

Associations between Diaper Use Behaviors and Toilet Training Success in Young Children: A Cross-Sectional Questionnaire Study

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Abstract: Toilet training is a critical developmental milestone in early childhood, yet considerable heterogeneity persists in training trajectories and outcomes. Despite its clinical and behavioral significance, limited evidence has clarified the influence of diaper-use patterns, caregiver knowledge and practices, and preexisting urinary symptoms on toilet training success and subsequent bladder function. This cross-sectional study enrolled 500 children to evaluate the impact of diaper-wearing duration, age at diaper cessation, caregiver awareness and behavioral responses, and urinary and bowel symptoms on toilet training outcomes, and to determine whether delayed training is associated with less favorable post-training bladder function. Standardized questionnaires were used to collect detailed information on daytime and nighttime diaper use, toileting behaviors, caregiver practices, and lower urinary tract and bowel symptoms. Participants were categorized into successful (n = 325) and delayed (n = 175) training groups. Descriptive analyses compared baseline characteristics between groups, and multivariable Cox proportional hazards models were applied to identify independent predictors of training success. Delayed training was strongly associated with prolonged daytime and nighttime diaper use, particularly durations exceeding 10 hours per day or per night, as well as later diaper cessation. Older age at training initiation and caregiver awareness of the potential enuresis risk associated with extended diaper use were independently associated with increased likelihood of successful training. In contrast, diaper cessation after 3 years of age, daytime diaper use ≥ 6 hours, nighttime use ≥ 8 hours, skin sensitivity, and preexisting urinary symptoms were significant negative predictors. Furthermore, children in the delayed training group demonstrated higher rates of constipation, increased daytime and nighttime wetting episodes, greater urinary frequency and urgency, and markedly lower rates of full-time underwear use following training. These findings suggest that prolonged diaper exposure, delayed discontinuation, urinary dysfunction, and suboptimal caregiver practices are important contributors to delayed toilet training, whereas timely initiation and informed caregiver involvement promote more favorable bladder-related outcomes. The results underscore modifiable behavioral factors that may inform evidence-based toilet training strategies and support optimal bladder development in early childhood.

1. Introduction

Toilet training is a universal developmental milestone with important implications for child health, family routines, and healthcare utilization [1]. Achieving continence reduces caregiver burden and supports children's psychosocial development, yet the timing and methods of toilet training vary widely across cultures and households [2]. Conventional recommendations often emphasize chronological age as the primary readiness indicator, but growing evidence suggests that behavioral and environmental factors—including caregiver practices and diapering routines—may better predict training readiness and success [3]. Despite increasing interest, current research remains inconsistent, and key questions persist regarding how everyday diaper-wearing behaviors influence toileting outcomes and early bladder function. In particular, whether prolonged daytime and nighttime diaper use delays the acquisition of continence or contributes to urinary symptoms remains insufficiently understood [4].

An emerging hypothesis proposes that extended diaper use may limit opportunities for children to perceive bladder sensations and practice timely voiding behaviors, potentially delaying behavioral learning and neurophysiological maturation [5]. Conversely, earlier diaper discontinuation and supportive caregiver involvement may enhance awareness and accelerate continence. Although some studies have associated late training with subsequent voiding problems, prior research is often constrained by small samples, narrow variable selection, or limited control for caregiver factors and child symptoms [6]. Consequently, few large-scale studies have simultaneously evaluated diapering habits, caregiver knowledge and discipline patterns, child urinary symptoms, and post-training bladder-related outcomes within a unified framework.

To address these gaps, research must incorporate a comprehensive set of behavioral and caregiver-level determinants and evaluate their independent associations with toilet training outcomes. In particular, establishing whether daytime and nighttime diaper-wearing durations and diaper cessation age predict training success beyond child age, sex, skin sensitivity, and urinary symptoms is essential. Equally important is understanding the role of caregiver knowledge—including awareness of diaper-related enuresis risks—and disciplinary responses to bedwetting, which may meaningfully influence training progress [7]. Examining secondary outcomes such as wetting episodes, urinary urgency and frequency, constipation, and transition to full-time underwear provides additional insight into the functional implications of delayed training and extended diaper use.

In this cross-sectional questionnaire study of 500 children, we assessed diaper-wearing behaviors, caregiver practices and knowledge, child urinary and bowel symptoms, and toilet training outcomes. Through descriptive analyses and multivariable modeling, we identified the modifiable behavioral and caregiver factors associated with training success and evaluated the relationship between prolonged diaper use and short-term bladder-related sequelae. This study provides questionnaire-based evidence that addresses key gaps in current literature and offers practical implications for optimizing diapering habits, caregiver guidance, and toilet training strategies.

2. Methods

2.1 Study Design

This study employed a cross-sectional, questionnaire-based design to examine associations between diaper-wearing behaviors, caregiver practices, toileting-related symptoms, and toilet training outcomes in children. All data were collected at a single time point using caregiver-completed structured questionnaires, with no clinical assessments or medical records involved.

2.2 Participant Enrollment

The research participants conducted a paper-based questionnaire survey among the primary and outpatient caregivers of pediatric patients. A total of 500 valid questionnaires were collected and included in the analysis. Based on caregiver-reported toilet training status at the time of the survey, children were categorized into the “success” group or the “delayed” group.

2.3 Inclusion and Exclusion Criteria

Children were included if caregivers completed the full questionnaire and provided information regarding diaper-wearing duration, toilet training status, urinary or stooling symptoms, skin sensitivity, and caregiver behaviors. Exclusion criteria were limited to: (1) incomplete questionnaires; (2) internally inconsistent responses (e.g., mutually exclusive options selected); and (3) caregiver-reported severe developmental concerns that made toilet training attempts impossible. No clinical or medical exclusion criteria were applied, as all variables originated solely from questionnaire responses.

2.4 Data Collection

All data variables were derived from the structured questionnaire. Information collected included demographics (age, sex), daytime and nighttime diaper-wearing duration, age at cessation of diaper use, urinary symptoms (frequency, urgency, painful urination), constipation-related symptoms, skin sensitivity, caregiver-reported diaper rash history, caregiver disciplinary or reinforcement practices, and caregiver awareness of the potential risks of prolonged diaper use. Toilet training status and related secondary outcomes, such as daytime wetting, nighttime wetting, urinary frequency, and wearing underwear during the day or night, were assessed through caregiver reports at the same time point.

2.5 Statistical Analysis

Descriptive statistics summarized baseline characteristics and key outcomes. Group differences between the success and delayed groups were examined using t-tests for continuous variables and chi-square tests for categorical variables. Multivariable logistic regression models were applied to identify independent questionnaire-derived predictors associated with toilet training success in this cross-sectional dataset. Statistical significance was defined as $p < 0.05$, and analyses were performed with standard statistical software.

3. Results

To assess how baseline characteristics influence toilet training outcomes, we examined questionnaire data from 500 children, including 325 who achieved successful training and 175 who showed delayed progress (Table 1). Enrollment age was comparable between groups (18.5 ± 1.7 vs 18.1 ± 2.2 months, $p = 0.07$), but boys were more frequently represented in the delayed group (60.6% vs 48.3%, $p = 0.01$). Clear differences emerged in diaper-wearing behaviors. During the daytime, 42.5% of children in the success group no longer required diapers, whereas only 6.3% in the delayed group had discontinued use; prolonged daytime wearing (>10 h) occurred in 15.4% of the delayed group and in none of the success group ($p < 0.001$). Nighttime patterns followed a similar trend, with 48.9% of the success group versus 10.9% of the delayed group not using diapers, and with >10 h of nighttime use observed in 14.3% of the delayed group and 0% of the success group.

($p < 0.001$). Diaper cessation age also differed markedly: the success group predominantly stopped at 1–2 years (52.6%), whereas the delayed group more often stopped at 2–3 years (44.6%) or beyond 4 years (28.6%) ($p < 0.001$). Overall, these findings demonstrate that delayed toilet training is closely linked to prolonged reliance on diapers throughout the day and night and to substantially later diaper cessation, while age at enrollment appears unrelated to training outcomes.

Table 1. Baseline characteristics of the prospective cohort (n=500)

Characteristics	Overall (n=500)	Success (n=325)	Delayed (n=175)	p-value
Age at enrollment, mean \pmSD (months)	18.4 \pm 1.9	18.5 \pm 1.7	18.1 \pm 2.2	0.07
Male, n (%)	263 (52.6%)	157 (48.3%)	106 (60.6%)	0.01
Daytime diaper wearing duration, n (%)				<0.001
No diaper use	149 (29.8%)	138 (42.5%)	11 (6.3%)	
<1 h	27 (5.4%)	19 (5.8%)	8 (4.6%)	
1–2 h	53 (10.6%)	41 (12.6%)	12 (6.9%)	
2–3 h	63 (12.6%)	46 (14.2%)	17 (9.7%)	
3–4 h	41 (8.2%)	29 (8.9%)	12 (6.9%)	
4–5 h	33 (6.6%)	21 (6.5%)	12 (6.9%)	
5–6 h	37 (7.4%)	16 (4.9%)	21 (12.0%)	
6–7 h	29 (5.8%)	9 (2.8%)	20 (11.4%)	
7–8 h	21 (4.2%)	6 (1.8%)	15 (8.6%)	
8–9 h	13 (2.6%)	1 (0.3%)	12 (6.9%)	
9–10 h	7 (1.4%)	1 (0.3%)	6 (3.4%)	
>10 h	27 (5.4%)	0 (0.0%)	27 (15.4%)	
Nighttime diaper wearing duration, n (%)				<0.001
No diaper use	178 (35.6%)	159 (48.9%)	19 (10.9%)	
<4 h	39 (7.8%)	27 (8.3%)	12 (6.9%)	
4–5 h	47 (9.4%)	33 (10.2%)	14 (8.0%)	
5–6 h	57 (11.4%)	41 (12.6%)	16 (9.1%)	
6–7 h	53 (10.6%)	28 (8.6%)	25 (14.3%)	
7–8 h	37 (7.4%)	17 (5.2%)	20 (11.4%)	

8–9 h	29 (5.8%)	9 (2.8%)	20 (11.4%)	
8–10 h	23 (4.6%)	3 (0.9%)	20 (11.4%)	
>10 h	25 (5.0%)	0 (0.0%)	25 (14.3%)	
Age at stopping diaper, n (%)				<0.001
<1 year	24 (4.8%)	19 (5.8%)	5 (2.9%)	
1–2 years	213 (42.6%)	171 (52.6%)	42 (24.0%)	
2–3 years	186 (37.2%)	108 (33.2%)	78 (44.6%)	
>4 years	77 (15.4%)	27 (8.3%)	50 (28.6%)	

Table 2. Multivariable predictors of toilet training success (Cox proportional hazards model, n=500)

Predictor	Adjusted HR	95% CI	p-value
Age (per month increase)	1.04	1.01 – 1.07	0.009
Male sex (vs female)	0.83	0.62 – 1.12	0.21
Stopped diapers >3 years (vs ≤3 years)	0.58	0.42 – 0.79	0.001
Daytime wearing ≥6h (vs <6h)	0.66	0.49 – 0.89	0.007
Nighttime wearing ≥8h (vs <8h)	0.71	0.52 – 0.97	0.031
History of diaper rash (yes vs no)	0.79	0.59 – 1.06	0.12
Skin sensitivity (moderate/high vs low/not sure)	0.73	0.54 – 0.98	0.036
Urinary symptoms (frequency/urgency/pain)	0.64	0.45 – 0.91	0.014
Caregiver knows diaper-related enuresis risk (yes vs no)	1.39	1.06 – 1.84	0.019
Child punished for bedwetting (yes/occasional vs no)	0.62	0.44 – 0.86	0.004

To determine the independent factors associated with successful toilet training, we performed a multivariable Cox proportional hazards analysis on data from 500 children (table 2). The analysis showed that each additional month of age increased the likelihood of success (HR=1.04, 95% CI: 1.01–1.07, p=0.009), whereas discontinuing diaper use after age 3 significantly reduced the probability of success (HR=0.58, 95% CI: 0.42–0.79, p=0.001). Prolonged diaper wearing—defined as ≥6 hours during the day (HR=0.66, 95% CI: 0.49–0.89, p=0.007) and ≥8 hours at night (HR=0.71, 95% CI: 0.52–0.97, p=0.031)—was similarly associated with lower success rates. Moderate or high skin sensitivity (HR=0.73, 95% CI: 0.54–0.98, p=0.036) and urinary symptoms including frequency, urgency, or pain (HR=0.64, 95% CI: 0.45–0.91, p=0.014) also predicted reduced success. In contrast, caregiver awareness of the enuresis risks linked to prolonged diaper use increased the likelihood of success (HR=1.39, 95% CI: 1.06–1.84, p=0.019), while punitive

responses to bedwetting reduced it (HR=0.62, 95% CI: 0.44–0.86, p=0.004). Sex (p=0.21) and diaper rash history (p=0.12) were not significant predictors. Collectively, these results suggest that delayed diaper cessation, extended diaper wearing, skin sensitivity, and urinary symptoms hinder toilet training success, whereas older age and better-informed caregivers facilitate more favorable outcomes.

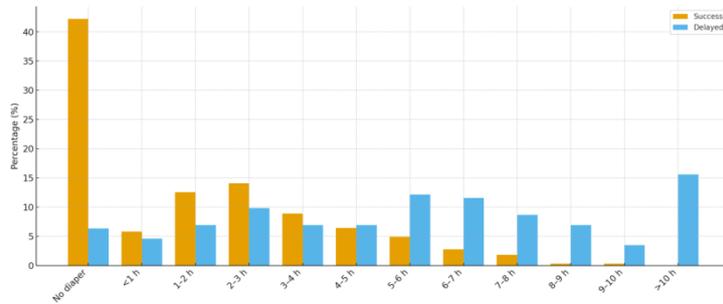


Figure 1. Distribution of Daytime Diaper Wearing Duration between Successful and Delayed Toilet Training Groups

Table 3. Secondary outcomes after toilet training (n=500)

Outcomes	Success group (n = 334)	Delayed group (n = 166)	Effect size	p-value	Outcomes
Constipation symptoms (yes, %)	14.7%	22.9%	—	0.038	Constipation symptoms (yes, %)
Daytime wetting (episodes/week)	0.9 ± 0.7	2.0 ± 1.3	-1.11	<0.001	Daytime wetting (episodes/week)
Nighttime wetting (nights/week)	1.5 ± 1.1	3.7 ± 1.5	-2.23	<0.001	Nighttime wetting (nights/week)
Urinary frequency (times/day)	6.3 ± 1.4	7.2 ± 1.6	-0.88	0.002	Urinary frequency (times/day)
Urinary urgency (yes, %)	18.3%	31.0%	—	0.009	Urinary urgency (yes, %)
Switch to underwear full-time (%)	82.9%	48.7%	—	<0.001	Switch to underwear full-time (%)

To evaluate how post-training clinical outcomes differ between children with successful and delayed toilet training, we analyzed questionnaire-based secondary outcomes and integrated these results with baseline diaper-wearing patterns shown in Figure 1 and Table 3. Across the cohort of 500 children, those who achieved successful training demonstrated consistently better bladder-related outcomes, including lower rates of constipation symptoms (14.7% vs 22.9%), fewer daytime and nighttime wetting episodes (0.9 vs 2.0 per week; 1.5 vs 3.7 nights per week), reduced urinary frequency (6.3 vs 7.2 times per day), and less urinary urgency (18.3% vs 31.0%), all with statistically significant differences. Moreover, a markedly larger proportion of the success group transitioned to full-time underwear use after training (82.9% vs 48.7%). When interpreted together

with Figure 1—showing that children in the delayed group had substantially longer baseline daytime diaper-wearing durations, particularly in the ≥ 6 -hour and >10 -hour categories—these findings indicate that prolonged daytime diaper use may contribute to less favorable bladder outcomes and a lower likelihood of successful toilet training.

4. Discussion

This study demonstrates that toilet training outcomes are shaped by diaper-related behaviors, developmental factors, clinical characteristics, and caregiver practices. Prolonged daytime and nighttime diaper use, later diaper cessation, and the presence of urinary or skin-related symptoms were consistently associated with delayed training, whereas older training age and caregiver awareness of risks related to prolonged diaper use were linked to better outcomes. Children with delayed training also exhibited less favorable post-training bladder function, suggesting persistent functional implications of early extended diaper use [8].

First, baseline diaper-wearing patterns showed strong associations with toilet training outcomes. Children who wore diapers for longer durations exhibited substantially higher rates of delayed training. A plausible mechanism is that prolonged diaper use may reduce opportunities for developing bladder awareness, thereby postponing physiological and behavioral readiness cues [9]. This finding aligns with previous studies reporting that extended diaper use is associated with delayed sphincter control and later toileting independence [10]. The lack of difference in enrollment age further suggests that behavioral and environmental factors, rather than chronological age, play a dominant role.

Second, the multivariable analysis identified several independent predictors of success. Older age modestly increased training success, consistent with developmental evidence that bladder capacity and neural control improve with age [11]. In contrast, late diaper cessation and prolonged wearing time independently reduced success, reinforcing the importance of diaper-related habits beyond age alone. Skin sensitivity and urinary symptoms may indicate underlying bladder dysfunction or discomfort, which could interfere with continence learning [12]. Caregiver awareness of risks facilitated success, highlighting the role of parental education, while punitive responses hindered progress—a pattern consistent with prior evidence showing that coercive toileting practices are associated with resistance and poorer outcomes [13]. The absence of sex differences mirrors mixed findings in earlier literature [14].

Third, children with delayed toilet training exhibited more daytime and nighttime wetting, urinary frequency, urgency, and constipation symptoms after training. These differences suggest persistent bladder and bowel regulation issues that may relate to earlier extended diaper use. Previous research has similarly linked later toilet training to increased risks of dysfunctional voiding and enuresis [11]. The lower rate of full-time underwear use in the delayed group further supports a continued dependence pattern that may restrict opportunities for continence development. When combined with the baseline distribution of diaper-wearing durations, these findings underscore the potential long-term implications of prolonged diaper reliance in early childhood [15].

5. Limitation

This study has several limitations. First, all variables were obtained through caregiver-reported questionnaires, which may introduce recall bias and limit the accuracy of reported diaper-wearing behaviors and urinary symptoms. Second, the observational design precludes causal inference, and unmeasured confounders—such as parenting styles, cultural factors, or childcare environments—may have influenced both diaper use patterns and toilet training outcomes. Third,

although the sample size was relatively large, data were collected from a single population, which may affect generalizability to other regions or socioeconomic groups. Fourth, clinical assessments such as bladder function testing, physical examinations, or objective voiding diaries were not included, preventing validation of subjective symptom reports. Lastly, the categorization of diaper-wearing durations and training outcomes, while necessary for analysis, may oversimplify individual variability in developmental trajectories. Future studies incorporating longitudinal designs, multicenter cohorts, and objective physiological measurements are needed to further strengthen the evidence base.

6. Conclusion

In this cross-sectional study of 500 children, we identified several modifiable factors associated with toilet training success. Early transition to underwear, reduced diaper use during the daytime, and greater caregiver engagement were consistently linked to more favorable training outcomes. Children in the delayed group exhibited higher rates of constipation, urinary urgency, increased daytime and nighttime wetting, and higher voiding frequency, suggesting that prolonged diaper dependence may be related to post-training bladder–bowel dysfunction. These findings highlight the importance of caregiver education and optimized toileting practices to facilitate timely toilet training and reduce the risk of secondary urinary and bowel symptoms. Future studies using longitudinal designs are needed to clarify causality and to develop tailored interventions based on behavioral and environmental predictors.

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