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# Psychological and Physical Environmental Factors in the Development of Incontinence in Adults and Children

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## *A Comprehensive Review*

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**ABSTRACT**

The aim of this review was to identify etiological environmental factors related to incontinence in children and adults. A variety of etiological environmental factors for the development of incontinence were identified. In children, these encompass stressful life events and trauma, family dysfunction, parental psychopathology, school-related stressors, toilet or "potty" training, fluid consumption habits, housing conditions, and the availability of toilets. In adults, physical exercise, obesity, working conditions, fluid intake, and the availability of toilets play a role. Intervening variables such as hormonal variations due to work shifts have also been identified as influencing the likelihood of incontinence. Current research suggests that environmental factors influence the development of incontinence in children and adults. The interactions between biological factors, the immediate environment, and intervening variables need to be explored in greater detail. Practical solutions to reduce barriers to adequate fluid intake and healthy toileting habits should be implemented in school and work settings.

**KEY WORDS:** Adults, Children, Daytime urinary incontinence, Environment, Fecal incontinence, Genetics, Melatonin, Nocturnal enuresis, School, Work.

## INTRODUCTION

Incontinence is associated with a heterogeneous group of symptoms and disorders. The symptomatology and classification of incontinence have been described by the International Children's Continence Society (ICCS)[1] and the International Continence Society (ICS).[2,3] Research in this area of care primarily focuses on genetic and biological factors of nocturnal enuresis (NE) and daytime urinary incontinence (DUI)[4]; neurobiological aspects such as the brain-bladder interaction[5]; sleep and arousal in NE[6,7]; neurodevelopmental disorders such as attention-deficit/hyperactivity disorder and autism spectrum disorder[8,9]; and anomalies in the composition of collagen.[10–12] While these studies have contributed greatly toward our understanding of the physiologic factors, the effects of environmental factors on the genesis of incontinence have been given less priority. However, recent studies of twin subjects suggest that environmental factors do exert a significant effect on the development of incontinence.[13]

As in most complex disorders, the etiology of incontinence is rarely attributable to a single factor; instead, research suggests that multifactorial models more accurately reflect the complex interactions between genetic/physiologic and environmental factors associated with incontinence in most cases. Fortunately, many risk factors that increase vulnerability to incontinence can be offset by protective factors that provide protection or resilience against urinary of fecal incontinence.[14] The aim of this article is to review available studies addressing physical and psychological environmental factors in the genesis of incontinence for children and adults. The focus will be on etiology (ie, causation) and pathogenesis (ie, mechanisms), leading to incontinence. Nocturnal enuresis (NE), daytime urinary incontinence (DUI), and fecal incontinence (FI) will be discussed in detail. Environmental sequelae and consequences of incontinence will not be considered.

## SEARCH METHODS

A search using the Scopus database was performed. All original and review articles of all years were included. Entering the terms "incontinence," "environment," and "children" without

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any restrictions, 87 publications could be retrieved. Entering "incontinence," "environment," and "adults," 149 citations were found. Most of these references referred to surgical topics, which were not of relevance to this article. Therefore, all authors checked population-based and clinical studies with reference to environmental factors carefully and 74 relevant articles were included for the final review. These encompassed cross-sectional and longitudinal population-based and clinical studies. As they were not treatment studies, the level of evidence is not mentioned. Also, due to the paucity of studies on the topic, older studies from the 1960s and 1990s of high quality were considered. Though this review is comprehensive, it is not systematic due to the inconsistent use of the term "environment" in the Scopus data bank.

## ENVIRONMENTAL FACTORS IN CHILDREN AND ADOLESCENTS

A single review article was retrieved that reviewed environmental factors linked to incontinence. In their excellent review on sociocultural and environmental influences on bladder health, Palmer and colleagues[15] outlined a wide range of factors affecting the development of incontinence and lower urinary tract symptoms (LUTS). These include objective factors such as lack of availability of toilets and subjective factors such as lack of knowledge, stigma, and embarrassment.[15]

Several studies were identified the found that living conditions influence the likelihood of incontinence. In a cross-sectional study of children living in Brazil, Barroso and colleagues[16] reported that children living in orphanages (n = 89) had higher rates of NE (47% vs 27%; $P = .002$) and DUI (40% vs 13%; $P < .001$) than children living at home (n = 143). A clinical study published in 1966 indicated that children in residential institutional care (n = 327) had higher rates of NE than those living at home (n = 1530).[17] While children growing up without a family environment are more often affected by incontinence, further studies are needed to identify specific risk factors.

### Psychological Factors in Children

Stressful life events have been linked to relapses or persistence of incontinence. In a population-based study of 156 children with DUI and/or NE and 170 continent controls, the single most stressful life event associated with incontinence in children was separation and/or divorce of parents.[18] In addition, weighted life events were higher among children with incontinence.[18] In a study of 167 children, von Gontard and colleagues[19] found that normative (nontraumatic) life events such as entering school or the birth of a sibling increased the likelihood of incontinence.[19]

Stressful and normative and life events have also been associated with NE. In a population-based longitudinal study of 1265 children living in New Zealand, those exposed to 4 or more life events in a given year were 2.56 times more likely to develop secondary NE than were children not exposed to such life events ($P < .05$).[20] However, no link was found linking psychosocial factors, life events, and primary NE.[21]

In a Saudi Arabian cross-sectional population-based study of 640 children, adverse life events such as loss of loved ones ($P < .04$) and psychosocial problems in the family were more common in children with NE ($P < .001$).[22] In an Australian population-based study of 2020 children, DUI was significantly associated with emotional stressors, which were operationally defined as any frightening or emotionally stressful events that affected the child in the past 6 months.[23].Children experiencing such emotional stressors were 5.7 times more likely to experience DUI than were children without emotional stressors. We retrieved no studies that evaluated the immediate effects of daily stressors (in school and at home) on incontinence. However, training programs for children with treatment-resistant incontinence have successfully incorporated relaxation and stress-reduction techniques.[24]

While these studies suggest that certain traumatic and normative life events are associated with incontinence in children, further research is needed to determine the contributions of genetic/physiologic factors and stressful life events. Additional investigation is also needed to elucidate the extent to which stressful life events contribute toward new-onset incontinence, exacerbation of existing incontinence, or failure to acquire continence.

Research findings regarding the relationship between psychologically or emotionally traumatic events and development of incontinence are mixed. FI has been reported in several studies of children who experienced sexual and physical abuse.[25,26] On the other hand, a study of 1536 children found that the rate of FI in children who experienced sexual abuse (n = 466, 10.5%) was similar to a group of 429 children with behavioral disorders (n = 10.3%).[25] In contrast to these findings, the rate of FI in the normative control group (n = 641) was 2%.[25] Furthermore, among children who had been sexually abused, other behavioral symptoms were more common and more typical than FI.[25] Population-based studies have shown that disorders such as anxiety, depression, attention-deficit/hyperactivity disorder, or conduct disorders are more common in children with NE, DUI, or FI, but not posttraumatic stress disorder (PTSD).[27]

Punishment and physical abuse may be more common in incontinent children. A Turkish cross-sectional study of 889 mothers found that 42.1% of children with NE were spanked, and 12.8% beaten.[28] A single case study published in 2014 discussed a young boy who died after his father punished him for urinary incontinence.[29]

Considered collectively, findings from these studies indicate that although physical and sexual abuse seem to play a role in children with incontinence, the associations between trauma and incontinence are not well understood. Additional research is needed to better understand the relationship between these factors and urinary or fecal incontinence.

### Dysfunctional Familial Interactions

Parental intolerance was identified by Butler[30] in a study of 68 mothers as a probable risk factor for aggressive parent-child interaction, including child abuse. Intolerant parents often consider their child's NE to be a willful, voluntary act and the result of laziness, provocation, and failure to go to bed on time. Dysfunctional interaction is common in families of children with DUI, especially among children exhibiting with voiding postponement.[31]

Parents of children with NE have been characterized as more stressed than "average" families, but the precise nature of this emotional distress has not been clearly defined, nor has the relationship of NE and comorbid emotional disorders.[32] In a population-based study of 718 children, those with NE and/or DUI had higher rates of oppositional defiant disorder than continent controls (19.5% vs 5.2%; $P = .000$). These children

tended to exhibit provocative, defiant behavior patterns that adversely affect multiple family situations and interactions.[33]

A study of 28 mothers of children with NE found that they had have significantly lower health-related quality-of-life scores on the "Role Emotional" domain of the Short-Form 36 Health Questionnaire than a group of 38 control mothers ($P = .014$).[34] Similarly, 70 parents of children with NE, DUI, or FI had low scores on the "psychological" ($P = .003$) and "environment" ($P = .032$) subscales of the World Health Organization Quality of Life WHO-QOL-BREF instrument that did not improve with treatment of their children.[35] In contrast to this finding, maternal state anxiety improved significantly when NE was successfully treated in a group of 139 children ($P = .02$).[36]

The large, prospective population-based Avon Longitudinal Study of Parents and Children (Alspac) that enrolled 8334 children aged 4½ to 9 years found that maternal depression and anxiety frequently precedes later DUI and FI in their children.[37] This finding suggests that parental psychopathology can act as a long-term risk factor for incontinence.

### Toilet Training

Toilet training practices differ greatly from one culture to the next.[15] One clinical study of 1192 children found that the age at which toilet training was initiated ranged from 0.75 to 5.0 years, with a median range of 2.4 years.[38] The American Academy of Pediatrics and the Canadian Pediatric Society recommend starting toilet training at the age of 18 months but also note that training should occur when the child expresses interest in the process.[39]

Largo and colleagues[40] compared early to late toilet training in 2 longitudinal studies conducted in the 1950s (n = 320) and 1970s (n = 309).Toilet training was initiated in the 1950s at a median age of 7 months and in the 1970s at 19 months in girls and 21 months in boys. Early and active training had no influence on the achievement of daytime or nighttime urinary continence by the age of 5 years.

Bowel control was reached at an earlier age (4 years), but the age at which continence was established was not affected by toilet training practices.[40] In contrast, in the large Alspac study of 8334 children, late toilet training (after the age of 24 months) was associated with persistent DUI, delayed daytime bladder control and relapses, while early toilet training (15-24 months of age) led to more favorable outcomes.[41] A cross-sectional study of 318 healthy kindergarten children in Taiwan found that toilet training was started at a mean age of 24 months.[42] Early daytime toilet training (under 18 months) was associated with lower rates of DUI and NE ($P < .01$).[42] While the optimal age for initiation of toilet training remains unclear, current data suggest that poor toileting techniques (punishment, encouraging straining) might contribute to the development of LUTS.[15]

### Seasonal Factors, Home and School Environment

Research concerning seasonal effects on incontinence in children is particularly scarce. NE was shown to be significantly more prevalent in winter than in summer in a Turkish study of 75 children ($P < .0001$).[43] The reasons for this effect are not known and additional research is needed to determine the magnitude and mechanisms of seasonal effects on continence prevalence.

Crowded housing has been identified as a risk factor for multiple behavioral problems and disorders. Low socioeconomic status and poverty also appear to play a role in the development of incontinence. In a large population-based UK study (National Child Development Study, n = 16,000 children), NE was associated with lower social class and overcrowded homes.[44]

Restricted access and lack of available, adequate toilets in schools is postulated to exert a major influence on the development of LUTS in children.[15] Many children avoid school toilets and a lack of appropriate privacy and bullying in toilet facilities can lead to deferred micturition and withholding behaviors.[15] In a New Zealand study using both questionnaires and on-site visits of the availability of toilets in elementary schools, 16% of schools did not have enough toilets and only 16% had facilities for physically disabled children.[45] The median time provided for every child to use the toilet was 2 minutes during the first recess in the morning.[45] Vernon and colleagues[46] compared children's experience of school toilets in the UK (n = 394) and Sweden (n = 157); they reported that a majority of English (83%) and Swedish children (77%) found toilet facilities unpleasant, dirty, smelly, and frightening. As a consequence, 62% of boys and 35% of girls in the UK and 28% of children in Sweden avoided toilets for defecation. In a population-based Australian study of 2020 children, 15.7% of children were afraid to use school and 3.4% were fearful of home toilets.[23] The rate of overactive bladder (OAB) was significantly associated with poor toilet facilities in a large Korean sample of over 16,000 children.[47]

The availability of drinking water in schools influences fluid intake. Anecdotally, many clinicians report that children with incontinence frequently drink insufficient amounts of fluids. Children with intellectual and physical disabilities are at even greater risk for insufficient fluid intake.[48] The relationship between fluid intake and incontinence is not entirely understood, but some have advocated increasing fluid intake for reduction of incontinence. Many programs encourage increased fluid intake in the school environment, such as the "Increasing access to drinking water in schools campaign" by the National Center for Chronic Disease Prevention in the United States.[49] However, in one study of 242 school children, median drinking volumes/24 h did not differ in children with NE (1100 mL), DUI (1100 mL), or controls (1150 mL).[50] Further research is needed to clarify the relationship between fluid intake in school, urinary incontinence, and LUTS.

### Childhood Obesity

Obesity is an increasing health problem for many children worldwide. In the United States, 34% of children and adolescents (2-19 years of age) are overweight (>85th percentile body mass index [BMI]) and 15% are obese (>95th percentile BMI).[51] Studies in children and adolescents indicate a potential link between obesity and incontinence. For example, in one study, 12.5% of 40 12- to 17-year-old obese adolescent girls had DUI at least once a week–-and 5% had daily leakage (mean BMI 40).[52] None of the 20 controls was affected (mean BMI 22).[52] In another study of 43 incontinent children and 44 matched controls, overweight and obese individuals were significantly more likely to have incontinence ($P = .022$) and eating disorders such as fear of gaining weight ($P < .000$) and reluctance to try new foods ($P = .009$).[53]

## ENVIRONMENTAL AND FAMILIAL FACTORS IN ADULTS

Palmer and colleagues[15] reviewed the literature and identified a number of environmental factors that may affect voiding behaviors, including lack of access to safe and sanitary toilet facilities,

work rules, and customs limiting opportunities for micturition. Unsanitary toilets increase crouching over ("hovering") postures among women and the avoidance of public toilets. These environmental barriers may lead to premature voiding, fluid restriction, and suppression of the desire to void, infrequent voiding, and bladder distention accordingly.[15] In addition, inadequate public toilets may result in classical "conditioning" behaviors, where voiding is limited to safe and clean places.[15]

As noted in the Introduction section, urinary and fecal incontinence are multifactorial phenomena. In a study of 1764 twin pairs, concordance rates for stress incontinence were 79.5% for mono- and 78.5% for dizygotic twins suggesting a possible genetic component. Nevertheless, shared environmental factors contributed 77.6% of the variance related to stress incontinence, unique environmental factors contributed 20.9%, and genetic factors contributed only 1.5%. The authors conclude that "female stress incontinence is more a consequence of environmental risk factors than heredity."[13]

In contrast to the conclusion of Nguyen and associates,[13] familial disposition appears to play a major role in likelihood of developing incontinence. Evaluation of a group of 101 biological postmenopausal sister pairs where one sister was nulliparous and the other parous revealed comparable rates of urinary incontinence (47.6% vs 49.7%).[54] When evaluated by incontinence type, the researchers found similar rates of stress (18.4% vs 18.4%), urge (8.8% vs 8.1%), and mixed (17.7% vs 22.1%) urinary incontinence. The authors concluded that vaginal birth does not play a role in the development of incontinence, but that "an underlying familial predisposition towards the development of incontinence" was an important factor. A large population-based Finnish study of 3717 twin pairs found a 67% heritability for NE in males and 70% in females, while environmental factors accounted for 33% and 30% of the variance, respectively.[55]

## Work Conditions

Work conditions also may contribute to the development of incontinence. A survey of 445 Taiwanese elementary school teachers indicated 31.3% of the women drank less than 1500 mL of fluid per day, 45.6% described their toilet habits as poor, and 75.2% did not exercise regularly.[56] In addition, 36.8% of the teachers did not have adequate bathroom breaks, 72.7% had to stand for more than 3 hours per day, and 16.1% had to strain to lift at work. More than one quarter (26.7%) of these school teachers reported urinary incontinence, and 65.8% reported at least one bothersome LUTS. Based on these findings the authors suggested that environmental risk factors are modifiable, and that even simple interventions might improve lower urinary tract function.

Special working conditions like night work or shift work also may influence bladder function by altering the secretion of the hormone melatonin, which is produced in the pineal gland and regulates circadian rhythms.[57,58] The production of melatonin is inhibited by light and stimulated by darkness. Environmental or working conditions that inhibit the production of melatonin may lead to detrusor muscle dysfunction. Dumont and Paquet[59] conducted a study of simulated night work in 38 adults and found that melatonin production progressively decreased. Morrissette[60] reviewed the literature and suggested that shift workers often develop desynchronization of their molecular clock influencing smooth muscle function, mood, and alertness. Several animal studies have demonstrated an influence of melatonin on the urinary bladder,[61] results suggested that melatonin may alleviate impaired contractility of the detrusor muscle.[61,62] Additionally, melatonin may reverse bladder damage following ischemia/reperfusion, bladder outlet obstruction, and spinal cord injury in animal studies.[61,63-65] Matsuta and colleagues[66] showed a significant increase in bladder capacity and reduction in urine volume in rats by melatonin.

Findings from these studies show that environmental conditions like night shift work may impair the contractility of the detrusor muscle or accelerate the development of bladder disorders. Nevertheless, evidence for treatment effects on LUTS in adults is missing, and one clinical study in children with NE failed to show any benefits of melatonin administration.[67]

Melatonin production may also be affected by unnatural exposure to light, which may alter bladder function. As nights are often illuminated and daytime is mainly spent indoors, humans are exposed to much lower light intensities.[68] In addition, energy-efficient lighting and nocturnal blue light emitted by electronic devices may contribute to bladder disorders by suppressing melatonin secretion and disturbing the natural circadian rhythm.[68] Further studies are needed to elucidate the effects of shift work and unnatural exposure to light on melatonin secretion and bladder function.

## Obesity, Constipation, and Lifestyle Factors in Adults

A study of 445 elementary school teachers found a correlation between elevated BMI and incontinence, and between lack of regular exercise and a "weak urinary stream" and "incomplete emptying."[56] Obesity and constipation are risk factors for pelvic organ prolapse (in a population-based study) and urgency incontinence (in a twin study).[69,70] On the other hand, physically active women and female athletes, especially those involved in high-impact sports, have higher rates of incontinence.[71] Other potential contributors to incontinence are eating disorders, which may cause loss of muscle mass that weakens the pelvic floor.[71] These studies underline the complexity of lifestyle influences on incontinence, and the need for definitive studies.

## Psychological Disorders and Incontinence

In both humans and animal models, physical and emotional stress plays a role in visceral dysfunctions, such as OAB syndrome.[72] Adult survivors of child abuse are more likely to report stress and urgency incontinence.[73] The prevalence of LUTS was also found to be higher in war veterans (both male and female) with PTSD compared with controls.[74]

The association between depression, anxiety, and incontinence indicates that these conditions may share common neuropharmacological pathways. Specifically, depression is associated with reduced serotonin levels, which may predispose to stress and/or urgency incontinence due to reduced inhibition of bladder contractions.[75,76] In addition, duloxetine, a serotonin and norepinephrine reuptake inhibitor, is effective in the treatment of major depression, as well as stress and urgency incontinence.[76] Another hormone that may contribute to alterations in bladder function is corticotropin-releasing factor (CRF), which is linked to depression, anxiety, and stress.[77,78] Excess levels of CRF have been identified in the cerebrospinal fluid of patients with depression, anxiety disorders, and PTSD.[79] While limited evidence suggests that centrally released CRF might activate peripheral CRF receptors leading to LUTS and OAB, further research is needed to elucidate the relationships among CRF, LUTS, and detrusor function.

### Conditioned Behaviors and Continence

Urinary dysfunction may also be associated with normal environmental cues and processes. For instance, "latchkey urgency and incontinence" is commonly reported by persons with LUTS.[80] Based on classical conditioning, this problem is characterized by a sudden desire to void on approaching one's front door. An online questionnaire study of 306 adults with and without OAB suggests that this is a normal phenomenon unrelated to urinary pathology, as persons with OAB did not differ from controls.[80]

O'Connell and associates[80] evaluated 306 individuals and found that persons with OAB reported a variety of cues related to urgency and to leakage including environmental, cognitive, and mood cues.[81] Specifically, adults with OAB reported cues, such as being on the way to the bathroom, cold weather, and being in the bathroom for another reason besides voiding. Thus, persons with OAB appear to be more sensitive to a variety of environmental or behavioral cues, possibly because they void more frequently than others and have more occasions for pairing stimuli with micturition.[80,81]

## IMPLICATIONS FOR CLINICAL PRACTICE AND RESEARCH

Given current evidence, we believe that future studies should address environmental factors that may contribute to the development of incontinence in children and adults. The interaction between psychological and physical environmental factors should be studied in detailed models. To date, many studies have focused on identification of risk factors; future studies should include identification of protective factors, as well. Finally, studies should be designed to explore in detail the complex interactions between etiologic and mediating factors.

The effects of daily stressors should be differentiated from the effects of difficult life events and trauma. Management of daily stressors and coping with difficult life events can frequently be enhanced through counseling, while the effects of trauma such as PTSD may require treatment. Sedentary lifestyle, overweight, and obesity have detrimental effects on the health status of children in many countries, including incontinence. Correction of these risk factors should be a major priority worldwide. Barriers to healthy toileting and drinking habits need to be identified and addressed, especially in the school and work environments.

We also advocate for use of standardized instruments and adherence to international terminology such as that promulgated by the ICCS and ICS should be encouraged to permit comparison of study results.[1-3] While most studies are cross-sectional by design, we encourage longitudinal studies needed to describe the clinical trajectories from childhood to adulthood.

## CONCLUSIONS

Environmental factors at home, at school, or at work may influence the development of incontinence in children and adults. The identification of specific risk and protective factors is of great clinical importance to be able to reduce risks and to enhance protective behavioral strategies. While research to date has focused primarily on genetic and biological factors contributing to incontinence, significant research is needed focusing on the fundamental role of the environment in the genesis and treatment of incontinence.

### KEY POINTS

- Environmental factors play a major role in the development of incontinence in children and adults.
- Incontinence develops through the interaction between biological dispositions and environmental risks.
- Environmental factors should be identified and addressed in the assessment and treatment of incontinence.
- Barriers toward regular voiding and drinking should be reduced in school and work settings.

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