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# The influence of delay elimination communication on the prevalence of primary nocturnal enuresis—a survey from Mainland China

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## Abstract

**Aims:** A pilot survey shows that primary nocturnal enuresis (PNE) prevalence has increased significantly during the past decade in Mainland China. Whether it is related to the delay of elimination communication (EC) is unclear. This study retrospectively investigated the influence of delayed EC on the PNE prevalence in children and adolescents in mainland China.

**Methods:** A cross-sectional study of PNE prevalence was performed by distributing 19 500 anonymous self-administered questionnaires to parents in five provinces of mainland China from July 2017 to October 2017. The questionnaires included sociodemographic data, family caregivers' information, and details about the disposable diapers (DD) usage, EC commencement date, psychological disorders, lower urinary tract symptoms, and family history of PNE in children and adolescents. The 2017 PNE prevalence was compared with that of 2006 in Mainland China.

**Results:** The total response rate was 97.04% (18 631 of 19 500) and 92.39% (18 016 of 19 500) qualified for statistical analysis. The PNE prevalence in 2017 has increased significantly compared to that of 2006 (7.30% vs 4.07%, $P < 0.001$). The PNE prevalence in children with EC starting before 6 months of age was significantly lower than those who start after 12 months of age. The longer DD were used and the later the beginning of EC, the higher the PNE prevalence was found.

**Conclusions:** The PNE prevalence in Mainland China has increased significantly during the past 10 years. A longer use of DD and later onset of EC may be risk factors for PNE.

Xi Zheng Wang and Yi Bo Wen contributed equally to this work.

  

# 1 | INTRODUCTION

Primary nocturnal enuresis (PNE) is diagnosed when children over 5 years of age have at least one enuresis episode per month, lasting at least 3 months.[1,2] Based on these criteria, a cross-sectional study of PNE from 2006 estimated the overall PNE prevalence in Chinese children and adolescents aged 5 to 18 years to be 4.07%; this prevalence was considerably lower than what was reported in Western countries, and we postulated that it was related to cultural and economic differences between China and the West.[3] In 2006, elimination communication (EC) from an early age of life was common, due to Chinese children using fewer disposable diapers (DD) compared to those in Western countries.

The "Guide to Toilet Training" published by the American Academy of Pediatrics (AAP) is currently having a significant impact on the practice of EC in Mainland China. It states that EC works best for most families if it is delayed until children are ready to control the process themselves.[4] However, some clinical experts increasingly recognize that long-time dependence on diapers and delayed EC and toilet training is associated with an unstable bladder, urinary frequency, urinary incontinence, and other elimination problems.[5,6]

Recently, we showed in a pilot survey that the PNE prevalence has increased significantly during the past decade in Mainland China.[7] Whether this increase is related to increased DD usage and/or delay of EC is unclear. In 2016, the US website "www.diaperfreebaby.org" encouraged parents to remove disposable diapers,[8] and BBC in 2017 recommended parents to go "nappy-free" and start EC as early as possible.[9] Such recommendations need supportive evidence. The present study aims to verify whether PNE prevalence is significantly higher than a decade ago and if it is, whether it is related to increased DD usage and delay of EC.

# 2 | MATERIAL (PATIENTS) AND METHODS

## 2.1 | Study participants

From July to October 2017, an epidemiological survey of PNE among children and adolescent aged 5 to 18 years was performed in five provinces throughout Mainland China: Hebei Province (North), Henan Province (Middle), Shanxi Province (West), Fujian Province (Southeast), and Guangdong (South). Twenty primary, 15 juniors, and 15 senior high schools in total were selected by means of systematic sampling; classes were randomly chosen according to the children's age distribution in the school. The results were compared with the main results of the 2006 survey.[3]

## 2.2 | Content of the questionnaire

The cross-sectional paper survey used a self-administered anonymous questionnaire consisting of four sections that required parents to "tick-off" boxes. Section 1 collected the child's background data—the child's date of birth, sex, and primary caregiver (including parents, grandparents, and babysitters). Section 2 collected information on DD usage. Section 3 collected information on EC and the parent's attitude to voiding training. Section 4 collected information on PNE history. Definition of EC: mother holds the baby's legs up over a baby's toilet or bucket. (Figure 1).

## 2.3 | Grouping

DD usage Group (D1-D6): All infants were grouped according to the duration of using DD since birth (Figure 2.1).

EC Group (E1-E7): Infants with EC were grouped according to the EC starting time (age [years]; Figure 2.2).

**FIGURE 1** Dummy

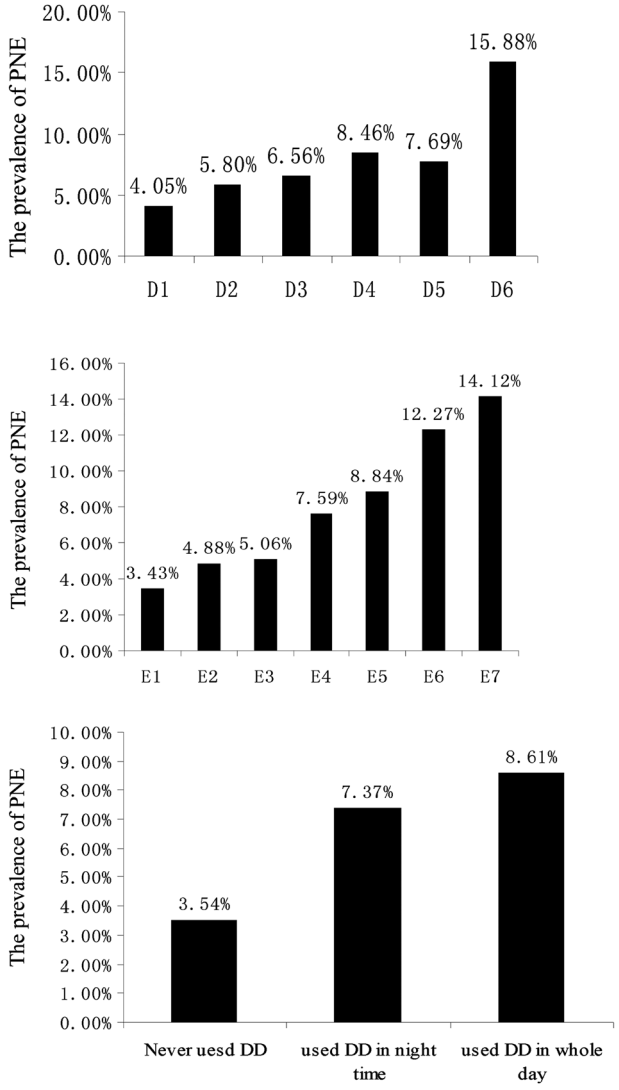


**FIGURE 2** The length and time of using disposable diapers (DD), starting time of elimination communication (EC), and their relationship to primary nocturnal enuresis (PNE) prevalence

## 2.4 | Statistical analysis

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS), version 11.0 for Windows. $\chi^2$ tests determined the difference in PNE prevalence between 2006 and 2017. Comparison of variables between different sexes, caregivers, habitation, attitude to early toilet training, difficulty awakening from sleep, family history of PNE, diaper usage, and EC were conducted by using $\chi^2$ tests or the Fisher exact tests when appropriate; $P < 0.05$ were considered statistically significant. Odds ratios and their corresponding 95% confidence intervals were calculated to measure associations. The original α-value was set at 0.05. To reduce the chance of obtaining type 1 errors from multiple analyses performed on the same dependent variable, the Bonferroni-adjusted *P*-values were calculated by dividing the α-value by the number of comparisons. Factors related to PNE were evaluated by logistic regression.

# 3 | RESULTS

A total of 19 500 children and adolescents aged 5 to 18 years were included in the study, and 18 631 questionnaires were returned: 92.39% (18 016 of 19 500) of them qualified ( all questions were clearly answered) for statistical analysis.

The PNE prevalence decreased with age from 11.83% and 15.13% in 5-year-olds to 1.05% and 1.13% in 18-year-olds, between 2006 and 2017, respectively. The overall PNE prevalence in 2017 was 7.30%, which is significantly higher than the prevalence found in 2016 (4.07%, $P < 0.001$). Compared with the results from 2006, the PNE prevalence in the age group 5 to 9-year-olds was significantly higher in 2017. No significant difference was found in the age group 10 to 18 years (Table 1).

A total of 82.42% (14 878 of 18 016) of all children began using DD immediately after birth. The PNE prevalence in infants with DD usage in D1, D2, and D3 was significantly lower than those of D3-D6, D4-D6, and D5-D6 (4.05% vs 8.57%, 5.80% vs 9.23%, 6.56% vs 10.03%; $P < 0.05$), respectively. The PNE prevalence of the different DD groups is shown in Figure 2.1.

Children who began using DD immediately after birth began EC at $10.79 \pm 8.26$ months of age. Those who never used DD began EC at $8.40 \pm 7.65$ months. The difference between the two groups was significant ($t = 12.630$, $P < 0.05$).

A significantly different PNE prevalence was found between those who used DD only at night vs those who used DD all day (7.37% vs 8.61%, $P < 0.05$). Only 17.42% (3138 of 18 016) of children never used DD after birth. Their PNE prevalence was significantly lower than in those using DD only at night (3.54% vs 7.37%, $P < 0.05$), and those using DD all day (3.54% vs 8.61, $P < 0.001$; Figure 2.3).

The PNE prevalence in groups E1 and E2, was significantly lower than those of E5-E7, and E6-E7 (3.43% vs 11.61%, 4.88% vs 13.48%; $P < 0.05$), respectively. The PNE prevalence in children who started EC before 18 months of age (E3, E4, E5) was all significantly lower than those who began at a later age (E7) (5.06% vs 14.12%; 7.59% vs 14.12%; 8.84% vs 14.12%; $P < 0.05$; Figure 2.2).

Possible risk factors including sex, childhood caregiver, difficulty with arousal from sleep, and family history of PNE, DD usage, and EC starting time with multi-level logistic regression analysis assessing determinants of PNE

**TABLE 1** Prevalence of primary nocturnal enuresis in children and adolescent in 2006 and 2017

| | PNE in 2017 | | PNE in 2006 | | | |
|---|---|---|---|---|---|---|
| Age, y | PNE% (95% CI) | PNE/n | PNE% (95% CI) | PNE/n | $\chi^2$ | *P* |
| 5 | 15.13 (13.51-16.76) | 332/2194 | 11.83 (9.25-14.41) | 71/600 | 4.154 | 0.042 |
| 6 | 12.97 (11.35-14.58) | 247/1905 | 10.10 (8.00-12.19) | 80/792 | 4.390 | 0.038 |
| 7 | 11.38 (9.86-12.90) | 215/1890 | 8.42 (6.12-10.72) | 47/558 | 3.930 | 0.047 |
| 8 | 9.79 (8.29-11.28) | 164/1676 | 7.04 (5.09-9.00) | 46/653 | 4.303 | 0.038 |
| 9 | 7.73 (6.46-8.99) | 144/1864 | 4.42 (3.01-5.83) | 36/815 | 9.902 | 0.002 |
| 10 | 6.04 (4.73-7.34) | 82/.1358 | 4.19 (2.70-5.68) | 29/692 | 3.055 | 0.080 |
| 11 | 3.34 (2.41-4.28) | 49/1466 | 2.97 (1.91-4.03) | 29/977 | 0.266 | 0.606 |
| 12 | 1.81 (1.19-2.45) | 32/1759 | 1.72 (1.10-2.43) | 22/1278 | 0.041 | 0.840 |
| 13-15 | 1.47 (0.95-1.99) | 30/2044 | 1.48 (1.03-1.93) | 41/2773 | 0.001 | 0.975 |
| 16-18 | 1.13 (0.65-1.61) | 21/1860 | 1.05 (0.40-1.70) | 10/950 | 0.034 | 0.854 |
| Total | 7.30 (6.91-7.70) | 1316/18 016 | 4.07 (3.68-4.6) | 411/10 088 | 117.016 | <0.001 |

Abbreviation: CI, confidence interval
n = the total number of groups.

are shown in Table 2. Sex, age, type of caregiver, difficulty in awakening from sleep, family history of PNE, length of using DD, and late EC onset, were risk factors of PNE ($P < 0.001$).

## 4 | DISCUSSION

It is well known that PNE prevalence gradually decreases with age. Further, the prevalence has shown some variation in different countries.[3] The literature on increased PNE prevalence over time in the same age group and in the same population is limited. Thompson et al[10] discovered a significant increase in PNE prevalence between 1998 and 2006 (3.2% vs. 7%, $P < 0.05$) in England, but did not report possible causes. In southwestern Nigeria, the reported PNE prevalence in children aged 6 to 12 years in 2003 was lower than that in similar age groups in 2015 (17.6% vs 32.95%), also without a clear etiology.[11,12] Yeung et al[13,14] performed two surveys in Hong Kong and found that PNE prevalence was much higher in 2006 (5.32% in ages 5 to 12 years) compared to that in 1997 (3.5% in ages 4 to 12 years). He suggested that the first reported low prevalence of PNE in Hong Kong was probably due to parental indifference to the problem. Unfortunately, data on DD usage and timing of EC were not collected in the study, leaving the question whether these two factors could be related to the PNE prevalence unsolved? The present study demonstrated not only a significant increase in PNE prevalence in the same age group (5- to 9-years old), compared to a similar the survey in 2006, in Mainland China, but it also points towards potential risk factors, such as DD usage and timing of starting EC.

EC helps infants to move quite easily into traditional toilet training when they are old enough. This method is still in use in many areas all around the world, where access to diapers and the facilities to wash them are simply not available. Much literature is available recognizing the importance of toilet training even for infants with a dysfunctional bladder.[15]

DD usage can be associated with side effects in infants, such as diaper rash. Further, popular usage of DD has resulted in postponing of toilet training worldwide.[16] Those who oppose early EC believe that it is useless for stopping fecal and urinary incontinence due to the fact that local conditioning of reflex sphincter control can only be effectively elicited after 9 months of age.[17] On the other hand, some experts hypothesize that the micturition reflex system initiates in the brainstem while bladder emptying is a spinal reflex that is not controlled by the brain at all in newborns and young infants; with maturation of the central nervous system (CNS), the cerebral cortex gradually assumes conscious control of micturition, so in theory early toilet training should be helpful in children develop urinary control.[18]

The relationship between voiding patterns and brain cortical activity in healthy preterm neonates using video-EEG indicated that babies might feel their elimination needs from birth.[19] We speculated that this connection between the CNS and bladder or voiding control, forms the basis of voiding training, to some extent. By taking babies to appropriate elimination places during infancy, this enables them to maintain a connection with their

**TABLE 2** Risk factors related to PNE

| | Prevalence of PNE% (NE/n) | B | $\chi^2$ | *P* | OR | 95% CI |
|---|---|---|---|---|---|---|
| Sex | | | | | | |
| Male | 8.03 (781/9723) | 1 (ref) | | | 1 (ref) | |
| Female | 6.45 (535/8293) | −0.270 | 19.284 | <0.001 | 0.763 | 0.677-0.861 |
| Caregiver | | | | | | |
| Parents | 6.51 (874/13 417) | 1 (ref) | 28.124 | <0.001 | 1 (ref) | |
| Grandparents | 9.59 (425/4434) | −0.166 | 0.355 | 0.551 | 0.847 | 0.490-1.643 |
| Babysitter | 10.30 (17/165) | 0.183 | 0.421 | 0.516 | 1.201 | 0.691-2.086 |
| Attitude to EC | | | | | | |
| Positive | 6.67 (945/14 186) | 1 (ref) | | | 1 (ref) | |
| Negative | 9.69 (371/3830) | 0.073 | 1.043 | 0.307 | 1.076 | 0.935-1.237 |
| Age | | −0.244 | 419.840 | <0.001 | 0.784 | 0.765-0.802 |
| Duration of using diapers | — | 0.020 | 55.845 | <0.001 | 1.020 | 1.015-1.025 |
| Awaken child from sleep | | | | | | |
| Easy | 4.23 (452/10 685) | 1 (ref) | | | 1 (ref) | |
| Difficult | 11.79 (864/7331) | 0.874 | 191.947 | <0.001 | 2.396 | 2.118-2.711 |
| Family history of PNE | | | | | | |
| No | 6.71(1167/17 382) | 1 (ref) | | | 1 (ref) | |
| Yes | 23.50 (149/634) | 1.799 | 261.294 | <0.001 | 6.044 | 4.859-7.517 |
| Starting time of EC | | | | | | |
| Starting time (E7) | 14.12 (311/2203) | 1 (ref) | 157.736 | <0.001 | 1 (ref) | |
| Starting time (E1) | 3.43 (129/3756) | −1.226 | 112.295 | <0.001 | 0.293 | 0.234-0.368 |
| Starting time (E2) | 4.88 (146/2992) | −1.014 | 82.545 | <0.001 | 0.363 | 0.292-0.452 |
| Starting time (E3) | 5.06 (81/1600) | −0.942 | 47.962 | <0.001 | 0.390 | 0.299-0.509 |
| Starting time (E4) | 7.59 (307/4045) | −0.737 | 64.256 | <0.01 | 0.478 | 0.399-0.573 |
| Starting time (E5) | 8.84 (200/2263) | −0.685 | 44.747 | <0.001 | 0.504 | 0.412-0.616 |
| Starting time (E6) | 12.27 (142/1157) | −0.401 | 12.079 | 0.001 | 0.669 | 0.534-0.839 |

Abbreviations: CI, confidence interval; EC, elimination communication; OR, odds ratio; PNE, primary nocturnal enuresis

Ref = reference, $P < 0.05$ means a significant difference. E1 = starting age < 3 mo old; E2 = starting age ≥ 3 but < 6 mo; E3 = starting age ≥ 6 but < 9 mo; E4 = starting age ≥ 9 but < 12 mo; E5 = starting age ≥ 12 but < 18 mo; E6 = starting age ≥ 18 but < 24 mo; E7 = starting age ≥ 24 mo

*The PNE prevalence was significantly higher in males than in females ($P < 0.05$), in those reported to be difficult to arouse during sleep than those easily awakened ($P < 0.05$), and in those with a positive PNE family history than those with a negative family history, respectively ($P < 0.001$). The PNE prevalence was significantly lower in children cared for by parents than those by grandparents or babysitters ($P < 0.05$), in parents with positive attitudes to EC than those with negative attitudes ($P < 0.05$) and in those started EC later than those starting earlier, respectively ($P < 0.001$).

bodily sensations and teaches them what to do, from an early age, when they experience these sensations.[20] Therefore, early and regular EC should lead to strengthening this connection, and help children develop the proper habits for urination, not only at the right time but also in the right place. However, EEG can only penetrate 1 to 2 cm into the brain, which cannot separate out activation from deactivation signaling to the bladder. Therefore, more research is needed for understanding these early brain-bladder connections.

It is well known that the etiology and pathophysiology of enuresis is very complex. Other factors, such as insufficient vasopressin secretion, fluid intake, and sleep disorders might also contribute to the development PNE in older children or adolescents. The present study surveyed the effects of arousal from sleep on the PNE and got similar results compared to our previous studies. The factors of insufficient desmopressin secretion and fluid intake were not collected in the present study, but this needs to be investigated as well, in the future. With improving economic status of families, a child's daily life style in China is changing. One of these changes includes increased DD usage and that delays EC now more than ever. The information collected in present study shows the increase of PNE prevalence is related to this change.

Although the maturation of brain alertness of bladder sensation and the development of the guarding effect on the control of voiding are possible factors for the diurnal

dryness in children, these factors still cannot explain why a child with prolonged DD use and delayed EC will develop PNE. However, our present study supports the prolonged usage of DD, while delayed EC might be one of the risk factors causing PNE, that is, a high probability for developing PNE in children who experienced prolonged DD usage and delayed EC. Joinson[16] also found that late EC was associated with a greater likelihood of persistent daytime wetting. Children may become used to the feeling of wearing DD and may develop manifestations of dependence, making them resistant to toilet training. Thus, starting EC earlier seems to be important. It can be practiced by stay-at-home or working parents. China has a history of early EC lasting thousands of years, and until at least 10 years ago. In 2006, we found the prevalence of attaining nocturnal urinary control was 52% and 70% in 1- and 2-year-old children, respectively, after EC, indicating that by using early EC, most Chinese infants developed voiding control by 2 years.[21] Most children begin kindergarten at 2 to 3 years of age in Mainland China. It is very beneficial for children to become dry by the time they enter kindergarten. Therefore, guidelines for starting EC after 18 months would not be acceptable for most Chinese children and parents.

The present study showed that PNE prevalence in children cared for by parents was significantly lower than for other caregivers. Due to national Chinese conditions, some parents cannot care for their baby full-time because of working conditions, which, sometimes is far from home. Instead, grandparents or babysitters care for the children, which has been shown to have negative effects on the development of voiding control in the child. A possible explanation for this might be that parents are likely to spend more time to help their baby with EC than another caregiver for getting their child dry early. Further, we found that the prevalence of PNE in those children who were easy to awaken from sleep is much lower than those difficult to arouse (4.23% vs 11.79%, $P < 0.001$, odds ratio = 2.396). This demonstrates that children who are "deeper sleepers" are at a higher risk for the prevalence of PNE.

The reasons of increase NE prevalence in China might be multifactorial. The major socioeconomic changes during the last years in Mainland China include many factors, such as annual income, parents' occupation, their educational background, and dietary changes, all which could contribute to the increase of the prevalence However, data regarding annual income, occupation, and educational background were not collected in this study due to potential for violation of privacy rules. This makes analyzing the socioeconomic differences or educational differences between the respondent's parents impossible to gather. To guarantee the quality of our survey, we only chose to include public schools in the city, but this might have caused a data bias by economic level and population mobility. According to Chinese per capita disposable income, there are no socioeconomic differences between the cities that we chose.

In addition, the reasons for increased NE prevalence in China might be multifactorial, as our present study shows that DD usage and delayed EC are one set of the risk factor that contribute to this increase. The relationship between other socioeconomic changes and the increase in NE prevalence as well as the prevalence of NMNE and bowel dysfunction need to be investigated as well, in the future.

## 5 | CONCLUSIONS

In summary, our study found a significantly higher PNE prevalence in 2017 than in 2006 in Mainland China, suggesting that the longer use of DD and later onset of EC may be risk factors for this increase. An international multicenter project is recommended to provide stronger evidence for update of present guidelines regarding DD usage and time of EC, not only in Mainland China, but worldwide.

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