU Int 97:1069–1073
48. Yeung CK, Diao M, Sreedhar B (2008) Cortical arousal in children with severe enuresis. N Engl J Med 358:2414–2415