



Epidemiology of Lower Urinary Tract Symptoms: Emphasis on the Status in Korea

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A comprehensive and correct understanding of epidemiologic finding about lower urinary tract symptoms (LUTS) is important for several reasons. First, LUTS are highly prevalent in both genders all around the world and are expected to be a major concern to physicians in the near future because of the rapid rise in the elderly population. Second, it is crucial to observe trends in prevalence when national health care policy is established. By using a Medline search with various terms related to LUTS and prevalence, a review of epidemiologic studies was undertaken with an emphasis on the status in Korea. Despite the suggestions made by the International Continence Society, the lack of uniform definitions and the lack of a unified threshold of symptoms are the biggest obstacles in epidemiologic study with regard to LUTS. Most Korean epidemiologic studies on LUTS have been reported since 2000 and reveal that the prevalences of specific clinical conditions, such as LUTS, benign prostatic hyperplasia, overactive bladder, and detrusor underactivity, are in line with prevalences in Western countries. However, the prevalence of nocturia is somewhat different from that in Western countries. Many epidemiologic studies of LUTS have provided us with valuable information and a better understanding of the clinical conditions. Given that the impact of these clinical conditions on quality of life and health care cost will be emphasized more in the near future, more studies on optimal management approaches to LUTS are needed on the basis of this knowledge.

Keywords: *Epidemiology; Korea; Lower urinary tract symptoms; Urinary bladder*

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INTRODUCTION

The proportion of the elderly population has been estimated at about 10% and is expected to reach 20% by 2050 [1]. In Korea, a similar increase has also occurred in the proportion of the elderly population, rising from 3.8% in 1980 to 9.5% in 2006 [2]. Lower urinary tract symptoms (LUTS) are highly prevalent in both genders all around the world and are expected to be a major concern to physicians in the near future because it is clearly shown that the prevalence of LUTS increases with age [3]. A comprehensive and correct understanding of epidemiologic studies on LUTS is important for better insight into such conditions, improved clinical decision making, and a more reasonable distribution of limited health care resources. Therefore, it is

crucial to observe the trends in LUTS prevalence when national health care policy is established.

Several factors should be considered in developing a study design of epidemiology. To produce valuable results from epidemiologic studies, selection of the target population, sampling and survey methods, and standardized questionnaires should be appropriate to represent the general population. There are several study designs for clinical epidemiologic studies. For observational studies, a longitudinal design has more value than does a cross-sectional (CS) design. The longitudinal design makes it possible to evaluate potential etiologic factors influencing the clinical conditions and the natural history (progression) of disease as well as the incidence and prevalence of the disease. However, a study with a longitudinal design requires more

time and is more costly to perform. Therefore, most studies on the epidemiology of LUTS have been performed by use of a CS design.

There have been many large-scale epidemiologic studies of LUTS from western countries since the 1990s. Among the clinical conditions of LUTS, benign prostatic hyperplasia (BPH), overactive bladder (OAB), stress urinary incontinence (SUI), and nocturia are the main concerns of researchers. At present, detrusor underactivity (DU) is attracting the attention of many researchers. In Korea, the history of epidemiologic studies of LUTS is relatively short; large-scale studies have been conducted since the late 2000s.

In this review, we summarized the clinical findings from outstanding large-scale epidemiologic studies on BPH, OAB, nocturia, and DU in the aspect of survey methodology. The current review does not deal with the epidemiology of SUI. In addition, we aimed to investigate the current status of LUTS epidemiology in Korea by comparison with data from Western countries.

METHODOLOGY OF EPIDEMIOLOGIC SURVEY

Survey means a systematic method of collecting information from a sample population. There are several methods of survey, such as personal interview (PI), telephone interview (TI), postal survey (PS), and web survey (WS). Choice of survey method can be influenced by several factors, such as cost, effectiveness, population sample, and population coverage or response rate. Also, different survey techniques can bring various mode effects that can influence the answers of respondents [4].

Conventionally, most epidemiologic studies on LUTS are performed by use of PI or PS methods. The PS became widely used beginning in the 1960s. The lower cost, higher efficiency, and lower mode effects make the PS stronger than the PI. Moreover, the PS method is suitable for a large-scale survey. TI was first introduced in the 1930s in western countries, but there were severe problems in the aspect of population coverage owing to the low penetration rate of telephones at that time. However, the penetration rate continued to increase around the world, and in the 1980s, the penetration rate of telephones in United States households had increased to 93%. With the random digital dialing technique, the TI method can achieve almost complete population coverage and became an acceptable survey method. The TI method is less expensive, less time-consuming, and is less influenced from an interviewer effect than the PI [5]. However, the development of several technologies such as call block, caller identification, answering machines, and cellular phones has increased rates of non-response and reduced coverage of specific populations. Also, the TI method has a chance of a social desirability bias, which can occur for sensitive questions such as urological issues [6].

Nowadays, large-scale epidemiologic studies are performed by WS [7]. The WS can collect extensive information

from large populations quickly and at lower costs than other conventional methods. Multimedia contents such as movie clips or pictures can be easily utilized in the WS and social desirability bias may be lower than with other conventional methods. Participants can answer the questionnaire at any time and place of their choice, stop at any time, and continue the survey later. However, there still is a huge possibility of coverage error from individuals who do not have access to the Internet or compatible devices, and also it takes time and effort to construct a web design and complete the programming [8,9].

Because every survey method has its own strengths and weaknesses, researchers should select a survey method wisely with consideration of the various factors, although the most practical limitation in selecting a specific survey method is often the budget of the particular study. Researchers can obtain information about well-acknowledged criteria for the specific clinical conditions of LUTS from various epidemiologic studies.

EPIDEMIOLOGY OF LUTS

The term LUTS was first introduced as a replacement for the term prostatism in 1994 [10]. Prostatism had usually been used to refer to symptoms related to BPH in men. Therefore, the meaning of prostatism was confined to the syndrome from BPH in men only and did not represent the various other clinical symptoms. In 2002, The International Continence Society (ICS) classified LUTS into three categories: voiding symptoms, storage symptoms, and postmicturition symptoms [11]. Most researchers have used this terminology for the generic description of urinary symptoms in their scientific articles.

Many epidemiologic studies have been conducted on the prevalence of LUTS, but the definition of LUTS varied from study to study (Table 1). Several studies used the American Urological Association-symptom index (AUA-SI) questionnaire or the International Prostate Symptom Score (IPSS), which is an international version of the AUA-SI [12-17]. These studies reported a wide range of prevalences of LUTS from 15.8% to 46.2% and demonstrated the association of the prevalence of LUTS with age. The largest scale study among these was a study by Seim et al. [16] that reported the prevalence of LUTS as 15.8% in a CS study with 21,694 Norwegian men. In their study, LUTS was defined as IPSS \geq 8 and the PS method was used. In addition, the prevalence appeared to increase by age when the cohort was divided into 10-year age groups. Boyle et al. [14] also reported the prevalence of LUTS as 16.2% to 25.1% in men and 12.6% to 23.7% in women from their CS study that was performed in multiple countries including Korea with random sampling from the general population. The PS was used in the United Kingdom, France, and The Netherlands, whereas the PI was used in Korea. The AUA-SI and IPSS are the most common tools for the diagnosis of LUTS in the clinical setting, but as the name suggests, they were originally designed to evaluate the presence and severity

TABLE 1. Epidemiologic studies of the prevalence of lower urinary tract symptoms

Author	Year	Design	Method	No.	Sex	Age (y)	Nation	Prevalence (%)	Definition of LUTS
Girman et al. [12]	1994	CS	PI	2,115	Male	40-79	US	33	AUA-SI \geq 8
Temml et al. [13]	2003	LD	PI	456	Male	40-84	Austria	22.6→27.6 (after 5 y)	IPSS \geq 8
Boyle et al. [14]	2003	CS	Mixed	8,769	Both	40-79	UK, France, The Netherlands, Korea	Men, 16.2-25.1; women, 12.6-23.7	IPSS \geq 8
Sarma et al. [15]	2004	LD	PI	149	Male	40-79	US	38.9→37.6 (after 4 y)	AUA-SI \geq 8
Seim et al. [16]	2005	CS	PS	21,694	Male	\geq 20	Norway	15.8	IPSS \geq 8
Taylor et al. [17]	2006	CS	PI	5,284	Male	\geq 65	US	46.2	AUA-SI \geq 8
Irwin et al. [18]	2006	CS	TI	19,165	Both	\geq 18	Canada, Germany, Italy, Sweden, UK	64.3	2002 ICS definition
Coyne et al. [7]	2009	CS	WS	30,000	Both	\geq 40	US, UK, Sweden	Men, 72.3; women, 76.3	2002 ICS definition
Moreira Jr et al. [19]	2013	CS	PI	3,000	Both	\geq 30	Brazil	Men, 81.5; women, 84.1	2002 ICS definition
Lee et al. [20]	2011	CS	TI	2,000	Both	\geq 18	Korea	61.4	IPSS \geq 8
Lee et al. [21]	1998	CS	PI	514	Male	\geq 50	Korea	23.2	IPSS \geq 8
Cho et al. [22]	2001	CS	PI	1,356	Male	40-79	Korea	16	2002 ICS definition

LUTS, lower urinary tract symptoms; CS, cross-sectional; PI, personal interview; AUA-SI, American Urological Association-symptom index; LD, longitudinal design; IPSS, International Prostate Symptom Score; PS, postal survey; TI, telephone interview; WS, web survey; ICS, International Continence Society.

of LUTS in men with BPH and contain only three questions on storage symptoms among the seven questions. These questionnaires do not contain any questions about post-micturition symptoms. Also, because the AUA-SI and IPSS are presented by a summed score, it is not easy to distinguish the prevalence of the individual symptoms or the relationship between them.

Recent studies have defined LUTS according to the 2002 ICS definition [11] and utilized questionnaires that were extracted from this definition. These studies are becoming the foundation for a more specific understanding of LUTS [7,18-20]. Unlike the findings of the studies that used the definition of LUTS from the AUA-SI and IPSS, however, these studies reported a relatively higher prevalence of LUTS when using the ICS definition. Irwin et al. [18] performed a CS study with the ICS definition by TI in multiple countries. The overall prevalence of LUTS was 64.3% in 19,165 persons and was similar between both genders (62.5% in men, 66.6% in women). Coyne et al. [7] reported the prevalence of LUTS from a population-based, CS study with a WS that consisted of 30,000 persons from three nations. LUTS was defined by two response thresholds: "at least sometimes" and "at least often." By the first definition, the prevalence of LUTS was 71.0% in men and 74.7% in women; by the latter definition, it was 47.9% in men and 52.5% in women. Moreira et al. [19] conducted a CS, random-sampled, population-based study by PI in Brazil. They found the prevalence of LUTS to be 81.5% for men and 84.1% for women. The significant differences in the prevalence of LUTS between studies using the AUA-SI/IPSS definition and those using the ICS definition are probably related to the way in which a judgment is to be made from the questionnaire obtained. For example, by the ICS definition, nocturia is defined as any complaint with any nighttime voiding [11]. The number of episodes can have a significant effect on the prevalence of LUTS. From the study of Coyne et al. [7], the prevalence of nocturia was reported

as 69.4% for men and 75.8% for women when they defined nocturia as \geq 1 episode per night, but decreased to 28.5% for men and 33.7% for women when they defined nocturia as \geq 2 episodes per night. On the contrary, in the studies with the AUA-SI/IPSS definition, a summed score of each individual LUTS is more crucial to the judgment of the presence of LUTS.

To the best of our knowledge, the large-scale epidemiologic studies on LUTS in Korea are stretched thin. Lee et al. [21] performed a community-based, CS study and reported the overall prevalence of LUTS as 23.2% in 514 men with the definition of LUTS as IPSS \geq 8. Cho et al. [22] estimated the prevalence of LUTS as 16% from their community-based, CS study with 1,356 men. The first population-based, epidemiologic study of LUTS with the ICS definition in Korea was the study by Lee et al. [20]. This study conducted by the TI method reported the overall prevalence as 61.4% in 2,000 participants.

The prevalence of LUTS in Korea from these studies appears to be similar to that in Western countries when classified by the AUA-SI/IPSS or ICS definition. However, compared with western countries, epidemiologic studies of LUTS are still lacking in number, and most studies were limited to men in Korea. In addition, there are no surveys with a longitudinal design in Korea. Further studies with coverage of general population through a longitudinal design will be needed for a better understanding of LUTS in Korean people.

EPIDEMIOLOGY OF BPH

BPH is a pathologic or histological term that refers to hypertrophy of prostatic stroma or epithelial cells and that can be diagnosed by biopsy or autopsy. Berry et al. [23], who summarized five studies of autopsy data, addressed that the prevalence of pathologic BPH increases according to age. The prevalence of pathologic BPH is 40% in autopsies

TABLE 2. Epidemiologic studies of the prevalence of benign prostatic hyperplasia

Author	Year	Design	Method	No.	Age (y)	Nation	Prevalence (%)	Definition of BPH
Sagnier et al. [24]	1994	CS		2,011	50-80	Scotland	Moderate, 13 severe, 1.2	Moderate: AUA-SI, 8-19; severe: AUA-SI \geq 20
Lee et al. [25]	1997	CS	PI	514	\geq 50	France	23.2	IPSS \geq 8
Garraway et al. [27]	1991	CS	PI	705	40-79	The Netherlands	Overall, 25.3; 40-49 y, 13.8 60-69 y, 43.0	Urinary symptom \geq 11, PV $>$ 20 gm, Qmax $<$ 15 mL/s
Safarinejad [28]	2008	CS	PI	8,466	\geq 40	Iran	Overall, 23.8; 40-49 y, 1.2 $>$ 70 y, 36	IPSS $>$ 7, PV $>$ 30 gm, Qmax $<$ 15 mL/s
Chicharro-Molero et al. [29]	1998	CS	PI	1,106	\geq 40	Korea	11.8	IPSS $>$ 7, PV $>$ 30 gm, Qmax $<$ 15 mL/s
Blanker et al. [30]	2000	LD	PI	3,924	50-75	Spain	8	IPSS $>$ 7, PV $>$ 30 gm, Qmax $<$ 10 mL/s
Verhamme et al. [31]	2002	Retrograde	Database review	80,774	\geq 45	The Netherlands	Overall, 10.3; 15.5 cases/1,000 man-year	Diagnosis of BPH, BPH treatment or surgery, unexplained urinary symptoms
Rhew et al. [32]	2001	CS	PI	278	\geq 40	Korea	25.5	IPSS $>$ 7, Qmax $<$ 10 mL/s,
Park et al. [33]	2009	CS	PI	301	\geq 65	Korea	40	IPSS $>$ 7, PV $>$ 30 gm

BPH, benign prostatic hyperplasia; CS, cross-sectional; PI, personal interview; PV, prostate volume; Qmax, maximum flow rate; AUA-SI, American Urological Association-symptom index; IPSS, International Prostate Symptom Score; LD, longitudinal design.

of men in their 50s and reaches 70% in autopsies of men in their 60s. However, pathologic BPH is not clinically significant for most patients in real practice. In most patients, BPH is diagnosed by their symptoms, not by their pathologic status. Several epidemiologic studies of clinical BPH have been performed in western countries. However, the definition of clinical BPH varied from study to study (Table 2). The lack of a uniform definition of clinical BPH consequently influences the results and makes it difficult to interpret and compare results between studies. Until now, there has been no appropriate consensus for the definition of clinical BPH. Also, different characteristics of the target population and method of collecting information can influence the results of studies.

Some studies of the prevalence of clinical BPH were performed by using only validated symptom scores by which the authors presumed the prevalence indirectly [24,25]. Sagnier et al. [24] reported the prevalence of clinical BPH as 14.2% among 2,011 men in France. They defined clinical BPH on the basis of the AUA-SI questionnaire only.

From the concept of Hald about the relationship between prostatism, obstruction, and prostatic enlargement [26], several studies defined clinical BPH by combining three parameters: symptom score, prostate volume (PV), and maximal urinary flow rate (Qmax). Garraway et al. [27] reported the overall prevalence of clinical BPH as 25.3% from a CS study performed with 705 men in Scotland. They defined clinical BPH as PV $>$ 20 g, Qmax $<$ 15 mL/s, and symptom score $>$ 11. Safarinejad [28] defined clinical BPH as PV $>$ 30 g, Qmax $<$ 15 mL/s, and IPSS $>$ 7 in a CS study with 8,466 Iranian men. The relation between prevalence and age was also demonstrated from this study. Chicharro-Molero et al. [29] demonstrated that the prevalence of BPH

varied according to the different definitions. They defined clinical BPH by using four different definitions by combination of IPSS score, Qmax, and PV. Whereas the highest prevalence was 27.0% when BPH was defined as Qmax $<$ 15 mL/s and PV $>$ 30 g, the prevalence was only 11.8% when BPH was defined as Qmax $<$ 15 mL/s, PV $>$ 30 g, and IPSS $>$ 7. Blanker et al. [30] also reported that the prevalence of clinical BPH ranges from 8% to 25% according to the various definitions. They also confirmed the positive association between age and clinical BPH. Verhamme et al. [31] performed a database analysis of 80,774 men who visited a primary care unit in Netherlands. They reported the prevalence of BPH as 10.3% by the definition of previous surgery of BPH, diagnosis of BPH, or urinary symptoms that could not be explained by other comorbidities.

In Korea, Lee et al. [25] reported the first epidemiologic study of clinical BPH in 1997, although only the IPSS was used to assess the prevalence of BPH. In the community-based, CS study, they defined clinical BPH as IPSS \geq 8 and reported an overall prevalence of 23.2% in 514 Korean men. Another community-based study was performed by Rhew et al. [32] and Park et al. [33] in Busan city and Seongnam city. Whereas Rhew et al. [32] reported the prevalence of clinical BPH as 25.5% by using the definition of BPH with IPSS $>$ 7 and Qmax $<$ 10 mL/s, Park et al. [33] found a prevalence of 40% by using IPSS $>$ 7 and PV $>$ 30 g.

The prevalence of clinical BPH in Korea ranges from 23.2% to 40% from these studies, which is quite similar to the findings from western countries. However, few studies utilized the combination of all of three parameters (symptom score, PV, Qmax) when defining clinical BPH in the survey.

TABLE 3. Epidemiologic studies of the prevalence of overactive bladder

Author	Year	Design	Method	No.	Sex	Age (y)	Nation	Prevalence (%)	Definition of OAB
Lee et al. [20]	2011	CS	TI	2,000	Both	≥ 18	Korea	12.2	2002 ICS definition
Milsom et al. [34]	2001	CS	TI/PI	16,776	Both	≥ 40	France, Germany, Italy, Spain, UK, Sweden	16.6	Frequency > 8/d, urgency, UUI, alone or in any combination
Homma et al. [35]	2005	CS	PS	4,570	Both	≥ 40	Japan	12.4	Frequency ≥ 8/d and urgency ≥ 1/wk
Stewart et al. [36]	2003	CS	TI	5,204	Both	≥ 18	US	Male, 16.0; female, 16.9	Urgency > 4/wk with frequency > 8/d or coping behaviors
Temml et al. [37]	2006	CS	PI	2,418	Both	20–91	Austria	OAB dry, 13.5; OAB wet, 4.1	OAB dry: urgency with frequency or nocturia; OAB wet: UUI with OAB dry
Moorthy et al. [38]	2003	CS	PI	2,369	Male	≥ 18	11 Asian countries	29.9	2002 ICS definition
Wang et al. [39]	2011	CS	PI	14,844	Both	≥ 18	China	6.0	2002 ICS definition
Chen et al. [40]	2012	CS	PI	1,247	Female	≥ 20	Taiwan	20.9	2002 ICS definition
Choo et al. [41]	2007	CS	TI	2,005	Both	≥ 40	Korea	OAB dry: male/female, 13.3/16.3; OAB wet: male/female, 7.5/15.	Urgency and frequency/nocturia±UUI

OAB, overactive bladder; CS, cross-sectional; TI, telephone interview; PI, personal interview; UUI, urgency urinary incontinence; ICS, International Continence Society.

EPIDEMIOLOGY OF OAB

OAB is a very common condition among populations and its deleterious effects on affected individuals and social and economic cost are profound. However, epidemiologic data on the prevalence of OAB are not abundant compared with other LUTS (Table 3). Among the studies, Milsom et al. [34] reported the largest population-based, CS study, which was undertaken in 6 European nations by the TI or PI method. In that study, frequency > 8/d, urgency, and urgency urinary incontinence (UUI), alone or in any combination, were considered as symptoms suggestive of an OAB. The study consisted of a total of 16,776 respondents, and overall prevalence was reported as 16.6%. Another study by Homma et al. [35] showed the prevalence as 12.4% in 4,570 Japanese persons by use of a definition of frequency ≥ 8/d and urgency ≥ 1/wk.

After the ICS provided the definition of OAB as “urgency with or without urge incontinence, usually with frequency and nocturia without proven infection or other obvious pathology” in 2002 [11], recent studies have tried to assess the prevalence of OAB by using this definition. Stewart et al. [36] performed a CS, population-based, random-sampled study. They collected data from 5,204 Americans by use of a computer-assisted TI method, and reported that the prevalence of OAB was slightly higher in women (16.0% in men, 16.9% in women). Temml et al. [37] analyzed a health screening project of Vienna that consisted of 2,418 persons and reported the prevalence of OAB without UUI as 13.5% and that of OAB with UUI as 4.1%. Moorthy et al. [38] also applied the ICS definition for OAB and reported the overall prevalence as 29.9% from the study performed in 11 Asian countries with 2,369 men. In China, however,

even though Wang et al. [39] adopted the ICS definition in a CS study with 14,844 persons, the overall prevalence of OAB was relatively lower (6.0%) than in other countries and nocturia was the most prevalent symptom besides urgency. Chen et al. [40] reanalyzed the data from their previous CS study with 1,247 Taiwanese women in 2012 by using the ICS definition. After excluding individuals who had a single symptom such as nocturia or frequency only, the prevalence of OAB decreased from 34.8% to 20.9%.

The reported prevalence of OAB varies, ranging from 6.0% to 29.9% between different studies. This may be due to the lack of a uniform threshold for the definition of OAB and a unified questionnaire, differences between target populations, or social desirability bias.

In Korea, Choo et al. [41] first conducted an epidemiologic study of OAB by use of the TI method in 2000. The prevalence was 13.3% and 16.3% for OAB dry and 7.5% and 15.0% for OAB wet in men and women, respectively. In addition, they found that the prevalence of most OAB symptoms increased with age, but in women, the prevalence of frequency did not. Also, Lee et al. [20] performed a population-based survey to estimate the prevalence of OAB in Korea by using the ICS definition. The study found that 12.2% had OAB with a similar rate in men and women among 2,000 persons aged ≥ 18 years. Although these studies are limited due to low response rate and CS design as with all other surveys, the results show that there is a similar pattern in the prevalence of OAB in Korean men and women compared with Western countries and that the prevalence increases with age.

TABLE 4. Epidemiologic studies of the prevalence of nocturia

Author	Year	Design	Method	No.	Sex	Age (y)	Nation	Prevalence (%)	Definition of nocturia
Lee et al. [20]	2011	CS	TI	2,000	Both	≥18	Korea	Male, 36.6; female, 48.2	≥1/night
Swithinbank and Abrams [42]	2000	CS	PS	2,614	Female	>18	UK	Male, 10.3; female, 14.0	≥2/night
Perry et al. [43]	1999	CS	PS	10,116	Both	≥40	UK	20.5	≥2/night
Kang et al. [44]	2004	CS	PI	34,694	Male	≥55	US	31	≥2/night
Kupelian et al. [45]	2011	LD	PI	15,988	Both	>20	US	Male, 15.5; female, 20.9	≥2/night
van Dijk et al. [46]	2002	CS	TI	2,506	Both	>18	The Netherlands	13	≥2/night
Schatzl et al. [47]	2000	CS	PI	2,368	Both	20-91	Austria	Male, 10.8; female, 11.0	≥2/night
Muscatello et al. [48]	1999	CS	TI	494	Both	≥41	Australia	Male, 25; female, 21	≥2/night
Tikkinen et al. [49]	2006	CS	PS	3,744	Both	18-79	Finland	33.4	≥1/night
Kageyama et al. [50]	2000	CS	Not specified	3,896	Both	≥20	Japan	Male, 28.1; female, 27.1	≥3/night
Choo et al. [51]	2008	CS	TI	2,005	Both	40-89	Korea	72.7/48.2	≥1/night/≥2/night
Lee et al. [52]	2012	CS	PI	439	Male	≥65	Korea	56.0	≥2/night

CS, cross-sectional; PS, postal survey; TI, telephone interview; PI, personal interview; LD, longitudinal design.

EPIDEMIOLOGY OF NOCTURIA

Nocturia is the leading symptom of discomfort among the various elements of LUTS. Nocturia is defined as the “complaint that the individual has to wake at night one or more times to void” according to the ICS [11]. However, most of the epidemiologic studies defined nocturia as ≥2 times/night [42-48] (Table 4). Although there is still some debate about whether a single episode of nocturia per night is really clinically significant, most of the urologists considered a single episode of nocturia per night to be clinically acceptable. Swithinbank and Abrams [42] and Perry et al. [43] reported the prevalence of nocturia as around 20% from their CS PS studies in England. Also, nocturia had a tendency to increase with age [43]. From the Prostate, Lung, Colorectal, and Ovarian Cancer Screening Trial, Kang et al. [44] analyzed data of 34,694 participants and reported the overall prevalence of nocturia to be 31%.

Several studies defined nocturia as ≥1 episode per night and some studies used multiple definitions of nocturia for the analysis [22,49-51]. The EpiLUTS study [7] was a recent large survey that had a target population of 30,000; the prevalence of nocturia was 69.4% for men and 75.8% for women when nocturia was defined as ≥1 episode per night. The prevalence, however, decreased to 28.5% and 33.7% for men and women when the definition of ≥2 episodes per night was applied. Tikkinen et al. [49] also reported the prevalence of nocturia as 33.4% with the definition of any nighttime voiding in a population of 3,744.

Using data from the third National Health and Nutrition Examination Survey between 1988 and 1994, Kupelian et al. [45] investigated the association of nocturia with subsequent mortality risk. Nocturia (≥2/night) was a common urinary symptom in the general population, but was more prevalent in women than in men (20.9% in women, 15.5% in men). By linkage of the third National Health and Nutrition Examination Survey to the National Death

Index, the authors showed a statistically significant trend of increased mortality risk with increased episodes of nocturia. The authors suggested that nocturia may be a clinically useful marker of overall health and mortality risk in younger and older adults.

There are a few epidemiologic studies on nocturia in Korea. Lee et al. [52] reported the prevalence of nocturia (≥2/night) as 56.0% in a community-based study with 439 elderly men in a single city. The prevalence was relatively higher than in previous studies that used the same definition (≥2/night), probably because of the older age of the target population (mean, 71.2 years) or the too small number of participants. Choo et al. [51] conducted a population-based, CS TI survey with 2,005 participants. That study demonstrated the overall prevalence of nocturia as 48.2% for at least two times per night and 72.7% for any nighttime voiding. The prevalence of nocturia in Korean populations appears to be relatively higher than in Western studies, even with allowance for the older age of the target population. For a better understanding of the epidemiology of nocturia in Korea, it may be worth evaluating whether the cultural background of the different countries might have a significant effect on the psychometric perception of nocturia.

EPIDEMIOLOGY OF DU

DU is defined as a contraction of reduced strength or duration, resulting in prolonged bladder emptying or a failure to achieve complete bladder emptying within a normal time span [11]. Various kinds of age-related changes in the lower urinary tract are recognized in the elderly. DU may be one such age-related change in the urinary bladder. Several research groups have reported that detrusor function decreases with age [53-55]. Despite the fact that DU may be related to several LUTS (slow stream, frequency, incomplete emptying sensation, etc.) and acute to chronic

TABLE 5. Prevalence of detrusor underactivity in a series of patients who suffered from lower urinary tract symptoms and who underwent urodynamic studies

Author	Year	Design	Method	No.	Sex	Mean age (y)	Nation	Prevalence (%)	Definition of DU
Abarbanel and Marcus [59] ^a	2007	Retrospective	Urodynamics	Male, 82; female, 99	Both	Male, 76.4; female, 75.1	Israel	Male, 48; female, 12	Q _{max} <10 mL/s and P _{det} Q _{max} <30 cm H ₂ O
Lee et al. [60]	1999	Retrospective	Urodynamics	96	Male	69.6	Korea	37	Q _{max} ≤10 mL/s and P _{det} max ≤30 cm H ₂ O or according to the Schafer nomogram
Jeong et al. [61]	2012	Retrospective	Urodynamics	Male, 632; female, 547	Both	Male, 72.3; female, 72.0	Korea	Male, 40.2; female, 13.3	BCI<100 (male), Q _{max} ≤12 mL/s and P _{det} Q _{max} ≤10 cm H ₂ O (female)
Valentini et al. [62] ^a	2010	Retrospective	Urodynamics	100	Female	83.2	France	15	Absence of detrusor contraction during voiding and large PVR
Groutz et al. [63]	1999	Retrospective	Urodynamics	206	Female	58.2	Israel	18.9	Q _{max} <12 mL/s or PVR>150 mL
Ameda et al. [64]	1999	Retrospective	Urodynamics	193	Male	69.6	US	41.9	P _{det} max, iso <60 cm H ₂ O or unstained isometric contraction

DU, detrusor underactivity; PVR, postvoid residual; Q_{max}, maximum flow rate; P_{det}Q_{max}, detrusor pressure at maximum flow rate; P_{det} max, maximum detrusor pressure; P_{det} max, iso, maximum isometric detrusor pressure; BCI, bladder contractility index.

^a:Patients with neurogenic bladder were included with ranged 10.1%–25.6%.

urinary retention and that DU may negatively influence the outcomes of surgery such as prostatic surgery for BPH [56] and midurethral sling surgery for SUI [57], very little attention has been paid to DU until now. In addition, because no standard measurement techniques or quantitative diagnostic criteria have been developed, the prevalence of DU in the community remains largely unknown. Subsequently, proper diagnosis and management of this condition is challenging. The prevalence of DU with and without detrusor overactivity is high among the institutionalized elderly, especially in incontinent nursing-home residents. DU is urodynamically present in up to 80% of female nursing-home residents [58].

To date, a population-based study of the epidemiology of DU has not been reported. Several studies have just reported the prevalence of DU among the community-dwelling population suffering from LUTS by using arbitrary urodynamic criteria for DU (Table 5) [59-64]. Abarbanel and Marcus [59] retrospectively analyzed the urodynamic findings of 181 elderly with LUTS. With the urodynamic definition of DU as Q_{max}<10 mL/s and maximum detrusor pressure at Q_{max} (P_{det}Q_{max})<30 cm H₂O, 48% and 12% of elderly men and women had DU. Other retrospective studies of patients with LUTS referred for urodynamic study also indicated that the prevalence of DU ranges from 37% to 48% and from 12% to 18.9% in elderly men and women, respectively (Table 5). However, these retrospective series with a urodynamic definition of DU obviously have innate limitations for extrapolation to the general population.

In Korea, Lee et al. [60] analyzed the data of 96 men with LUTS and demonstrated that DU was present in 37% of pa-

tients when DU was defined as Q_{max}≤10 mL/s and P_{det}Q_{max}≤30 cm H₂O or according to the Schafer nomogram. Recently, Jeong et al. [61] reviewed urodynamic studies of 1,179 patients with LUTS by use of a specific definition of DU for both sexes. DU was defined as a bladder contractility index under 100 in men and Q_{max}≤12 mL/s and P_{det}Q_{max}≤10 cm H₂O in women. The prevalence of DU was 40.2% for men and 13.3% for women, and almost half of men and three quarters of women with DU also had combined other abnormalities such as detrusor overactivity, bladder outlet obstruction, or urodynamic SUI. Despite the limited data among individuals with LUTS in Korea, the prevalence of urodynamic DU appears to be similar to the prevalences reported in western studies.

The fact that the diagnosis of DU is mainly dependent on urodynamic findings makes it difficult to perform an epidemiologic study for a general population or to extrapolate results to the general population. DU is impossible to differentiate from bladder outlet obstruction on the basis of symptoms, Q_{max}, or raised postvoid residual, making large studies of epidemiology and natural history difficult. Accurate noninvasive methods of estimating bladder contraction that would allow the acquisition of larger data sets are needed [65]. In addition, most of the studies of DU are limited to patients who visited the hospital for urologic symptoms or institutionalized populations in health care units. However, current findings imply that DU is indeed common among patients with LUTS undergoing urodynamic studies. Therefore, further research is warranted to develop a consensus on the definition of clinical DU or “underactive bladder” syndrome like OAB.

CONCLUSIONS

Until now, many epidemiologic studies on individual symptoms of LUTS have provided us with valuable information and a better understanding of these clinical conditions. Given that the impact of such clinical conditions on quality of life and health care cost will be emphasized more in the near future, more studies on the optimal management approaches to LUTS are needed on the basis of this knowledge. In Korea, many more attempts should be made to explore the community-based prevalence of individual symptoms of LUTS with greater population coverage, including both genders and broad ranges of age.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

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