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Original Article: Clinical Investigation

Primary nocturnal enuresis is associated with lower intelligence quotient scores in boys from poorer socioeconomic status families

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Abbreviations & Acronyms
CNS = central nervous system
IQD = intelligence quotient discrepancy
IQ = intelligence quotient
PIQ = performance intelligence quotient
PNE = primary nocturnal enuresis
SES = socioeconomic status
VIQ = verbal intelligence quotient

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Objectives: To explore intelligence quotient in boys with primary nocturnal enuresis compared with normal boys considering their socioeconomic status.

Methods: A total of 152 school-aged boys (including 55 boys with primary nocturnal enuresis and 97 matched normal controls) were assessed. Boys with a history of any neurological or urological disease were excluded. Two different districts of Tehran: Khani-Abad (a poor district) and Pirouzi (a middle class district) districts were enrolled according to socioeconomic status data reported by the World Health Organization. Intelligence tests were carried out using a validated Iranian translation of the Wechsler Intelligence Scale for Children Revised. Total, as well as performance intelligence quotient and verbal intelligence quotient scores and verbal–performance discrepancy (the difference between verbal and performance intelligence quotient scores for each individual) were compared using a *t*-test between boys with primary nocturnal enuresis in each district and their matched controls.

Results: Considering each district separately, the total intelligence quotient score was lower in primary nocturnal enuresis cases than controls only in the lower income district (90.7 ± 23.3 *vs* 104.8 ± 14.7, $P = 0.002$). Similarly, boys with primary nocturnal enuresis ranked lower in verbal intelligence quotient ($P = 0.002$) and performance intelligence quotient ($P = 0.004$) compared with their matched normal controls only in lower income district, whereas in the higher income district, boys with primary nocturnal enuresis ranked similar in total intelligence quotient to their matched controls.

Conclusions: Boys with primary nocturnal enuresis had a lower intelligence quotient compared with the control participants only in low-income district. It seems important to adjust the results of the intelligence quotient assessment in these children according to their socioeconomic status.

Key words: child, intellectual disability, nocturnal enuresis, social class, socioeconomic factors.

Introduction

PNE is defined as involuntary loss of urine during sleep time that persists beyond the age of 5 years, which is the accepted age for complete bladder development and normal voiding habits.[1] PNE is a common disorder in children, with an estimated prevalence of 20% in young children (aged <5 years) and 2% in young adults.[2] Children who develop enuresis after a dry period of at least 6 months have secondary enuresis. Children with any other urinary symptoms including daytime enuresis, urgency or voiding dysfunction are categorized as non-monosymptomatic nocturnal enuresis, whereas those who present with only bedwetting have monosymptomatic nocturnal enuresis.[3]

An underlying disease is detected in 5–10% of patients with PNE; however, in other situations the etiology and mechanism is not fully understood.[4] PNE has been shown to be correlated with numerous factors that could be genetic, environmental, biological, neurological and psychological in nature, or be a consequence of nocturnal polyuria. The maturational delay theory is

confirmed with the accompanying symptoms seen in these children, including sleep architecture alterations, academic disabilities, neuromotor delay and minor neurological dysfunction.[5,6] Some studies have shown complex maturational CNS deficits in children with enuresis.[6–11] Other studies have shown that children with bedwetting show the most evidence for cognitive differences compared with normal children.[12] However, the etiology of this cognitive deficit is not clarified. Whether this deficit is part of their maturational brain delay or a consequence of lower self-esteem or psychological problems associated with enuresis is not well understood.

Intelligence is a capacity through which humans possess the ability to learn, form concepts, understand, apply logic and reason.[13] IQ is measured using the Wechsler IQ test, which involves two primary components including VIQ and PIQ.[14] This test does not directly measure the quantity of intelligence capacity of the individual. In fact, the Wechsler IQ test measures the ability of person to use their intellectual capacity to adapt and constructively solve problems in the environment. Therefore, the results of the IQ test are subject to environmental factors. SES is an environmental factor that can influence IQ. Indeed, some brain disorders have been detected in the brain magnetic resonance imaging of children in poor SES areas.[15] In addition, inappropriate parental behavior toward enuretic children could affect their IQ. Physical or verbal punishment is widespread behavior among families with an enuretic child in low SES areas.[16] The impact of SES on the intellectual ability of children with enuresis has not been evaluated yet. The aim of the present study was to explore whether children with PNE have a lower IQ compared with normal children in accordance with their SES.

Methods

Two different districts of Tehran (Khani-Abad District and Pirouzi District) were selected according to the SES of the people who live in the districts. These two districts are significantly different with regard to their level of income, family size, occupation, educational facilities, housing condition, unemployment rates and so on according to the recent World Health Organization report.[17] Different schools in each district were chosen. Recruitment was limited to boys in order to reduce heterogeneity as a result of sex.

Boys with enuresis were found through questionnaires completed by all parents. Then, the boys were evaluated by a general practitioner under the observation of a pediatric urologist. All children in the PNE group met the following inclusion criteria: urination was under control with no urinary symptom during daytime, but involuntary urination while sleeping (monosymptomatic nocturnal enuresis); the absence of soiling and any other neurological or urological disorder or abnormality, including urinary tract infection, stone disease, reflux disease or neurogenic bladder; and a negative history of previous treatment with any psychoactive drugs. All enuretic children with any urinary symptom during daytime (non-monosymptomatic nocturnal enuresis) were excluded. Furthermore, patients who had received any medication for treatment of enuresis were excluded. All children were counseled by clinical psychologists to investigate the current or historical diagnosis of any neurological and psychiatric disease according to the Diagnostic and Statistical Manual of Mental Disorders published by the American Psychiatric Association. As lower IQ scores of boys with lower SES might be related to the presence of attention deficit hyperactivity disorder in these children, we excluded participants with attention deficit hyperactivity disorder from the present study. In addition, children whose parents answered positive to the question, "Do you have any family problems that can upset the child?" were also excluded from the study.

The control participants for each individual with PNE were selected randomly from his classmates. We supposed two controls for each case. Then, in each district, 40 cases and 80 controls were randomly picked up from the population at the beginning. After exclusion of the children with psychological and neurological problems, 29 cases and 48 controls in Khani-Abad district and 26 cases and 49 controls in Pirouzi district remained in the study.

Intelligence evaluation

Intelligence tests were carried out by two clinical psychologists (Nahid Yousefi and Hojatollah Ebrahimi) using the Iranian translation of the Wechsler Intelligence Scale for Children Revised in their schools.[14] All children completed 11 individual tests, including six verbal subsets of the Wechsler scales (information, similarities, arithmetic, vocabulary, comprehension, digit symbol) to evaluate the children's recall, and word and symbol use; and five performance subsets (picture completion, picture arrangement, block design, object assembly, coding), which measure the skills of manipulating objects, problem solving and visual perception. Based on individual testing, the VIQ, PIQ and total IQ were computed progressively, as well as the "VIQ–PIQ discrepancy."

Ethical standards

This study was approved by the ethics committee of Shahid Beheshti University of Medical Science, and was carried out in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

All parents gave their informed consent before inclusion of their children in the study.

Statistical analysis

Data obtained from intelligence tests underwent statistical analysis using the SPSS 19.0 software package (SPSS, Chicago, IL, USA). The total IQ, VIQ and PIQ were expressed as a mean ± SD. The normality was checked by the Kolmogrov–Smirnov test and the equality of variance was assessed using Levene's test. The student *t*-test was used to compare the independent groups. The healthy and PNE groups were classified according to their SES, and their total IQ, VIQ and PIQ were compared using the *t*-test. The verbal–performance discrepancy (IQD; the difference between VIQ and PIQ for each individual) was also compared between these participants. A P-value <0.05 was considered statistically significant.

Results

Study population

Total of 152 children including 55 PNE children and 97 matched normal controls were enrolled. No significant differences between the two study groups were found for the age ($P = 0.531$), and parents' age ($P > 0.05$). Irrespective of the area, no significant difference was shown between the cases and controls ($P = 0.14$) in the whole group.

In order to identify the impact of SES, the whole group was split according to the economic status of the districts.

IQ in relation to PNE and SES

1 Comparing PNE cases with their control in each district: Considering each district separately, the total IQ score was lower in PNE cases than controls only in the lower income district (90.7 ± 23.3 *vs* 104.8 ± 14.7, $P = 0.002$). Similarly, boys with PNE ranked lower in VIQ ($P = 0.002$) and PIQ ($P = 0.004$) compared with their matched normal controls only in lower income district, whereas in the higher income district, boys with PNE ranked similar in total IQ to their matched controls (Fig. 1).

2 Comparing PNE cases between the two districts: Among boys with PNE, the total, verbal and PIQ scores were lower in the Khani-Abad district when compared with the Pirouzi district ($P < 0.001$; Table 1); In the subscales, all items except digit symbol (from VIQ) and picture arrangement (from PIQ) were significantly lower in the Khani-Abad district than the Pirouzi district.

3 Comparing control groups in the two districts: Normal controls had identical total IQ and VIQ scores in the two different districts (Fig. 1, Table 1). Nevertheless, PIQ controls ranked lower in the Khani-Abad district ($P < 0.05$). This difference was also observed in some subsets (picture completion, block design, coding) between the control participants within the two districts ($P < 0.05$).

4 In the whole group, the frequency of individuals with an IQ lower than average (<90) was greater in PNE cases (29%) than the controls (10%; $P = 0.01$). In addition, for the total study population, the PNE cases registered lower scores in the performance components of IQ (complete picture, set image, cube) compared with their controls ($P = 0.04$, 0.01, 0.001, respectively).

5 In terms of the IQD, the PNE cases had higher scores compared with controls (7.53 ± 17.39 *vs* 3.84 ± 18.21). However, the difference was significant only in the high income district ($P = 0.01$; Table 1).

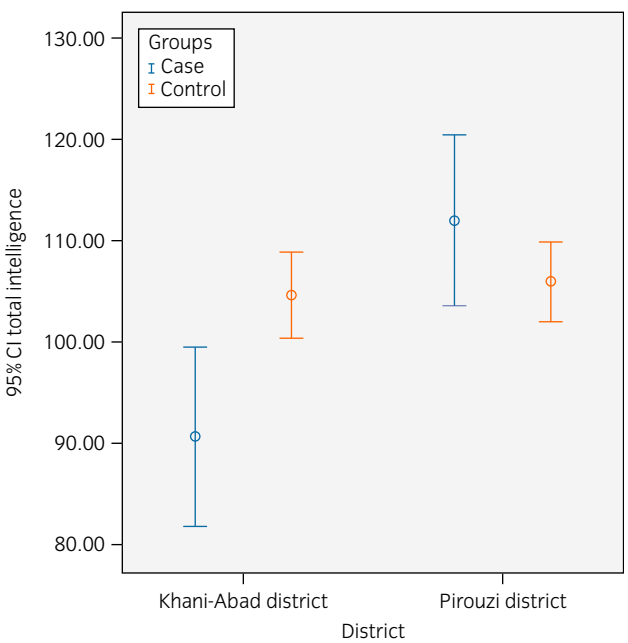

Fig. 1 Total IQ score in the boys with PNE compared with their normal control group in each district.

Discussion

The present study found that boys with bedwetting in the lower income district were particularly characterized by reduced total IQ scores, including VIQ, PIQ and PIQ subset scores including picture completion, picture arrangement and block design, whereas their normal control classmates were identical considering their IQ levels between the two districts (Fig. 1). It could be speculated that environmental factors related with SES that have been observed in these children previously might be responsible for lower IQ levels.[12]

Joinson *et al.* found that children with bedwetting showed the most evidence for cognitive differences compared with normal children in England.[12] In another study, Dai *et al.* compared the intelligence levels of 40 Chinese school-aged children with enuresis with those of 40 age-matched normal children. Their results showed normal total intelligence levels for children with enuresis, but lower memory/attention levels compared with normal control chldren.[18] However, none of the aforementioned studies considered SES as a confounding factor, which can affect IQ as well as parental behavior towards enuretic children. The strongest feature of the present study was that we compared the IQ scores of the PNE boys with their sex- and age-matched control subjects in two different districts according to their SES.

Maturational delay is thought to be the cause of PNE in children. The two proposed mechanisms of maturational delay of CNS in nocturnal enuresis are lack of waking when the bladder is full or lack of inhibition of the micturition reflex during sleep.

Some authors have theorized that lower intellectual scores in these children could also be related with brain disorders. There are reports that show developmental delay in the maturation of the response inhibition of the prefrontal cortex in children with PNE. Similar disorders have been shown to be present in the areas related to attention in these children.[19–22] Nevertheless, data regarding the relationship between lower IQ, brain disorders and enuresis should be further investigated. There is some evidence that the memory/attention levels in these children might increase after treatment of the

Table 1 IQ subset and total scores in boys with enuresis compared with their control subjects divided in two different districts

	Khani-Abad district			Pirouzi district				
(mean ± SD)	Enuretic 29	Control 48	Within district (*P*-value)	Enuretic 26	Control 49	Within district (*P*-value)	Between enuretics (*P*-value)	Between controls (*P*-value)
VIQ	90.31 ± 25.16	105.62 ± 17.37	0.002	113.84 ± 16.97	106.57 ± 17.54	0.09	0.0001	0.79
Information	8.96 ± 4.5	10.43 ± 3.34	0.11	11.61 ± 2.43	11.36 ± 3.51	0.65	0.010	0.24
Similarities	7.82 ± 4.3	10.45 ± 4.08	0.01	11.8 ± 3.48	10.97 ± 3.79	0.36	0.0001	0.52
Arithmetic	9.32 ± 3.38	10.8 ± 3.59	0.08	11.07 ± 2.74	10.67 ± 3.13	0.58	0.042	0.84
Comprehension	9.75 ± 3.56	10.89 ± 3.55	0.18	13.08 ± 2.85	10.97 ± 2.85	0.004	0.011	0.37
Vocabulary	8.35 ± 5.17	10.02 ± 4.18	0.13	11.92 ± 4.73	10.77 ± 4.14	0.28	0.0001	0.90
Digit symbol	7 ± 3.31	10.21 ± 2.3	0.03	10.25 ± 3.2	10.76 ± 1.89	0.15	0.182	0.87
PIQ	86.03 ± 19.37	99.04 ± 18.53	0.004	102.69 ± 10.49	105.4 ± 11.01	0.30	0.0001	0.04
Picture completion	7.35 ± 3.36	8.7 ± 2.34	0.04	9.46 ± 3.02	10.83 ± 2.91	0.06	0.020	0.0001
Picture arrangement	7.5 ± 3.48	9.62 ± 3.47	0.01	9.07 ± 3.28	9.22 ± 2.07	0.81	0.093	0.49
Block design	8.03 ± 3.13	10.43 ± 2.72	0.001	11.26 ± 3.36	12.02 ± 3.79	0.40	0.001	0.02
Object assembly	8.75 ± 5.26	11.2 ± 3.73	0.02	11.57 ± 3.16	15.57 ± 5.6	0.48	0.022	0.31
Coding	7.78 ± 4.73	7.78 ± 3.44	0.99	10.73 ± 3.86	11.76 ± 4.16	0.30	0.016	0.0001
Total IQ	90.79 ± 23.31	104.79 ± 14.71	0.002	112.15 ± 20.95	106.1 ± 13.8	0.14	0.0001	0.65
VIQ–PIQ discrepancy (IQD)	4.27 ± 18.21	6.58 ± 20.48	0.62	11.15 ± 16.00	1.16 ± 15.4	0.01	0.145	0.14

Data is presented as mean ± SD.

enuresis with desmopressin.[23] In that study, Muller *et al.* enrolled 40 children with PNE in a double-blind randomized placebo controlled cross-over study to evaluate the effect of desmopressin on CNS function. They observed that short-term memory significantly increased in children under treatment with desmopressin compared with the placebo. They theorized that in addition to the kidney, the CNS might be a target of desmopressin, and its function might be affected directly.[23] Based on this finding, the memory deficit of these children appears to be reversible, and could be secondary to lower antidiuretic hormone levels, not a consequence of a structural CNS disorder in these children. A randomized clinical trial may be designed to evaluate improvement in the IQ score of children with enuresis after treatment with desmopressin.

SES is related with some brain disorders. Hair *et al.* evaluated 823 magnetic resonance imaging of 389 normal developing children, and correlated those findings with their SES. Their result showed that poverty is related to structural differences in several areas of the brain associated with school readiness skills.[15] The present study showed that control participants had identical total IQ and VIQ scores in the two different districts. By contrast, boys with PNE in the low SES district showed lower total, PIQ and VIQ scores. Therefore, studies on brain disorders of children with enuresis should mention their SES as well.

Some investigators have studied the relationship between enuresis and sleep disorders.[24] Meanwhile, for some children, nocturnal enuresis is related with obstructive sleep apnea,[25] and subclinical signs of disordered respiration have been detected in enuretic children with no history of snoring.[26] In contrast, sleep disorder could also affect memory.[27,28] Regarding the relationship between PNE and sleep disorders with lower IQ scores in these children, it might be speculated that the lower IQ scores of children with PNE could be a consequence of the inferior sleep quality in these children. In other words, it should be noted that poor sleep quality secondary to the troubles associated with nocturnal enuresis during sleep time, obstructive sleep apnea or the psychological outcome of parental punishment might play a role in lower memory/attention levels of these children.[16] The present findings, which show lower IQ scores in boys of low-income areas, but not in higher income areas, support the environmental theory. Although our study did not clarify those environmental factors that affect IQ scores of boys with PNE of low SES compared with their matched classmates, parental punishment toward an enuretic boy could be one of these factors.[16] We had engaged the rate of parental punishment in our questionnaire, but most parents did not respond to this question precisely. Therefore, we omitted this question from the final analysis.

The difference between VIQ and PIQ (IQD) has been related to some developmental delays in children with neurological disorders.[29] However, the clinical use of IQD is not well understood. Some authors have postulated that a VIQ > PIQ might indicate limitations in visual motor integration. Yu *et al.* evaluated motor competence using the motor subtests of the Comprehensive Developmental Inventory for Infants and Toddlers in children (aged 2.5–6 years) at risk for developmental delays.[29] They showed that children with significant IQD (VIQ > PIQ greater than one standard deviation) have lower motor competence. In the present study, which excluded children with developmental or neurological disorders, the mean VIQ score was higher than PIQ (VIQ > PIQ) in both the PNE and control groups in the two districts. However, the IQD was only significantly higher in the PNE group in the better SES district compared with their control group. Although, this might indicate a lower visual motor integration in boys with PNE, its relationship to SES should be further evaluated.

The present data show that boys with PNE had lower IQ scores compared with the control participants only in low-income areas. It seems important to adjust the results of the IQ assessment in these children according to their SES.

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Conflict of interest

None declared.

References

1 Mark SD, Frank JD. Nocturnal enuresis. *Br. J. Urol.* 1995; **75**: 427–34.
2 Weaver A, Dobson P. Nocturnal enuresis in children. *J. Fam. Health Care* 2007; **17**: 159–61.
3 Neveus T, von Gontard A, Hoebeke P *et al.* The standardization of terminology of lower urinary tract function in children and adolescents: report from the Standardisation Committee of the International Children's Continence Society. *J. Urol.* 2006; **176**: 314–24.
4 Johnson M. Nocturnal enuresis. *Urol. Nurs.* 1998; **18**: 259–73; quiz 74-5.
5 Esposito M, Gallai B, Parisi L *et al.* Primary nocturnal enuresis as a risk factor for sleep disorders: an observational questionnaire-based multicenter study. *Neuropsychiatr. Dis. Treat.* 2013; **9**: 437–43.
6 Von Gontard A, Schmelzer D, Seifen S, Pukrop R. Central nervous system involvement in nocturnal enuresis: evidence of general neuromotor delay and specific brainstem dysfunction. *J. Urol.* 2001; **166**: 2448–51.
7 von Gontard A, Freitag CM, Seifen S, Pukrop R, Rohling D. Neuromotor development in nocturnal enuresis. *Dev. Med. Child Neurol.* 2006; **48**: 744–50.
8 Kohyama J, Kumada S, Shimohira M, Araki S, Itoh M, Iwakawa Y. Nocturnal enuresis and the pontine reticular formation. *Eur. Urol.* 2000; **38**: 631–4.
9 Unal M, Tataroglu C, Toros F, Kanik A, Pata YS. Brainstem evaluation in children with primary nocturnal enuresis. *Acta Med. Okayama* 2004; **58**: 1–6.
10 Hallioglu O, Ozge A, Comelekoglu U *et al.* Evaluation of cerebral maturation by visual and quantitative analysis of resting electroencephalography in children with primary nocturnal enuresis. *J. Child Neurol.* 2001; **16**: 714–8.
11 Iscan A, Ozkul Y, Unal D *et al.* Abnormalities in event-related potential and brainstem auditory evoked response in children with nocturnal enuresis. *Brain Dev.* 2002; **24**: 681–7.
12 Joinson C, Heron J, Butler R *et al.* A United Kingdom population-based study of intellectual capacities in children with and without soiling, daytime wetting, and bed-wetting. *Pediatrics* 2007; **120**: e308–16.
13 Legg S, Hutter M. *A Collection of Definitions of Intelligence*. Proceedings of the 2007 conference on Advances in Artificial General Intelligence: Concepts, Architectures and Algorithms: Proceedings of the AGI Workshop 2006. IOS Press, 2007; 17–24.
14 Wechsler D. *Manual for Wechsler Preschool and Primary School of Intelligence(WPPSI)*. The Psychological Corporation, New York, 1967.
15 Hair NL, Hanson JL, Wolfe BL, Pollak SD. Association of child poverty, brain development, and academic achievement. *JAMA Pediatr.* 2015; **169**: 822–9.
16 Karaman MI, Koca O, Kucuk EV, Ozturk MI, Akyuz M. Methods and rates of punishment implemented by families to enuretic children in Turkey. *Int. Braz. J. Urol.* 2013; **39**: 402–7.
17 Mohsen Asadi-Lari MRV-M. An overview on Urban-HEART Tehran. WHO website. Available from URL: http://www.who.int/kobe_centre/publications/urban_heart_tehran/en/.
18 Dai XM, Ma HW, Pan XX. Intelligence level and intelligence structure of children with primary nocturnal enuresis. *Zhongguo Dang Dai Er Ke Za Zhi* 2007; **9**: 433–5.
19 Yu B, Sun H, Ma H *et al.* Aberrant whole-brain functional connectivity and intelligence structure in children with primary nocturnal enuresis. *PLoS ONE* 2013; **8**: e51924.
20 Yu B, Kong F, Peng M, Ma H, Liu N, Guo Q. Assessment of memory/attention impairment in children with primary nocturnal enuresis: a voxel-based morphometry study. *Eur. J. Radiol.* 2012; **81**: 4119–22.
21 Lei D, Ma J, Du X, Shen G, Tian M, Li G. Altered brain activation during response inhibition in children with primary nocturnal enuresis: an fMRI study. *Hum. Brain Mapp.* 2012; **33**: 2913–9.
22 Yu B, Guo Q, Fan G, Ma H, Wang L, Liu N. Evaluation of working memory impairment in children with primary nocturnal enuresis: evidence from event-related functional magnetic resonance imaging. *J. Paediatr. Child Health* 2011; **47**: 429–35.
23 Muller D, Florkowski H, Chavez-Kattau K, Carlsson G, Eggert P. The effect of desmopressin on short-term memory in children with primary nocturnal enuresis. *J. Urol.* 2001; **166**: 2432–4.
24 Dhondt K, Van Herzeele C, Roels SP *et al.* Sleep fragmentation and periodic limb movements in children with monosymptomatic nocturnal enuresis and polyuria. *Pediatr. Nephrol.* 2015; **30**: 1157–62.
25 Stone J, Malone PS, Atwill D, McGrigor V, Hill CM. Symptoms of sleep-disordered breathing in children with nocturnal enuresis. *J. Pediatr. Urol.* 2008; **4**: 197–202.
26 Neveus T, Leissner L, Rudblad S, Bazargani F. Respiration during sleep in children with therapy-resistant enuresis. *Acta Paediatr.* 2014; **103**: 300–4.
27 Twigg GL, Papaioannou I, Jackson M *et al.* Obstructive sleep apnea syndrome is associated with deficits in verbal but not visual memory. *Am. J. Respir. Crit. Care Med.* 2010; **182**: 98–103.
28 Wallace A, Bucks RS. Memory and obstructive sleep apnea: a meta-analysis. *Sleep* 2013; **36**: 203–20.
29 Yu TY, Chen KL, Chou W *et al.* Intelligence quotient discrepancy indicates levels of motor competence in preschool children at risk for developmental delays. *Neuropsychiatr. Dis. Treat.* 2016; **12**: 501–10.

Editorial Comment

Editorial Comment to Primary nocturnal enuresis is associated with lower intelligence quotient scores in boys from poorer socioeconomic status families

The article by Basiri *et al.* raises new issues regarding the relationship between intellectual abilities and socioeconomic status.[1] The authors compared different intelligence quotient (IQ) scores between two enuretic cohorts (boys only) located in two different regions with different socioeconomic status. They were able to show lower IQ scores in primary nocturnal enuresis patients than non-enuretic controls, but only in the area with low socioeconomic status. The authors speculate that environmental rather than developmental factors seem to play a role in this aspect of primary nocturnal enuresis.

It is well known that children, who are inappropriately brought up, have similar cognitive behavior as children with attention deficit hyperactivity disorder or autism spectrum disorder. Although the authors mentioned they excluded these