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Epidemiology of Stress Urinary Incontinence in Women

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Abstract Stress urinary incontinence is common and affects many women globally. About 50% of women with urinary incontinence report symptoms of stress incontinence, but estimates of the prevalence and incidence are limited by inconsistent methods of measurement between epidemiologic studies in different populations. Estimates also are affected by underlying differences in the age and ethnicity of study populations. Longitudinal studies assessing the incidence and natural history of stress incontinence estimate an annual incidence of 4% to 10%. While remission does occur, data on this remains sparse. Multiple risk factors have been associated with stress incontinence and may to contribute to the development of the condition. Recent epidemiologic studies have focused on defining additional lower urinary tract symptoms besides mixed or urge incontinence that may be associated with stress incontinence, but the significance of this is not yet known.

Keywords Female urology · Epidemiology · Population studies · Prevalence · Incidence · Incontinence · Stress urinary incontinence · Mixed urinary incontinence · Urge urinary incontinence · Risk factors · Pelvic prolapse · Cluster analysis · Voiding dysfunction

Introduction

Urinary incontinence (UI) is a common health condition that affects women of all ages and racial and ethnic groups. Stress urinary incontinence (SUI), the involuntary leakage of urine on effort or physical exertion or on sneezing or coughing, is the most common subtype of UI reported by women. While all subtypes of UI represent a significant burden to individuals and health care systems, SUI is the subtype that is most amenable to surgical correction. In the 1990s, 10% to 13% of female beneficiaries of Medicare in the United States underwent at least one surgical procedure to treat SUI [1], a rate similar to data from the U.S. National Hospital Discharge Summary for 2003, during which 12% of American women underwent SUI surgery [2]. With contemporary trends to increasingly perform SUI surgery at ambulatory and outpatient surgery centers, these numbers probably underestimate the total number of procedures. Recent estimates for the United States predict that the number of women with UI will nearly double, from 18 million in 2010 to 28.4 million in 2050 [3]. Epidemiologic studies describing SUI can help to quantify and understand the existing burden of disease as well as future trends.

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Epidemiologic Principles and Considerations

Epidemiology, the study of the occurrence and distribution of disease in populations, is concerned with 1) determining the frequency and extent of health-related conditions in certain populations; 2) documenting the natural history and clinical course of health conditions; and 3) identifying and understanding causes of disease in individuals and populations [4••]. The most common ways to quantify the epidemiologic descriptions of disease are by prevalence (the probability of experiencing a symptom or having a condition within a defined population at a defined time point) and incidence (the probability of developing the condition

during a defined time period, often reported as a rate of the number of new cases of disease within a given time interval).

In general, UI is characterized by the presence of specific symptoms or findings, type of UI, frequency of urine leakage, severity of leakage or symptoms, and degree of bother to the individual. Depending on what specific characterizations are used to define UI, estimates of prevalence and incidence can vary widely. Presently, there are no standardized or consistent epidemiologic definitions for UI or SUI.

As the result of practical necessities, most large population-based studies assess the presence of UI based on a participant's self-report or description of symptoms of UI on a questionnaire or survey instrument. A multitude of psychometrically validated questionnaires are available to assess and document urinary symptoms [5], but few have been designed specifically for epidemiologic studies in large populations. One such instrument is the Sandvik Severity Index for Urinary Incontinence, which has been widely used in several epidemiologic studies [6, 7]. Another emerging tool is the International Consultation on Incontinence Modular Questionnaire (ICIQ), which includes various patient-reported outcome and health-related quality of life measures and has undergone rigorous psychometric testing and validation in a wide variety of populations [8•].

Epidemiology of Stress Urinary Incontinence

Numerous studies have described the various elements of the epidemiology of UI. Several attempts have been made to summarize these data; one of the more exhaustive and thorough summaries has been performed as part of the International Consultation on Incontinence, currently in its fourth iteration [4••]. The authors of this review commented on the fact that due to wide variability and heterogeneity of definitions and survey methods and populations, it is difficult to accurately estimate epidemiologic statistics for UI and SUI.

Prevalence

Prevalence of SUI tends to vary with the prevalence of UI in the population. Prevalence is subject to variations in case definition, survey methods, and populations assessed. About 50% of women with UI report SUI as the primary or sole symptom of incontinence [4••]. Data from the U.S. National Health and Nutrition Examination Survey (NHANES) confirm these approximations, according to survey data from 2001 to 2004, 49.6% of women reported any UI, with 49.8% reporting pure SUI, 34.4% reporting mixed UI (MUI), and 15.9% reporting pure urge UI (UUI) [9]. In other recent population surveys, researchers from the Boston Area Community Health (BACH) study reported the prevalence of female SUI to be 26.4% [10], while those from the multinational Epidemiology of Lower Urinary Tract Symptoms Study (EpiLUTS) reported SUI in 44% of women studied, depending on the presence of associated symptoms [11•]. Specifically assessing women without an existing diagnosis of UI, Wallner et al. [12] surveyed female members from the Kaiser Permanente Northwest HMO (health-management organization) and determined the age-adjusted prevalence of undiagnosed SUI to be 18.7% [12].

While most population data has focused on European or Western countries, a few studies have examined SUI in Asia and non-Western countries. In a large survey of 20,000 Chinese women of all ages, 18.9% of women reported SUI [13], while in another survey, of women specifically from Beijing, the prevalence was 22.9% [14]. The prevalence of SUI in Japanese women was similar, reported to be 19.3% [15]. In Korea, SUI was estimated to be present in 48.8% of women with any UI, reported by 24.4% of the population assessed in a national interview survey [16]. In eastern Turkey, 46% of women surveyed reported SUI [17].

Data from less-industrialized regions has heretofore been rare; however, studies increasingly have examined this issue. Ojenbede et al. [18] reported data from a cross-sectional survey of community women in Nigeria and found the prevalence of SUI to be only 2.3%, although the cohort was young, with a mean age of 33 years. In Puerto Rico, 34.8% of 21-to 64-year-old women reported UI, with 46.8% reporting SUI-specific symptoms [19]. A recent review nicely summarizes the published data on pelvic floor disorders, including UI and SUI, in less-industrialized nations (defined as low-income or lower middle-income by World Bank standards), discussing not only prevalence but also risk factors and social and economic consequences of these disorders [20••]. The numbers of women with SUI are variable according to this summary, and prevalence ranges from 5% to 61%; nevertheless, SUI represents a significant health burden to these developing economies.

Effects of Age, Race, and Pregnancy on Prevalence

One aspect that makes estimating overall prevalence of SUI so difficult is that several factors are known to affect prevalence of SUI. In particular, differences in SUI prevalence have been repeatedly reported according to age and race/ethnicity. In addition, SUI often can occur during pregnancy and immediately after delivery (on a temporary or permanent basis) and this may be in addition to the risk of subsequently developing SUI in a woman's lifetime.

Several studies have supported the observation that the prevalence of SUI increases with age initially, peaks around the fourth or fifth decade, and then decreases with increasing age (see Fig. 1). This is in contrast to MUI

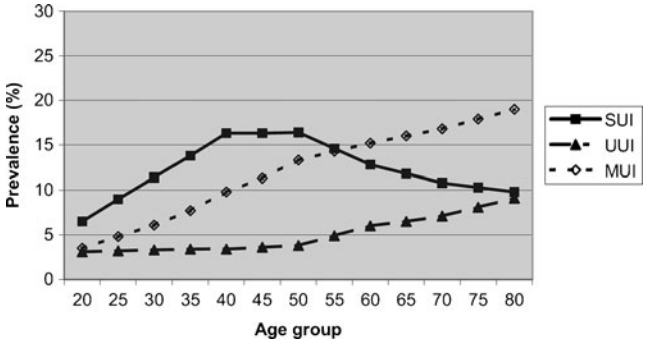

Fig. 1 Prevalence of SUI, UUI, and MUI by age group. Results of pooled estimates of population-based studies [21] *MUI* mixed urinary incontinence; *SUI* stress urinary incontinence; *UUI* urge urinary incontinence

and UUI, which generally increase with age [1, 21]. When stratified by decade of age, the peak prevalence of SUI (60%) occurred in 40-to 49-year-old women in the Norwegian EPINCONT (Epidemiology of Urinary Incontinence in Nord-Trøndelag) study, then decreased with age [22]. In women older than 54 years enrolled in the Nurses' Health Study (NHS), SUI decreased with age (RR: 0.63), while MUI and UUI increased over a 2-year observation period (2000–2002) [23]. Why this peak and subsequent decrease in SUI prevalence occurs as women age is unclear, but may be related to behavior changes (decreasing physical activity with age), natural history, evolution of SUI symptoms, or the rise in concurrent urinary symptoms, specifically UUI, which may overshadow SUI emphasis. In addition, most of these population-based surveys cannot account for treatment effects for women who have been successfully treated for SUI. While most women with SUI do not undergo treatment [1, 24], the peak rates for surgery for SUI were highest in age groups 40 to 59 years and 60 to 79 years (17 and 19 per 10,000 women, respectively) according to U.S. National Hospital Discharge Survey data from 2003 [2].

Differences in the prevalence of SUI between various racial and ethnic groups have been well-recognized [4••]. Non-Hispanic white women consistently report higher prevalence of SUI than non-Hispanic black women [1]. According to data from NHANES, 12.3% of black women report SUI as compared to 26.5% of white or 25.8% of Mexican–American women (OR for SUI in white vs black women: 2.79) [9]. Similar results recently have been reported for women in the BACH survey [10], in the NHS [25], within the U.S. military health system [26], and those living in the state of Michigan [27]. Physiologic differences to explain racial variation in prevalence have not been well studied [1, 4••].

SUI is common during pregnancy and in the postpartum period, and has been estimated to occur in 40% to 59% of pregnant women, with increasing prevalence and severity as pregnancy progresses from the first to the third trimester [4••]. In postpartum women, UI is almost always SUI and is reported by 15% to 30% of women during the postpartum year [4••]. Vaginal delivery appears to incur a greater risk of postpartum SUI than cesarean-section delivery (2.4-times greater risk in previously asymptomatic women) [28].

Thom et al. [29] recently reviewed the literature on postpartum UI and found that the mean prevalence of SUI within the first 3 months after delivery was 24.6%. Furthermore, when the number of women reporting SUI within the first 4 months was compared to those greater than 4 months postpartum, there were few differences in prevalence between the two time periods; 10 of 16 studies in their review reported differences in prevalence of 3% or less between the two time periods. Others have reported that postpartum SUI is increased in women with SUI during pregnancy, even up to 3 years after delivery [28].

Incidence and Remission

Incidence reflects the number of previously continent women who develop new-onset UI within a given time period. As such, determining incidence rates is dependent on the timeframe of study, including how frequently individuals are assessed and the natural history of the condition, because incontinence may remit as well as develop in any individual. Several longitudinal surveys and cohort studies have reported incidence rates for SUI of 4% to 11% per year [4••, 30]. Correspondingly, annual remission rates of SUI have been reported as 4% to 5% [4••].

Longitudinal studies also have provided data on the natural history of SUI. A cohort of 402 incontinent Australian women was followed for 2 years (2006–2008) without treatment of UI. Of those with SUI only at enrollment (n=61), 23% were reclassified as MUI at the study end because of the onset of UUI, while 59% remained SUI only [31]. The authors also reported a 2-year incidence of 6.1% and a remission rate of 18% for SUI in this cohort. Similar results were reported from the Hordaland Women's Cohort in Norway, which followed 41-to 45-year-old women for 10 years [32]. Women who were continence at enrollment (n=1274) and developed new-onset UI during the follow-up period (40.3%) were more than twice as likely to report SUI (49%) than UUI (18.3%) or MUI (20.3%). Furthermore, when followed over 4 years after onset of UI, the vast majority of women with SUI did not report a change in UI type; 83% remained stress incontinent, while 17% reported the development of MUI. Obviously, both of these studies were limited by relatively short follow-up.

Racial differences also appear to affect incidence of SUI across Asian, black, and white women in the United States. Townsend et al. [25] analyzed data from the NHS

(2000–2005) and determined that the incidences for SUI in white and Asian women were similar (0.8 and 1.0 per 100 person-years, respectively), while significantly less in black women (0.1 per 100 person-years). This finding was associated with a significant hazard ratio of 0.15 (95% CI, 0.06–0.35) for black women relative to white women.

Risk Factors for Stress Incontinence

Multiple risk factors have been proposed and studied for the development of SUI in women. Certainly, SUI is a multifactorial health condition with many contributing factors involved in the pathogenesis. Table 1 lists potential risk factors that have been more widely studied epidemiologically [4••]. Among those listed, only age, parity, vaginal delivery, obesity/body mass index (BMI), hormone replacement, diabetes, and family history have been reproducibly associated with increased risk of SUI across most studies.

An important consideration when identifying risk factors for disease is whether those risk factors are truly modifiable and, if modified, result in changes in the natural history of disease. An important illustration for this concerning SUI is seen with obesity. Multiple studies established that obesity, BMI, and weight gain all are associated with increased odds of SUI prevalence and incidence [33]. In addition, there now are several instances where interventions for weight loss have resulted in improvement or cure of SUI. Randomized clinical trials have demonstrated that weight loss through behavioral changes results in improved SUI [34••, 35] and that weight loss after bariatric surgery also dramatically decreases the number of women reporting SUI in follow-up (up to 49% of women after 2 years of follow-up in one series) [36, 37].

Genetic associations have been proposed as a potential nonmodifiable risk factor for SUI. While familial associations with SUI between first-degree relatives have been reproducible in epidemiologic studies [4••, 38], recent studies have reported mixed data on the role of genetic contributions to the prevalence of SUI. In two large studies analyzing information from twins identified in the Swedish twin registry, the authors estimated the contributions of genetic effects to be 34% and 41%, with the balances representing environmental (both shared and unshared) effects [39, 40]. However, a recent study of 882 female twins from the United States found genetic effects to explain only 1.49% of the prevalence of SUI in study members [41]. A study of Norwegian twins also failed to show a defined role for genetic effect on SUI [42]. Nevertheless, a substantial amount of molecular genetics research is ongoing to identify specific genetic factors involved in the development of SUI [38]. Several candidate genes that have effects on extracellular matrix proteins responsible for maintaining the connective tissue structure of the pelvic floor have been identified [43]. Not surprisingly, there is considerable overlap between proposed genetic factors for both SUI and pelvic organ prolapse (POP).

In a recent review of the epidemiology of pelvic floor disorders, Sung and Hampton [44] highlighted a conceptual model in which causative factors that may contribute to pelvic floor dysfunction in varying degrees and at different points in a woman's life are grouped into five categories: predisposing, inciting, promoting, decompensating, and intervening [44]. While this model is not specific for SUI, the condition shares many of these causative factors with other pelvic floor conditions. Coexistence of multiple pelvic floor disorders is common, and SUI often is present with other symptoms. Nygaard et al. [45] analyzed data from NHANES and reported that 23.7% of women had symptoms of more than one pelvic floor disorder, including UI, POP, and anal incontinence (AI) [45]. Similar results, where the prevalence of one or more pelvic floor disorders was 35.9%, were demonstrated in women enrolled in a managed health-care plan in the United States [46]. Furthermore, SUI and AI co-occurred in 58.4%, SUI and POP in 43.5%, and POP and AI in 49.8% of women surveyed in the study. Overall, 81% of women with symptoms of SUI had symptoms of an additional pelvic floor disorder. The specific association of SUI with POP is complex; SUI is more often reported with lesser degrees of POP and less SUI is reported as POP severity increases [21]. However, SUI can be demonstrated in 35% to 80% of continent women with severe POP after prolapse reduction, a finding known as occult incontinence [47].

Table 1 Potential risk factors associated with stress urinary incontinence

Age[a]
Parity[a]
Vaginal delivery[a]
Obesity/body mass index[a]
Diabetes[a]
Hormone replacement therapy[a]
Hysterectomy
Physical activity
Smoking
Diet
Other medical conditions
Family history[a]

[a] Factors consistently associated with increased risk

Emerging Epidemiologic Concepts

Changing perceptions of UI have recognized that SUI infrequently exists as an isolated entity, but is more

commonly associated with other urinary symptoms as well as other pelvic floor symptoms. Contemporary understanding of UI includes the notion that most women exhibit an overlap of SUI and UUI and that isolated SUI and isolated UUI exist only at the ends of a spectrum. Indeed, there are data suggesting that one subtype increases the risk of onset of the other subtype [21]. In addition, other lower urinary tract symptoms (LUTS) besides UUI may be associated with SUI (eg, voiding, storage, or post-micturition symptoms, including overactive bladder syndrome), but their role in the natural history of SUI is poorly understood. Until recently, epidemiologic studies of UI have not attempted to capture these associated symptoms and record their impact on SUI. However, several studies now have reported on the coexistence of multiple LUTS in female populations.

Cluster analysis involves sorting patients based on common specified variables into groups or clusters, such that the members of each cluster are as similar as possible to other members, but as different as possible to members of other clusters. Coyne et al. [48] performed cluster analysis on participants enrolled in the European Prospective Investigation into Cancer and Nutrition (EPIC) study and were able to group women into six clusters based on similar LUTS profiles. Clusters then were designated according to the predominant symptom reported by members of each cluster. In the EPIC population, 8.1% of women were clustered together with a dominant symptom of SUI, reported by 99.7% of cluster members. While most other LUTS assessed in the study were represented in less than 10% of the cluster, 15.9% reported frequency, 30.9% reported nocturia two or more times per night, 10.3% reported urgency, and 11.4% reported terminal dribble. Patients reporting UUI or MUI were categorized in a separate cluster, which was characterized by the presence of multiple LUTS. As the number of patients reporting LUTS increased in each cluster, the number of risk factors and comorbidities also increased.

Cluster analysis also was performed on women participating in the BACH study [49]. In this analysis, women with SUI were primarily grouped into clusters dominated by general UI (in which equal proportions of women reported SUI and UUI [62.4%]) and by multiple symptoms of high prevalence (in which 73.5% reported SUI and 78.5% reported UUI). Within the four clusters, there was none that aggregated patients with SUI-only symptoms; instead, most patients seemed to report significant mixed symptomatology. Similar to the previous study, as the proportion of women in each cluster reporting LUTS increased, the numbers of risk factors and comorbidities also increased for each cluster.

While the authors from the EpiLUTS study did not perform formal cluster analysis, they did analyze the degree of overlap of LUTS in the study participants [50]. Individuals with SUI were grouped with other women with storage symptoms (including frequency, urgency, nocturia, UUI, and SUI), which dilutes the interpretation specifically for women with only SUI. However, only 22.4% of the cohort reported storage-only symptoms; an additional 44.4% of women reported storage symptoms in conjunction with voiding (including slow/weak stream, intermittency, hesitancy, and straining) and/or postmicturition symptoms (including incomplete emptying and postvoid dribbling). While these findings suggest that consideration be given to these additional symptoms when planning SUI treatment, the full implications of these findings and the roles that additional LUTS play in the disease course of SUI remain to be determined.

Conclusions

Epidemiologic studies have contributed significantly to understanding the distribution and natural history of SUI in women. The evidence reflects that SUI is a common condition reported by a large number of women, a number that will increase substantially as the population ages. Recent studies analyzing clustering of symptoms suggest that SUI uncommonly exists in isolation, but is typically associated with other LUTS. How these additional symptoms, beyond just other forms of UI (ie, MUI and UUI), impact a woman's experience of SUI or affect surgical treatment outcomes has yet to be understood. Additional longitudinal studies will be needed to address these issues and to document the natural history of these more complex voiding patterns. Furthermore, standardization of assessment tools for SUI and other LUTS applicable to large, population-based studies is fundamental for future epidemiologic research. This will require collaboration between professional organizations and expert experience to develop and validate instruments that can be administered uniformly and consistently in large epidemiologic studies.

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