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ORIGINAL PAPER

Children Treated for Nocturnal Enuresis: Characteristics and Trends Over a 15-Year Period

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Abstract
Background Nocturnal Enuresis (NE) is one of the most prevalent childhood disorders and has significant negative psychosocial impact on the child and family.
Objective To assess the characteristics of children with NE and trends over a 15-year period.
Methods The study included 18,677 children [11,205 (60 %) boys and 7,472 (40 %) girls] referred to a network of clinics specializing in treatment of voiding problems (*Age range*: 4–12 years; *Mean age* = 7.06) between the years 1995–2009. We analyzed socio-demographic characteristics and trends over time using a standard questionnaire administered in the clinics.
Results Over the course of the 15-year period, children were referred to treatment at a younger age (*Mean age 1st period* = 7.52, *Mean age 2nd period* = 7.12, *Mean age 3rd period* = 6.71) and the likelihood of referrals of younger children (4–5 years) increased (1st period = 24.5 %; 2nd period = 33.6 %; and 3rd period = 41.9 %). More children were referred during winter than summer or transition seasons. The higher prevalence of boys was maintained across this period. In addition, girls had 34 % higher chance to suffer from primary NE compared to boys and had 12 % higher chance to suffer from NE only compared to boys. Birth order and children's age predicted NE type (primary/secondary) and in addition to family size also predicted enuresis pattern (NE only/combined NE and Diurnal Enuresis).
Conclusions The findings of this largest study on children referred for NE treatment provides a wider understanding of important associated factors to this phenomenon.

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Introduction

According to DSM IV criteria Enuresis is defined as repeated voiding of urine into bed or clothes (whether involuntary or intentional), with a severity of at least twice a week for at least 3 consecutive months, or related to clinically significant distress or impairment in social, academic or other important areas of functioning. In addition the child should be at least 5 years of age, and the phenomena must not be provoked by congenital or acquired defects of the central nervous system or by the direct physiological effect of a substance (APA 2000).

Enuresis can be defined as either primary or secondary (APA 2000; Butler and Holland 2000). Primary enuresis relates to children that never achieved a substantial period of dryness (Approximately 70 % of the children). Secondary enuresis relates to children that had a period of at least 6 consecutive months of dryness and then relapsed (APA 2000).

Enuresis can also be classified to Nocturnal Enuresis (NE) (only nighttime wetting), Diurnal Enuresis (DE) (daytime wetting), or combined NE and DE (APA 2000). Between 15 and 25 % of children with NE also suffer from DE (Mark and Frank 1995).

NE is one of the most widespread and persistent childhood disorders (Chandra et al. 2004) second to insomnia (Neveus 2003). Prevalence rates of NE range between approximately 3 and 15 % according to its definition and age (Kajiwara et al. 2006; Tai et al. 2007). Epidemiological studies suggest that the prevalence of NE declines with age (Butler and Heron 2008; Chang et al. 2001; Chiozza et al. 1998; Verhulst et al. 1985; Yeung et al. 2006). For example, Yeung et al. (2006) reported a reduction in the prevalence of NE from 16.1 % in 5-year-olds, 10.1 % at 7 years and 2.2 % at 19 years. Similar rates have been reported in other countries and populations (Gür et al. 2004; Kajiwara et al. 2006; Kanaheswari 2003; Wen et al. 2006).

Additionally, different definitions of NE are utilized across surveys, even in recent epidemiological surveys (Butler and Heron 2008). NE definition has ranged from >2 wet nights/week (Chiozza et al. 1998) to >1 wet night over a 6-month period. Thus, much higher prevalence rates are reported where a lenient definition has been used (Butler and Heron 2008).

NE is more prevalent in boys than in girls of the same age (Butler and Holland 2000). For example, in a study that included 10,960 children in the U.S., the prevalence of NE in girls at the ages of 7 and 10 years was 6 and 3 %, respectively, however the prevalence of NE in boys at the same ages was 9 and 7 %, respectively (Byrd et al. 1996).

The etiology of NE is complex and is still not fully understood (Neveus 2009). Different models and explanatory factors have been proposed, potentially involving neurological, urological, sleep, genetic, and psychological influences (Butler 2004; Butler and Holland 2000; Campbell et al. 2009; Culbert and Banez 2008; Hagglof et al. 1998; Neveus 2003; Robson 2009; von Gontard et al. 2001). One of the main etiological models was proposed by Butler (Butler 2004; Butler and Holland 2000). Butler's "three systems model" postulates that the following underlying factors are involved in NE: (a) excessive nocturnal urine production; (b) nocturnal bladder overactivity; and (c) failure to wake in response to bladder sensations.

Although NE is not considered to result directly from psychological factors, it is evident that NE has significant negative psychosocial impact on the child, increasing the likelihood

of a child with NE to become socially isolated, emotionally distressed and have a low self-esteem (Butler and Stenberg 2001; Butler 2001; Chiozza et al. 1998; Hjalmas 1998). It also has negative impact on the child's sleep patterns and daytime alertness (Cohen-Zrubavel et al. 2011).

In light of the high prevalence of NE and its adverse impact on the functioning of children and their families, the aim of this study was to assess a number of important features associated with NE in a clinical cohort of Israeli children suffering from NE. In particular, as there were advancement's in knowledge of pathogenesis and management of enuresis in the past decades (Neveus 2009; Pennesi et al. 2004), we were interested in trends that may have occurred over an extended period of 15 years.

In addition, previous research assessing the links between birth order and family size to NE are scarce and demonstrate mixed results (Gunes et al. 2009; Hanafin 1998; Kanaheswari 2003; Rona et al. 1997; Toktamis et al. 2008). Thus we were also interested in exploring the association between these familial factors as well as gender factors and NE. Finally, clinical observations indicate that the prevalence of children referred for NE treatment at winter is elevated compared to other seasons. To the best of our knowledge there are no studies addressing this issue. Thus, another aim was to explore the seasonal pattern of NE.

Most of the research utilizing clinical samples of children with NE is based on relatively small number of subjects. To the best of our knowledge, this analysis covers the largest clinical cohort of children with NE reported to date.

We hypothesized that significant trends over the time span relating to NE treatment will be found: (a) An increase in the number of children receiving treatment across time. (b) A decrease in the age at which children are referred to treatment. We also assumed that similar previously established links between socio-demographic factors related to the phenomenology of enuresis will be demonstrated: A higher prevalence of boys referred for treatment compared to girls.

Method

Participants

The study was based on a retrospective chart review (made by two of the authors) of 18,677 children suffering from NE [11,205 (60 %) boys and 7,472 (40 %) girls] referred to clinic specializing in treatment of voiding problems (age range for the total cohort = 4–12 years; *Mean age* = 7.06, SD = 2.09). Enuresis and its subtypes were diagnosed according to DSM-IV criteria at the initial interview in the clinic (APA 2000). Although DSM-IV identifies the child being at least 5 years of age (or equivalent developmental level) in order to formally diagnose enuresis, ICD-10 suggests a mental age of at least 4 years. Verhulst et al. (1985) argue for flexibility in age criteria due to different rates of acquisition for boys and girls. In addition various professionals have stressed the importance of treatment at an early stage when the problem becomes a source of concern for parents and children (Longstaffe et al. 2000). Moreover, the literature provides evidence that children at this age range can benefit from treatment similarly to children in older age range (Shapira and Patrick 2007). Thus, children between 4–5 years of age that met all NE diagnostic criteria with the exception of the age limit were included in this study. The sample included 1,078 (5.8 %) children 4 years of age.

Measures and Procedure

We analyzed data collected as a part of standard clinical interview based on DSM IV parameters for diagnosing enuresis (APA 2000) in a network of clinics (24 included) specializing in behavioral treatment of voiding problems and alarm treatment for NE, located in different cities across Israel.

All children were interviewed and diagnosed by Ph.D. level licensed clinical psychologists, experts in the field of voiding problems. In cases where there was concern for underlying physiological problem for enuresis, treatment had not begun and children were referred for their pediatrician. These children were excluded from the study. The data was collected between the years 1995 and 2009 and saved in the archives of the clinics.

Data derived from the files included: Age of the child, birth order, number of children in the family, gender, year and month of referral, NE type: (a) primary; (b) secondary, and enuresis pattern: (a) Nocturnal Enuresis (NE)—being wet during the night only; (b) combined NE and Diurnal Enuresis (DE) (being wet during the night and day) (APA 2000).

The study was approved by departmental ethical committee.

Results

Time, Age and Gender Related Findings

Figure 1 shows the distribution of children receiving treatment across year and gender. As shown in the figure, there was a gradual increase in the number of children receiving treatment between the second half of the 90s decade till the end of the first decade of the 2000s. The proportions between boys and girls remained stable (see Fig. 1).

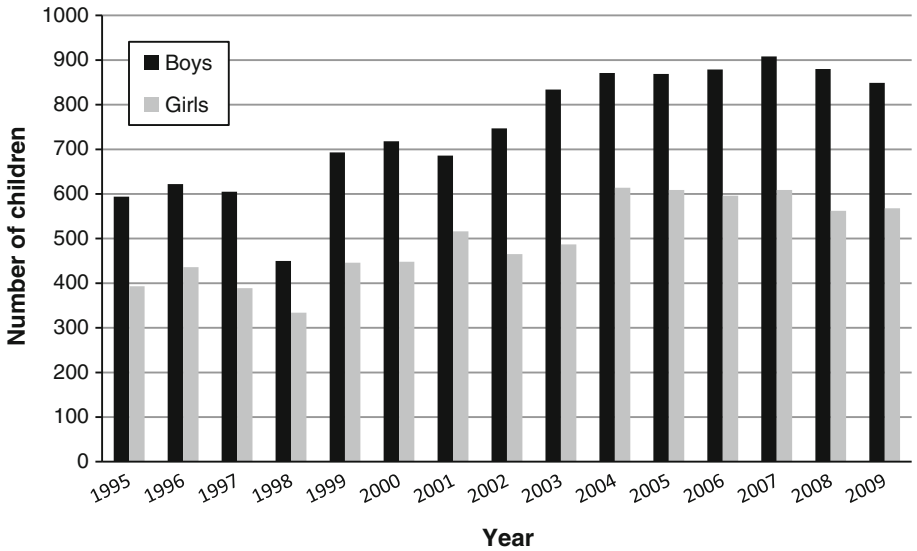

Fig. 1 Number of children receiving treatment for Nocturnal Enuresis by year and gender

The data revealed that in each age group the percentage of boys was significantly higher than the percentage of girls receiving treatment. Overall 60 % of the referred children were boys (see Fig. 2).

To examine trends over the 15 year study period, we divided the years into 3–5-year periods: The first period consisted of children treated between the years 1995 and 1999, the second period consisted of children treated between the years 2000 and 2004, and the third period consisted of children treated between the years 2005–2009.

To test the changes in the referred children's age, we used a two-way ANOVA with period and gender as two independent variables and age as the dependent variable. A significant main effect was found for gender $F(1,18671) = 69.31$, $p < 0.002$), showing that the average age of the girls ($M = 6.95$, $SD = 2.07$) was significantly lower than that of boys ($M = 7.14$, $SD = 2.1$). In addition, a significant main period effect was found for average age $F(2,18671) = 427.65$, $p < 0.05$) indicating that the average age of children being referred for NE treatment is decreasing over time. Average age ($M = 7.52$, $SD = 2.19$) in the first period was significantly higher than the average age of children in second period ($M = 7.12$, $SD = 2.04$), and the average age of children in this period was higher than children in the third period ($M = 6.71$, $SD = 2$). No significant period by gender interaction effect was found $F(2,18671) = 0.522$, n.s), (see Fig. 3).

To test whether there was a period difference in the number of children specifically between 4 and 5 years of age referred to treatment, a Chi square test was performed for this

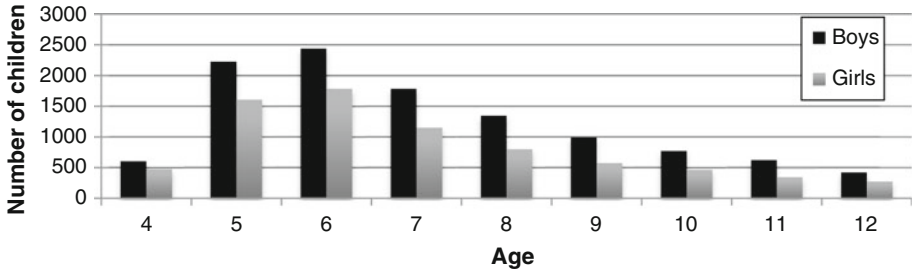

Fig. 2 Number of boys and girls receiving Nocturnal Enuresis treatment at every age group

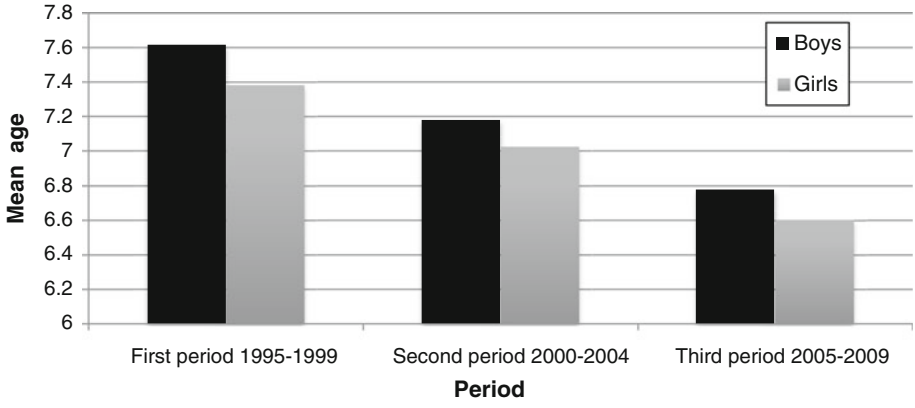

Fig. 3 Average age of referral by gender and period. Main effect for gender ($p < 0.0002$) and main effect for period ($p < 0.05$)

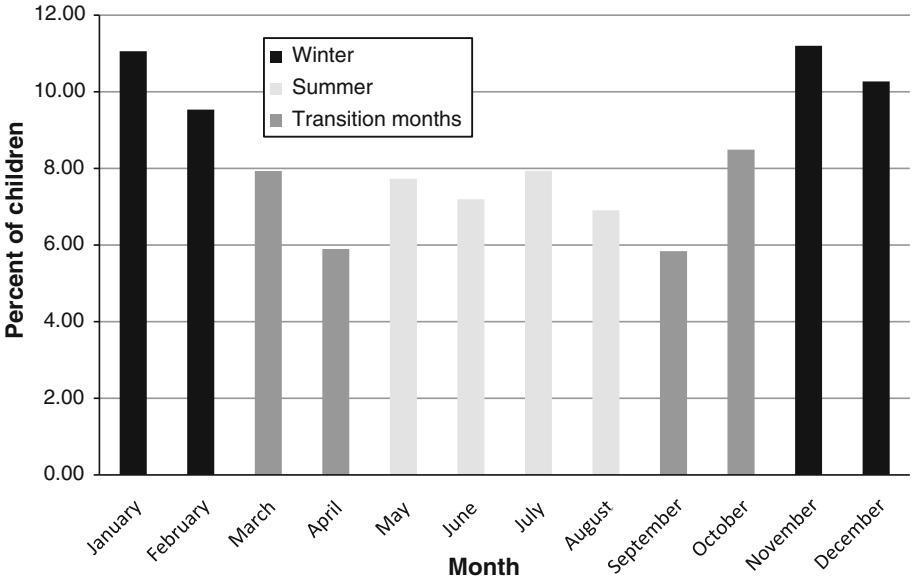

Fig. 4 Seasonal difference in children receiving treatment for Nocturnal Enuresis

age group. The results revealed an incline over time $\chi^2(2) = 49.21$, $p < 0.0001$; First period = 24.5 %; Second period = 33.6 %; and Third period = 41.9 %.

Seasonal Effects

To assess the role of the time of the year in determining the number of children referred for treatment a new variable, *Season,* was computed. The winter season included children the months November, December, January and February. The summer season included months May, June, July and August, and the third transition season included the months March, April, September, and October.

The percent of children receiving treatment during the winter season (41.8 %; $n = 7{,}809$ children) was significantly higher than in the summer season (30 %; $n = 5{,}603$ children), and in the transition season (28.2 %; $n = 5{,}265$ children). This difference was significant $\chi^2(2) = 613.19$, $p < 0.0001$; see Fig. 4).

Nocturnal Enuresis Type and Enuresis Pattern

Logistic regression was performed to assess the predictive values of age, gender, family size and birth order on NE type and enuresis pattern (see Table 1). The logistic regression model was significant $R^2 = 0.02$, $\chi^2 = 139.65$, $p < 0.0001$. The findings of the logistic regression to predict NE type indicated that: (a) girls had 34 % higher chance to suffer from primary NE compared to boys; (b) higher birth order predicts higher chance to suffer from primary NE; (c) Older children had lower chance to suffer from primary NE compared to younger children. Family size did not predict the type of NE.

The findings of the logistic regression in predicting enuresis pattern indicated that: (a) girls have 12 % higher chance to suffer from NE only compared to boys; (b) older

Table 1 Logistic regressions predicting separately: (a) NE type and (b) Enuresis pattern

	Regression coefficient	SE	Wald ($df = 1$)	Sig.	Odds ratio	95 % CI
(a) NE type[b]						
Gender[b]	0.29	0.05	40.58	0.000	1.34	[1.23,1.47]
Age[a]	−0.11	0.011	96.26	0.000	0.90	[0.88,0.92]
Birth order[a]	0.07	0.030	4.99	0.026	1.07	[1.01,1.13]
Family size[a]	−0.02	0.035	0.37	0.543	0.98	[0.92,1.05]
(b) Enuresis Pattern[b]						
Gender[b]	0.11	0.041	7.71	0.005	1.12	[1.03,1.22]
Age[a]	0.21	0.012	322.48	0.000	1.23	[1.20,1.26]
Birth order[a]	0.08	0.028	9.77	0.002	1.09	[1.03,1.15]
Family size[a]	−0.14	0.032	19.71	0.000	0.87	[0.81,0.92]

Predictors: gender, age, birth order and family size

NE Nocturnal Enuresis

[a] Continuous variables—age, birth order, family size

[b] Categorical variables gender, NE type, Enuresis pattern

children have a higher chance to suffer from NE only compared to younger children; (c) higher birth order predicts a larger chance to suffer from NE only; (d) larger family size predicted a lower probability to suffer from NE only compared to combined NE and DE. The logistic regression model was significant $R^2 = 0.04$, $\chi^2 = 380.51$, $p < 0.0001$.

Discussion

The aim of this study was to assess a number of important features associated with enuresis in a very large group of Israeli children referred to treatment for NE or combined NE and DE. To the best of our knowledge, this study covers the largest clinical cohort and time span reported in this field. Our findings reflect important characteristics related to children with enuresis, some of them have never been addressed in the literature.

Before addressing our findings, two important limitations of this study should be considered. The first limitation is that our population represents a clinical cohort of children receiving treatment for NE and not a general population of children with NE. Another limitation is that the results are based on an of Israeli cohort of children and cultural factors may underlie some of these findings (e.g., weather, parenting decision to seek help).

The data revealed that across the years there was a gradual increase in the number of children receiving treatment. Similarly, a recent study found that the referral rate for outpatient pediatric clinics had increased significantly between 1988 and 2006 and one of the most common conditions referred was enuresis (Thompson et al. 2011). However, the increase found in our current study might also be explained by an incline in referrals specifically to the network of clinics that participated in the study.

In addition, in all age groups the percentage of boys (about 60 %) was significantly larger than the percentage of girls (about 40 %) receiving treatment. This finding is consistent with findings of population based studies, demonstrating that the prevalence of boys suffering from NE is significantly higher than girls of the same age (Butler and Holland

2000). Interestingly, the age in which girls were referred to treatment was significantly lower than the boys' age.

Girls attain toilet training skills at younger ages than boys (Schum et al. 2002), and NE is more prevalent in boys than in girls of the same age (Butler and Holland 2000), therefore it is possible that girls are expected to become dry at night at an earlier age than boys and their parents are more motivated to seek treatment at an earlier age. However the difference found in our study was relatively small (6.95 in girls compared to 7.14 years in boys) and its clinical significance should be furthered explored.

Although toilet training is occurring at older ages than it did in the past, especially in Europe and America in the last 30–40 years (Blum et al. 2004) we found that across the timeline children were referred to NE treatment at earlier ages. When families seek advice and/or clinical services for their child's sleep problem, pediatricians are among the most common source of referrals, followed by other child professionals including psychologists and psychiatrists (Jenni and O'Connor 2005; Owens and Mindell 2002; Young et al. 1998). Furthermore, due to knowledge gained in the past decades of pathogenesis and management of enuresis (Neveus 2009; Pennesi et al. 2004), it might be hypothesized that parents are seeking treatment or that clinicians are referring for treatment at younger ages. This topic should be further explored and verified. Notwithstanding these possible explanations, referring for treatment in younger age has very important implications regarding the well-being of children and families. Various professionals have stressed the importance of treatment at an early stage when the problem becomes a source of concern for parents and children (Longstaffe et al. 2000). It has been argued that even children who suffer from symptoms that can remit over time without treatment should be eligible for treatment, given the immediate and future negative influence on children and family (Kazdin and Weisz 1998). In addition, research indicates that prolonged suffering from symptoms of bedwetting increases the child's likelihood to develop behavioral and emotional problems (Butler and Stenberg 2001; Butler 2001).

Another interesting finding was that the proportion of children aged 4–5 years has significantly increased over the time span of 15 years. The effectiveness of NE interventions is very high (Butler and Gasson 2005) and can reduce symptoms length and decrease associated stress level for both child and family (Butler and Stenberg 2001). In this context previous findings suggest that age is unrelated to NE alarm treatment outcomes (Butler and Robinson 2002). Shapira and Patrick found that the applied urine alarm treatment was similarly effective for children age 4 to age 7 (Shapira and Patrick 2007). Thus children can benefit from treatment even at an early age.

Our findings indicate that girls had a higher likelihood to suffer from primary NE and a lower chance to suffer from secondary NE compared to boys. Previous studies did not report such differences (Fergusson et al. 1990; Robson et al. 2005). In addition, although the prevalence of NE has been widely studied in a variety of age groups, the prevalence of DE or combined NE and DE is less well described (Swithinbank et al. 2010; Toktamis et al. 2008).

We found that girls had a lower likelihood to suffer from combined NE and DE and higher probability to suffer from NE only compared to boys. Previous studies assessing gender differences of DE and combined NE and DE found mixed results regarding this issue, with some studies reporting similar results (Sureshkumar et al. 2000; Swithinbank et al. 1998), others reporting the opposite results (Jarvelin et al. 1988; Witt et al. 2002) and yet other studies reporting no differences (Gür et al. 2004; Toktamis et al. 2008). In light of these mixed reports it could be hypothesized that this factor varies between samples and therefore possibly influenced by cultural issues that should be further explored.

Another very interesting finding was that the percent of children receiving treatment in winter months was substantially higher than in other seasons. We found no previous studies assessing the seasonal patterns of referrals for mental health treatment in general and also specifically for NE treatment in children. Thus, to the best of our knowledge, this is the first study addressing this issue. We speculate that there are strong motivators for families to seek therapy in winter months as bedwetting produces more family stress; For example, the possibility of drying the clothes and bed covers outside are reduced significantly, and sleeping with wet clothes in cold weather may raise more concerns and produce other health related issued. These interpretations should be further explored.

Somatic and psychosocial environmental factors are considered to have significant effects on the etiology of NE (Jarvelin 1999; von Gontard et al. 2001), and as our study suggest can be linked to the clinical picture. We found that higher birth order predicted a higher likelihood to suffer from primary NE versus secondary NE. Furthermore, higher birth order of the child predicted higher probability for NE only as opposed to combined NE and DE. We found no supporting or contradicting data in the literature regarding these associations. However, conflicting data were detected regarding the association between NE only and birth order. In a previous study, lower ordinal position in the family was associated with higher risk for NE, and the authors hypothesized that this risk might be linked to lower self-esteem of lower ordinal children (Hanafin 1998). Other studies revealed no association between birth order and NE (Gunes et al. 2009; Kanaheswari 2003; Rona et al. 1997).

With regard to family size, we found no association between NE type and family size. However, a larger family size predicted a lower likelihood of NE only compared to combined NE and DE. There are very few studies addressing this issue providing an inconsistent picture (Hanafin 1998; Toktamis et al. 2008).

Notwithstanding our findings, a referral bias confound should be considered. Pervious research has indicated that firstborns have a higher rate of clinic referrals (Padgett et al. 1993; Piacentini and Lahey 1986; Tuckman and Regan 1967a), and family size has been shown to be inversely associated with clinical services use in several studies (Jensen et al. 1990; Padgett et al. 1993; Piacentini and Lahey 1986; Tuckman and Regan 1967b). For example parents with a first born child with NE might be anxious and seek treatment sooner for NE while a parent of a later born child might wait longer to seek treatment (e.g., less anxious, less resources and time to seek treatment). Thus, the implications of the associations found for birth order, family size and different manifestations of enuresis are not immediately clear, clearly, further research is needed to explore if family size and birth order plays a significant role in the etiology or clinical management of enuresis.

In conclusion our study of a large cohort of children referred to NE treatment over a substantial period of time enhances the knowledge of NE and provides a wider understanding of important associated factors to this phenomenon. Key findings include the persistent predominance of boys in comparison to girls and the decreasing age of referrals over the years of the study. Further research is needed to validate the benefits (and potential costs) of early referrals. It is suggested that addressing NE at an early age may limit its adverse effects, and potentially enhance the well-being of children and their families.

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