

Correlation between the Severity of Female Urinary Incontinence and Concomitant Morbidities: A Multi-Center Cross-Sectional Clinical Study

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Purpose: The aim of this study was to identify the relationship between urinary incontinence (UI) and low back pain (LBP) discomfort and disability, static balance, and demographic factors.

Methods: A total of 348 women aged 20-80 years were included in this cross-sectional study. The general characteristics of the subjects and the main outcome (UI condition, LBP discomfort, LBP disability, and static balance ability) were assessed by using clinical questionnaires and assessment tools.

Results: Of all the subjects, 22.8% had experienced UI. Women with UI showed a significantly higher relationship of LBP and disability, and static balance ability ($P < 0.01$). We found a significant correlation between UI, age, LBP and disability, and static balance ability ($P < 0.01$).

Conclusions: These findings suggest that UI correlates negatively with LBP discomfort, LBP disability, and static balance ability. Further studies should focus on the identification of the precise mechanisms underlying UI and its related physical symptoms and on the development of therapeutic strategies to manage this condition.

Keywords: Urinary incontinence; Women; Low back pain

INTRODUCTION

Urinary incontinence (UI) is a common condition among women [1,2]. Abrams et al. [3] defined UI as “the complaint of any involuntary leakage of urine.” The prevalence of UI is 21.0% in women aged 20 to 50 years [4] and 45.5% in women aged 63 to 90 years [5] in Korea. In women, UI frequently occurs during stress situations, and it is associated with involuntary urinary leakage on sudden physical exertion such as sneezing or coughing. Urgent UI - more common in elderly women - is defined as the complaint of involuntary leakage immediately preceded by urgency [3].

Risk factors for UI include age, childbirth, pelvic surgery, and infection of the lower urinary tract. In addition, specific factors

such as overweight, physical effort, and straining during passage of stool, which increase intra-abdominal pressure, may contribute - alone or in combination - to increase the prevalence of UI [1]. Many clinicians have recognized the clinical relevance of UI with respect to deficits in the active and passive structures within the pelvic cavity, which may be related to pelvic floor trauma from vaginal deliveries and recurrent urinary infections [6].

Current evidence has suggested that women with UI have increased activity of the trunk and pelvic floor muscles (PFMs) in response to challenges in postural control in the lumbopelvic region [7,8]. PFMs are known to assist in the control of continence through stabilization of the bladder neck and increase of the intra-urethral pressure [9-11]. Consequently, bladder fullness has been related to increased activity of the PFMs. An ad-

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ditional postural challenge during daily routine activities contributes to increasing PFM demand. However, when the activity of these muscles does not adjust to meet the increased demand, continence or postural control may be impaired. In addition, it is possible that altered control of these muscles may challenge other aspects of body function such as ambulation and balance, and contribute to physical discomforts such as low back pain (LBP) and disability [7,8,12,13]. Balance may be further challenged by the level of bladder fullness, which influences trunk muscle activity [14]. Thus, muscular efforts that compromise the quality of postural adjustments may cause an additional impairment of balance.

Although LBP has been associated with limited control of trunk stability [15,16], the mechanisms involved in LBP and balance impairment are still unknown. Similarly, little is known about the relationship between UI and LBP. The relationship between UI and demographic factors such as age, weight, and height is still controversial [17-19]. To our knowledge, little attention has been given to UI-related factors including LBP, static balance, and demographic factors. Previous studies on LBP and UI have mostly focused on the relationship between physical and psychological health [17-19]. In this context, this study was designed to identify correlations between UI severity condition, LBP and disability, and static balance ability. We hypothesized that a more severe UI condition results in more intense LBP and functional disability, and in lower static balance ability.

MATERIALS AND METHODS

Subjects

A total of 348 women aged 20 to 80 years were enrolled in this study. Data were collected during December 2009 to January 2010 in a total of 14 institutions, including general hospitals, public health centers, and welfare centers located in Daejeon. Inclusion criteria for the subjects were as follows: 1) no pregnancy, 2) no orthopedic or neurological diseases that may affect the result of the study, and 3) no psychological or emotional problems. Further, subjects with internal organ problems were excluded from the data analysis. The data of 23 (6.6%) of the 348 women that initially participated in the survey were excluded because of insufficient responses and failure to assess static balance. Consequently, the data of 325 women (93.4%) were used for the analysis. The subjects were given a detailed description about the study's purpose and procedure prior to the study. Written informed consent was obtained from all the subjects at the time

of data collection.

Outcome Measures

This study was a cross-sectional study of women with or without UI based on questionnaires completed by them. The questionnaire given to the subjects included the items concerning the general characteristics of the subjects and the assessment tools for UI, LBP, functional disability, and static balance. All subjects responded to the questionnaire through individual interview, and were given a detailed description of the aim and procedure of the study.

Urinary incontinence

The severity of the UI was assessed by using a self-reported questionnaire developed by Hendrickson [20] and then modified by Lee [21]. The questionnaire assessed the frequency and severity of the UI, in a total of 18 items. Each item was attributed a score between 0 and 4, and the range of the total score was between 0 and 72. The total score was categorized as mild (0 to 24 points), moderate (25 to 48 points), and severe (49 to 72 points). The reliability coefficient of an original version of this assessment tool was 0.71; the reliability coefficient after adjustment by the Spearman-Brown formula was 0.83 [22].

Low Back Pain

A 100-mm visual analog scale (VAS) was used to identify the perceived level of LBP. The VAS score was determined on the basis of the 100-mm line, with the left end of the line (0) indicating no pain and the right end of the line (100) indicating the worst pain imaginable [23]. The subjects marked their own degree of LBP or discomfort on the line, and the length (mm) between the left end and the mark was calculated and defined as the perceived level of LBP. The test-retest reliability ($r=0.99$) and inter-rater reliability ($r=1.00$) of the VAS was sufficiently high [24].

Functional Disability Related to LBP

Functional disability on daily life was assessed by using the Korean versions of the Oswestry Disability Index (KODI), which were kindly provided by Kim et al. [25]. The KODI consisted of the assessment of pain level, personal hygiene, object lifting, walking, sitting, standing, sleeping, social activities, and traveling and moving (a total of 9 items), each on a 6-point scale. The score of the KODI ranged from 0 to 45, and the assessed score was expressed as the percentage of the total score (45 points).

Higher KODI score indicates increased functional disability [26]. The test-retest reliability of the KODI was sufficiently high ($r=0.92$).

Static Balance

Static balance was assessed according to the Frailty and Injuries: Cooperative Studies of Intervention Techniques (FICSIT-4), which comprised 4 scales related to static balance: parallel, semi-tandem, tandem, and 1-legged stances. The assessment was performed after detailed description of the procedure and safety of the measurements. The FICSIT-4 consists of a total of 7 tests, including parallel, semi-tandem, tandem with eyes open or closed, and 1-legged stance with eyes open. All tests were sequentially performed to determine the balance ability. If a subject failed to perform any of the tests properly during sequential testing, this subject was not allowed to progress to the next test. Scores were added up for successful testing only. Each test was scored on a scale of 0 to 4; the total test score was 28 points. A higher score meant better balance ability. The test-retest reliability of the FICSIT-4 has been reported to be $r=0.66$ [27].

Testing was independently performed by the subjects without any help or support. The parallel stance test was performed in the standing position with feet parallel and eyes open and then in the same position with eyes closed. Semi-tandem stance was tested in a position in which 1 heel was placed immediately next to the big toe of the other foot and the toes were directed to the front. The test for this stance was conducted both with the eyes open and closed. Then, the subjects performed tandem stance, a position in which 1 heel is placed immediately in front of the other foot and the toes are directed to the front. This test was also

conducted both with the eyes open and closed. The final stance was lifting 1 leg with the eyes open.

Data Analysis

The collected data were statistically processed by using the SPSS ver. 12.0 (SPSS Inc., Chicago, IL, USA). The general characteristics of the subjects and the experience of UI were identified by using one-way ANOVA or crosstab analysis. The comparisons of VAS, KODI, and FICSIT-4 scores between 2 UI severity conditions were analyzed by one-way ANOVA. The severity score of UI, VAS, KODI, and FICSIT-4 per age and BMI group were also analyzed by the one-way ANOVA. When $P < 0.05$, post-hoc pairwise comparisons with Bonferroni adjustments were used to identify specific differences. Correlations among age, VAS, KODI, FICSIT-4, and UI severity score were determined by Pearson correlation analysis. The level of significance for all analyses was set at $P < 0.05$.

RESULTS

General Characteristics of Subjects

Table 1 summarizes the general characteristics of the subjects. Women who experiencing UI comprised 22.8% of all subjects. The mean age and BMI value were 50.6 ± 14.0 years and 22.9 ± 3.0 , respectively. Statistically significant differences in age and BMI were found between 3 UI conditions as categorized by the UI severity scored by the subjects themselves ($P < 0.01$). However, there were no significant differences in the number of deliveries or labor method ($P > 0.05$).

Table 1. Characteristics of the subjects

Variables	Urinary incontinence score ^{a)}				F/ χ^2
	None (n = 250)	Mild (n = 63)	Moderate (n = 11)	Total (n = 324)	
Age (yr)	9.55 ± 14.03	52.83 ± 13.15	62.18 ± 10.45	50.61 ± 13.96	5.445 ^{b)}
Body mass index	22.58 ± 2.87	23.65 ± 3.19	25.23 ± 3.16	22.88 ± 3.00	6.980 ^{b)}
No. of childbirth	2.40 ± 1.38	2.60 ± 1.23	2.00 ± 1.83	2.45 ± 1.39	1.316
Labor method					
Only vaginal birth	186 (74.40)	52 (86.67)	8 (78.57)	249 (76.85)	10.546
Only caesarean section	48 (19.20)	5 (8.33)	1 (7.14)	54 (16.67)	
Vaginal and caesarean	7 (2.80)	2 (3.33)	0 (0.00)	9 (2.78)	
No birth	9 (3.60)	1 (1.67)	2 (14.29)	12 (3.70)	

Values are presented as mean ± SD or number (%).

^{a)} UI score (mild: 0-24, moderate: 25-48). ^{b)} $P < 0.01$.

Comparison of LBP, Functional Disability, and Static Balance According to the UI Severity Conditions

Table 2 provides the values of LBP (VAS) and disability (KODI), and static balance of women with UI according to the UI severity conditions. There were significant differences in VAS, KODI, and FICSIT-4 between 3 UI conditions ($P < 0.01$). After post-hoc testing, significant differences in VAS were found between absence of UI and mild UI, and between absence of UI and moderate UI. On the other hand, significant differences in KODI and FICSIT-4 were found between absence of UI and mild UI, between absence of UI and moderate UI, and between mild and moderate UI.

Comparison of UI Severity Condition, LBP, Functional Disability, and Static Balance According to Different Age Groups of Women with UI

Table 3 provides the values of the UI condition, LBP and disability, and static balance of women with UI according to different age groups. There were significant differences for VAS ($P < 0.05$), KODI, and FICSIT-4 ($P < 0.01$) among 3 of the age groups. Af-

ter post-hoc testing, significant differences for these variables were found between women in their forties and sixties.

Comparison of UI Severity Condition, LBP, Functional Disability, and Static Balance According to BMI-Classified Groups of Women with UI

Table 4 provides the values of the UI condition, LBP and disability, and static balance of women with UI according to BMI-classified groups. There were significant differences in VAS among 4 of the groups ($P < 0.05$). After post-hoc testing, significant differences for these variables were found between underweight and overweight groups.

Correlation of UI Severity with Age, BMI, LBP, Functional Disability, and Static Balance

Table 5 presents the correlation among the values of UI severity, age, BMI, LBP and disability, and static balance. Significant correlations with the UI score were found for all the variables ($P < 0.01$) except BMI. A significant correlation with age was noted in the case of BMI, VAS, KODI, and FICSIT-4 ($P < 0.01$).

Table 2. Low back pain, functional disability, and static balance according to the UI severity conditions

Variables	UI score ^{a)}			F ^{b)}
	None (n = 250)	Mild (n = 63)	Moderate (n = 11)	
VAS (mm)	21.96 ± 28.08	33.33 ± 26.21 ^{c)}	50.91 ± 19.21 ^{c)}	9.302
KODI (%)	11.24 ± 14.90	15.84 ± 11.90 ^{c)}	37.17 ± 18.99 ^{c,d)}	18.267
FICSIT-4 (score)	26.13 ± 2.82	23.77 ± 4.90 ^{c)}	19.25 ± 6.65 ^{c,d)}	10.680

Values are presented as mean ± SD.

UI, urinary incontinence; VAS, visual analog scale; KODI, Korean version of the Oswestry Disability Index; FICSIT-4, Frailty and Injuries: Cooperative Studies of Intervention Techniques.

^{a)} UI score (mild: 0-24, moderate: 25-48). ^{b)} $P < 0.01$. ^{c)} Significant difference compared with none UI condition. ^{d)} Significant difference between mild condition.

Table 3. UI severity condition, low back pain, functional disability, and static balance according to different age groups of women with UI

Variables	40s (n = 30)	50s (n = 20)	60s (n = 24)	χ^2/F
UI score ^{a)}				
Mild	29 (96.67)	15 (75.00)	20 (79.2)	5.451
Moderate	1 (3.33)	5 (25.00)	5 (20.8)	
VAS (mm)	26.77 ± 17.68	40.50 ± 30.86	43.75 ± 27.63 ^{b)}	3.540 ^{c)}
KODI (%)	11.41 ± 8.98	21.00 ± 15.56	26.85 ± 16.72 ^{b)}	8.737 ^{d)}
FICSIT-4 (score)	26.58 ± 2.15	24.67 ± 3.08	20.19 ± 5.81 ^{b)}	7.573 ^{d)}

Values are presented as number (%) or mean ± SD.

UI, urinary incontinence; VAS, visual analog scale; KODI, Korean version of the Oswestry Disability Index; FICSIT-4, Frailty and Injuries: Cooperative Studies of Intervention Techniques.

^{a)} UI score (mild: 0-24, moderate: 25-48). ^{b)} Significant mean difference between 40s and 60s. ^{c)} $P < 0.05$. ^{d)} $P < 0.01$.

Table 4. UI severity condition, low back pain, functional disability, and static balance according to BMI-classified groups of women with UI

Variables	BMI-classified groups ^{a)}				χ^2/F
	Underweight (n = 10)	Acceptable (n = 38)	Overweight (n = 23)	Obese (n = 3)	
UI score ^{b)}					
Mild	10 (100)	34 (89.5)	16 (69.6)	3 (100)	7.241
Moderate	0 (0)	4 (10.5)	7 (30.4)	0 (0)	
VAS (mm)	16.00 ± 17.13	36.05 ± 23.43	42.17 ± 27.13 ^{c)}	53.33 ± 46.19	3.106 ^{d)}
KODI (%)	13.56 ± 13.64	17.60 ± 14.00	23.96 ± 17.16	17.04 ± 12.24	1.409
FICSIT-4 (score)	28.00 ± 0.00	23.16 ± 4.86	22.10 ± 6.51	22.50 ± 3.54	1.005

Values are presented as number (%) or mean ± SD.

UI, urinary incontinence; BMI, body mass index; VAS, visual analog scale; KODI, Korean version of the Oswestry Disability Index; FICSIT-4, Frailty and Injuries: Cooperative Studies of Intervention Techniques.

^{a)} BMI groups (underweight: under 20, acceptable: 20-25, overweight: 25-30, obese: 30-35). ^{b)} UI score (mild: 0-24, moderate: 25-48). ^{c)} Significant mean difference between underweight and overweight. ^{d)} $P < 0.05$.

Table 5. Correlation of UI severity with age, BMI, low back pain, functional disability, static balance

	UI score	Age	BMI	VAS	KODI
Age	0.488 ^{a)}				
BMI	0.222	0.311 ^{a)}			
VAS	0.380 ^{a)}	0.313 ^{a)}	0.278 ^{b)}		
KODI	0.700 ^{a)}	0.555 ^{a)}	0.191	0.546 ^{a)}	
FICSIT-4	-0.456 ^{a)}	-0.609 ^{a)}	-0.182	-0.057	-0.605 ^{a)}

UI, urinary incontinence; BMI, body mass index; VAS, visual analog scale; KODI, Korean version of the Oswestry Disability Index; FICSIT-4; Frailty and Injuries: Cooperative Studies of Intervention Techniques.

^{a)} $P < 0.01$. ^{b)} $P < 0.05$.

Further, we found significant correlations between VAS and KODI, and between KODI and FICSIT-4 ($P < 0.01$).

DISCUSSION

UI may be associated with balance impairment and ultimately lead to a variety of musculoskeletal problems [8]. This study was designed to identify the relationship between UI and low back discomfort and disability, static balance, and demographic factors. We found that the severity of UI was significantly correlated with the level of LBP and disability and static balance ability.

Women have a show a higher prevalence of UI than men because of the relatively short length of the urethra as well as hormonal and delivery-associated factors [28]. In this study, the prevalence of UI was 22.8%. The majority of the subjects (85.1%)

had a mild UI condition. The prevalence of UI in this study was similar to that reported by Kim et al. [4] and Lee [29]. The main finding of this study was the strong correlation between UI, age, LBP and disability, and static balance ability. The higher the severity of UI, the higher was the perceived level of LBP and LBP-related functional disability, and the lower was the static balance ability. These results are in agreement with the studies by Smith et al. [12,13], which reported that all age groups of women with urination control disability were more vulnerable to LBP than the normal population. Such vulnerability may be strongly related to the muscular function of the pelvic girdle. Women may have limited musculoskeletal support of the pelvic organs, a factor strongly associated with the pregnancy and the labor process [30]. PFMs play an important role in providing postural stability to the lumbopelvic region as well as in controlling bladder continence [31]. The dual function of PFMs is considered an essential prerequisite to improve the quality of motor control and movement during various daily activities.

Recently, PFMs have been associated with the stability of the lumbopelvic region for its connection with the muscles around the trunk [32]. Previous studies have recognized the involvement of the co-activation of the pelvic floor and abdominal muscles in the development of intra-abdominal pressure and trunk load transfer, which normally improves pelvic stability and supports urinary control [31,33-35]. Therefore, PFM dysfunction contributes to urinary disorders or lumbopelvic pain. We believe that a strong relationship between low back discomfort/disability and UI, as found in this study, may be ascribed to PFM dysfunction in women with UI. In women with UI, insuf-

ficient postural activity of these muscles may explain the higher prevalence of LBP [12]. Moreover, UI is regarded as a contributing factor to the deregulation of trunk muscle control, which boosts the development of LBP and disability. Smith et al. [13] found that the activity of the pelvic floor and trunk muscles were higher in women with UI than in women without UI.

In women with UI, impaired PFM function may also be clinically relevant with regard to balance problems. Balance problems result from a reduced contribution of the trunk movement to postural correction or compromised proprioceptive acuity [8]. This study reported that women without UI exhibit higher static balance scores than do women with UI. A possible explanation for this finding is that increased use of the pelvic floor and trunk muscles stimulates postural control of the lumbopelvic region, thus resulting in decline balance ability. It is possible that wider movements of the pressure center limit trunk motion and the susceptibility of proprioceptors to control static balance [8]. Further, previous studies have suggested that the level of bladder fullness may be associated with reduced balance ability as a result of a change in the activity of the abdominal muscles [8]. In this context, ageing is also considered to be a factor contributing to the reduced contraction strength of the bladder and the decline in bladder volume and urinary control. In this study, we found a significant correlation between UI and age.

Further studies will circumvent certain limitations of the present study. In this study, the main variables were assessed by using clinical rather than quantitative tools. Although the assessment tools used in this study are currently used in clinical settings, it was difficult to obtain detailed information about the subjects. Further, most of the subjects included in our study were women with mild UI conditions. This factor may limit the extrapolation of our results to all women suffering from UI.

In conclusion, our study reported that women experiencing UI show higher degree of LBP and disability, and lower static balance ability than those who did not. Women with UI may experience LBP and a decline in static balance as a result of the decreased activity of the pelvic floor and the trunk muscles as well as an imbalance in such muscles. These factors should be taken into consideration when managing UI-related problems such as LBP and disability, and balance impairment. Further studies are required to prove the mechanisms underlying the decline in balance of women with UI by using more qualified measurement tools, to develop management programs to reduce UI-related problems, and to investigate their effects.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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