

## Relationship of spinal curvature, mobility, and low back pain in women with and without urinary incontinence

Şeyda TOPRAK ÇELENAY<sup>1\*</sup>, Derya ÖZER KAYA<sup>2</sup>

<sup>1</sup>Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Yıldırım Beyazıt University, Ankara, Turkey

<sup>2</sup>Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, İzmir Kâtip Çelebi University, İzmir, Turkey

Received: 19.09.2016 • Accepted/Published Online: 08.04.2017 • Final Version: 23.08.2017

**Background/aim:** This study aimed to investigate the relationship of sagittal spinal curvature, mobility, and low back pain (LBP) in women with and without urinary incontinence (UI).

**Materials and methods:** Thirty-two women with UI (incontinence group) and 41 women without UI (control group) were included in this study. The sagittal spinal curvature and mobility were assessed with a Spinal Mouse device (IDIAG, Fehraltorf, Switzerland). Urogenital symptom distress, LBP, and disability caused by LBP were assessed using the Urogenital Distress Inventory-6 (UDI-6), a visual analog scale (VAS), and the Oswestry Disability Index (ODI), respectively.

**Results:** It was seen that the sagittal thoracic curvature, lumbar curvature, and pelvic tilt were increased in the incontinence group in comparison to the control group ( $P < 0.05$ ). An increase in sagittal lumbar mobility and pelvic mobility was found in the incontinence group ( $P < 0.05$ ). It was observed that 71.9% of the women with UI and 12.2% of the women without UI had LBP. There were positive correlations of the UDI-6 with the VAS ( $r = 0.363$ ,  $P = 0.041$ ) and the ODI ( $r = 0.511$ ,  $P = 0.003$ ).

**Conclusion:** The sagittal spinal alignment and lumbopelvic hypermobility should be taken into consideration in the existence of UI.

**Key words:** Low back pain, spinal curvature, spinal mobility, urinary incontinence

### 1. Introduction

Urinary incontinence (UI) is a common condition in women causing social and hygienic problems (1). The prevalence of UI increases with age: for young adults the prevalence is reported to be 20%–30%, and in middle-aged individuals, it increases up to 30%–40% (1). Age, pregnancy, childbirth, pelvic surgery, lower urinary tract infections, and various factors increasing the intraabdominal pressure, such as overweight, constipation, physical exertion, and chronic cough due to smoking, are traditionally considered risk factors for UI, alone or in combination (2). Although no single factor completely explains the etiology, the condition of the pelvic floor and particularly the pelvic floor muscles (PFMs) are focused on primarily (3). The principal roles of the PFMs include the maintenance of continence (4), the support of the abdominal contents (4), and sexual functioning (5). In addition, the PFMs, multifidus, transversus abdominis, and diaphragm play important roles in motor control, providing dynamic stability of the lumbopelvic area (6). Current data have demonstrated altered or delayed activation of the deep

trunk muscles and PFMs in lumbopelvic dysfunction in association with UI (6–8).

A cadaveric study by Pool-Goudzwaard et al. (9) indicated that simulated tension of the PFMs significantly stiffened the sacroiliac joints by 8.5% and produced a backward rotation of the sacrum. The authors suggested that increased activity of the PFMs might improve pelvic stability and the ability to transfer load through the lumbopelvic region. Furthermore, studies have suggested that correct spinal configuration and normal curvatures might protect the pelvis or pelvic floor from direct intraabdominal forces and enable efficient contraction for the PFMs (10–12). Recent data have also suggested that PFM activity varies with the lumbar curvature in healthy women (12,13). Sapsford et al. (11) showed that in the sitting position, greater PFM activity was recorded during voluntary PFM contractions performed in an upright unsupported posture as compared to in a slumped supported posture. Capson et al. (12) also found that in the standing position, higher resting PFM activity in the hypolordotic posture (pelvis is tilted posteriorly) occurred

\* Correspondence: sydtoprak@hotmail.com

in comparison to normal and hyperlordotic postures. These results indicate that spinal curvature and pelvic position may be important variables when evaluating the risk factors of UI. However, there exist contradictory and insufficient results related to this issue in the literature (10–12,14).

Furthermore, recent studies have demonstrated a link between genitourinary dysfunction and low back pain (LBP) and also reported that a great of majority of women with LBP had UI (9,15). Although it is known that spinal hyper- or hypomobility could be an important risk factor for LBP (16,17), to the best of our knowledge, there is no report regarding the relationship among spinal curvatures, mobility, and UI.

Therefore, the aim of this study was to investigate the relationship among sagittal spinal curvatures, mobility, and LBP in women with and without UI. The following hypotheses were investigated: 1) The sagittal spinal curvatures and spinal mobility would be different in women with UI compared to those without UI. 2) The urogenital distress severity is associated with LBP and disability in women with UI.

## 2. Material and methods

### 2.1. Study design

In this study, a case-control design was used. It was conducted in accordance with the rules of the Declaration of Helsinki. The participants were fully informed about the nature and purpose of the study. Written informed consent was obtained. The study was approved by the Ethics Committee of Yildirim Beyazıt University, Ankara, Turkey (Approval number: 2015-31/12, Approval date: 27.02.2015).

### 2.2. Patients

Forty-seven women, aged between 20 and 65 years and diagnosed with stress and mixed UI by urogynecologists and urologists, were assessed. Women with prior history of injury or surgery related to the spine, spinal deformity, systemic pathology including any rheumatologic disease, neurologic conditions, symptomatic pelvic organ prolapse, malignancy, and pregnancy were excluded from the study. In total, 32 women with UI (incontinence group, age:  $48.87 \pm 9.84$  years) were included. The control group was composed of 41 participants out of 60 women without UI (age:  $44.56 \pm 8.70$  years) randomly selected from a Healthy Life Center. The inclusion criteria for the control group included volunteering to participate in the study, age between 20 and 65 years, no previous incontinence or pelvic organ prolapse (lifetime to date), no spinal or pelvic surgery, and no spinal pain or deformity prior to the study.

### 2.3. Outcome measures

Demographic and physical characteristics of all participants, such as age, weight, height, parity, gravidity,

education, menopause status, smoking, and exercise habits, were recorded with a form. Participants' body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Assessments related to the sagittal spinal curvatures, pelvic tilt, mobility, and LBP were administered. All assessments were conducted by the same physical therapist (ŞTÇ) using a standardized protocol to ensure the consistency of subject instructions, overall testing procedures, and positioning. The examiner was blinded to the participants.

The sagittal spinal curvatures, pelvic tilt, and mobility of all participants were evaluated in standing position with a Spinal Mouse (IDIAG, Fehraltorf, Switzerland), a computer-assisted and noninvasive device. During measurements, the participants were in their underwear with no shoes. All measurements were taken around midday on each testing day (between 1100 and 1300 hours) to control diurnal variations in spinal curvatures. The demographic data of the participants were recorded using computer software. The spinal processes of the vertebrae from C7 to S3 were marked. The Spinal Mouse device was slid from top to bottom along the spine for measurement. Evaluation was performed while the participants were standing in an upright position and with the maximum trunk flexion and maximum trunk extension positions. The sagittal curvatures of the thoracic spine (T1–2 to T11–12) and lumbar spine (T12–L1 to the sacrum) and the position of the sacrum and the hips (difference between the sacral angle and the vertical position) were recorded. In the lumbar curvature, negative values corresponded to lumbar lordosis (posterior concavity). With respect to the pelvic tilt, a value of  $0^\circ$  represented the vertical position. A greater angle reflected an anterior pelvic tilt and a lower angle (negative values) reflected a posterior pelvic tilt. The sagittal spinal mobility for the thoracic, lumbar, and sacrum/hip regions was calculated by software. The intratester, intertester, and day-to-day reliability of the Spinal Mouse device were published previously (18).

The presence and severity of various urogenital symptoms were assessed with the Urogenital Distress Inventory-6 (UDI-6). All of the women with UI were asked to complete the UDI-6 questionnaire (19). With this instrument, patients rated the degree of bother using a 4-point rating scale: 0 = not at all, 1 = slightly, 2 = moderately, and 3 = greatly. The best total score is 0 and the worst total score is 100. A higher total score indicates more severe urogenital distress. The Turkish version of the UDI-6 is a reliable, consistent, and valid instrument (20).

The presence of low back pain intensity was assessed with a visual analog scale (VAS), which was scored on a 10-cm horizontal line with 0 indicating "no pain" and 10 "unbearable pain". Women with UI were asked to mark their low back pain on the horizontal line. The reliability of this measure was determined by Clark et al. (21).

The Oswestry Disability Index (ODI) was used to determine the impact of low back pain on subjects' daily living activities. The ODI consisted of 10 items (degree of pain, self-management, raising objects, walking, sitting, standing, sleeping, hobbies, movement, and sexual activity). According to the degree of the patients' performance, each of the 10 items was assigned a point ranging from 0 to 5. The condition of no pain was given 0 points and the condition of the worst degree of pain was given 5 points. The best score was 0 and the worst score was 50. Lower scores indicated less disability. The validity of the Turkish version of the ODI was established by Yakut et al. (22).

#### 2.4. Statistical analyses

Ten participants from each group were randomly recruited for the pilot study. The G\*Power software program (G\*Power, Version 3.0.10, Franz Faul, Universität Kiel, German) was used to determine the required sample size for this study. It was calculated that a sample consisting of 64 subjects (32 per group) was needed to obtain 80% power with  $d = 0.63$  effect size,  $\alpha = 0.05$  type I error, and  $\beta = 0.20$  type II error. Data analysis and calculations were conducted using IBM SPSS Statistics 21.0 (IBM Corp., Armonk, NY, USA). An overall P-value of less than 0.05 was considered to show a statistically significant result.

The variables were investigated using visual (histograms and probability plots) and analytical methods (Shapiro–Wilks test) to determine whether they were normally distributed. Descriptive statistics of normally distributed variables were presented as means and standard deviations, and those of nonnormally distributed and ordinal variables

were presented as medians, minimum–maximum values, and frequency tables. Baseline demographic and physical characteristics were compared between groups using independent sample t-tests or Mann–Whitney U tests for numeric variables and the chi-square test for categorical variables. The sagittal spinal curvature, pelvic tilt, and spinal mobility between groups were analyzed by independent sample t-test. The Pearson correlation test was used to assess the relationship among the UDI-6, VAS, and ODI scores.

#### 3. Results

There was no difference between the demographic and physical characteristics of the groups, except for parity and gravidity ( $P < 0.05$ ), as presented in Table 1. Eleven (34.4%) of the women with UI had stress UI and 21 (65.4%) had mixed UI.

It was found that the sagittal thoracic curvature ( $P = 0.004$ ), lumbar curvature ( $P < 0.001$ ), and anterior pelvic tilt ( $P = 0.002$ ) were increased in the incontinence group in comparison to the control group (Table 2). In addition, the sagittal lumbar mobility ( $P = 0.009$ ) and the sagittal pelvic mobility ( $P < 0.001$ ) were increased in the incontinence group. However, no difference related to the sagittal thoracic mobility was seen between the groups ( $P = 0.118$ ) (Table 2).

In this study, it was observed that 23 (71.9%) of the women with UI and 5 (12.2%) of the women without UI had LBP. Positive correlations of the UDI-6 scores ( $28.51 \pm 13.22$ ) were observed with the VAS scores ( $3.75 \pm 3.07$  cm) ( $r = 0.363$ ,  $P = 0.041$ ) and the ODI scores ( $13.56 \pm 10.08$ ), ( $r = 0.511$ ,  $P = 0.003$ ) in women with UI.

**Table 1.** Demographic and physical characteristics of the participants.

Characteristics	Incontinence group (n = 32)	Control group (n = 41)	P
Age (years, X $\pm$ SD)	47.93 $\pm$ 9.52	44.29 $\pm$ 8.53	0.094
BMI (kg/m <sup>2</sup> , X $\pm$ SD)	31.03 $\pm$ 5.65	29.18 $\pm$ 4.71	0.132
Parity (median, (min–max))	2.0 (0.0–4.0)	1.0 (0.0–3.0)	<0.001*
Gravidity (median, (min–max))	3.0 (0.0–4.0)	2.0 (0.0–3.0)	<0.001*
Menopausal status (n, %)			
No	23, 71.9	31, 75.6	0.718
Yes	9, 28.1	10, 24.4	
Smoking (n, %)			
No	26, 81.2	28, 68.3	0.211
Yes	6, 18.8	12, 31.7	
Exercise habits (n, %)			
No	28, 87.5	32, 78.0	0.295
Yes	4, 12.5	9, 22.0	

\*P < 0.05; X: mean; SD: standard deviation, BMI: body mass index, Min: minimum, Max: maximum.

**Table 2.** Differences between the sagittal spinal curvature, pelvic tilt, and mobility of the groups.

The sagittal spinal measurements	Incontinence group (n = 32) X ± SD	Control group (n = 41) X ± SD	t values	P
Spinal curvatures (degrees)				
Thoracic curvature	47.84 ± 7.32	41.36 ± 11.11	-2.992	0.004*
Lumbar curvature	-38.12 ± 10.48	-27.02 ± 10.43	4.500	<0.001*
Pelvic tilt	22.78 ± 8.57	15.39 ± 11.51	-3.143	0.002*
Spinal mobility (degrees)				
Thoracic	23.12 ± 11.85	28.12 ± 14.48	1.581	0.118
Lumbar	59.50 ± 21.37	44.34 ± 25.67	-2.690	0.009*
Pelvic	52.03 ± 27.12	28.70 ± 23.58	-3.925	<0.001*

\*P &lt; 0.05.

#### 4. Discussion

This study put forward the following findings: 1) women with UI showed a greater sagittal thoracic curvature, lumbar curvature, anterior pelvic tilt, and lumbar and pelvic mobility than those without UI; 2) most of the women with UI (71.9%) had LBP; and 3) urogenital distress was positively correlated with LBP intensity and disability.

Some healthcare providers believe that sagittal spinal curvatures and mobility have an influence on health (16,17,23). In their review, Christensen et al. (24) declared no strong evidence for any association between sagittal spinal curvatures and any health outcomes, including spinal pain. However, they demonstrated moderate evidence for an association between sagittal spinal curvatures and four health outcomes, namely temporomandibular disorders, urogenital prolapse, daily function, and death. Lind et al. (10) found that excessive thoracic kyphosis was associated with pelvic organ prolapse. Mattox et al. (14) studied the relationship between spinal curvature and pelvic organ prolapse and found that an abnormal change in spinal curvature, especially the loss of lumbar lordosis, could be a significant risk factor in the development of pelvic organ prolapse. This result suggested that variations in spinal curvature might alter intraabdominal vector forces and possibly potentiate the development of pelvic organ prolapse. In our study, significant differences were observed for thoracic curvature, lumbar curvature, and anterior pelvic tilt in women with UI. Biomechanically all parts of the spine and pelvis position are interrelated. Therefore, any changes of the lumbar lordosis may be due to postural changes of the thoracic spine. Moreover, the angle of the sacrum is related to the degree of lumbar lordosis (25), and the degree of lumbar lordosis is related to the degree of pelvic tilt (26). In a hypolordotic posture, the pelvis is tilted posteriorly. As such, the hypolordotic posture may shorten the PFMs by changing the orientation

of their attachments at the sacrum, coccyx, and pubis. There is some evidence that a muscle may receive more excitatory input from the central nervous system when it is held in a shortened position (27), which may explain the increase in resting PFM activity when subjects were standing with a reduced lumbar lordosis. This situation is contrary in hyperlordotic posture. Therefore, these results suggest that increasing thoracic kyphosis, lumbar lordosis, and anterior pelvic tilt could be associated with decreasing PFM activity in women with UI. However, further studies assessing the muscle activity are warranted.

Moreover, to our knowledge, this is the first study investigating spinal mobility in women with and without UI. In our study, increased lumbopelvic mobility was observed in women with UI. This may point out the insufficiency of lumbopelvic stability. Any dysfunction in the lumbopelvic area, especially stability deficiency, was associated with LBP in the literature (6). This might explain the rate of LBP incidence in our study group with UI. The study of Eliasson et al. (15) pointed out that 78% of the women with LBP reported UI. Similarly, in our study approximately 72% of the women with UI had LBP. Therefore, clinicians treating patients with UI or LBP should be aware of the possible relationship and plan the treatment accordingly to improve lumbopelvic stability. Furthermore, recent research has focused on the relationship of LBP with respiratory disorders, incontinence, and gastrointestinal problems (7,28). Smith et al. (28), in a study involving 2943 younger, 2298 middle-age, and 2258 older women from an Australian longitudinal study on women's health, reported that women with preexisting incontinence, gastrointestinal problems, and breathing disorders were more likely to develop LBP than women without such problems. This was considered a result of changes in the control of the trunk muscles following involvement with incontinence, respiratory, and gastrointestinal problems. Changes in the morphology and

altered postural activity of the trunk muscles including muscles of continence, which provide mechanical support to the spine and pelvis, have been shown to be related to the development and occurrence of LBP (6–8). Our results also point out that increased urogenital distress in women with UI was related to increased LBP intensity and disability. These results may be beneficial to clinicians when assessing and determining the treatment program for patients with UI.

There were some limitations of the current study. First, the sagittal spinal curvature and mobility values in only women with and without UI were represented and compared in the study. Investigation of these values in men with and without UI should be considered because of various biomechanical differences between women and men. However, to standardize, only female subjects were included here. Second, we did not evaluate PFM activity response in this study, which may be investigated in future studies assessing spinal curvature and mobility. Third, in this study, the spinal curvature and mobility values in women with stress UI and mixed UI were presented.

These values could be investigated in different types of UI in further studies due to the differences in etiology of stress and urge incontinence. Fourth, the demographic and physical characteristics of the subjects in the groups were different (10% difference in age, 7% difference in BMI, and statistically significant differences in parity and gravidity). The differences may affect the results. Nevertheless, age, increased BMI, pregnancy, and childbirth are traditionally considered risk factors for UI, alone or in combination (2). For this reason, these differences between the women with and without UI were expected. It may be better to compare groups with similar demographic and physical characteristics in further studies.

In conclusion, an increase in the sagittal spinal curvatures, pelvic tilt, and lumbopelvic mobility was seen in women with UI compared to women without UI in this study. Most of the women with UI had LBP. The urogenital distress was related to LBP and disability. It was concluded that sagittal spinal alignment and lumbopelvic hypermobility should be taken into consideration in the treatment of UI.

## References

- Hunskar G, Lose G, Sykes D, Voss S. The prevalence of urinary incontinence in women in four European countries. *BJU Int* 2004; 93: 324-330.
- Hunskar S, Arnold EP, Burgio K, Diokno AC, Herzog AR, Mallett VT. Epidemiology and natural history of urinary incontinence. *Int Urogynecol J Pelvic Floor Dysfunct* 2000; 11: 301-319.
- DeLancey JO. Structural support of the urethra as it relates to stress urinary incontinence: the hammock hypothesis. *Am J Obstet Gynecol* 1994; 170: 1713-1723.
- Raizada V, Mittal RK. Pelvic floor anatomy and applied physiology. *Gastroenterol Clin North Am* 2008; 37: 493-509.
- Dean N, Wilson D, Herbison P, Glazener C, Aung T, MacArthur C. Sexual function, delivery mode history, pelvic floor muscle exercises and incontinence: a cross-sectional study six years post-partum. *Aust N Z J Obstet Gynaecol* 2008; 48: 302-311.
- Cholewicki J, Silfies SP, Shah RA, Greene HS, Reeves NP, Alvi K, Goldberg B. Delayed trunk muscle reflex responses increase the risk of low back injuries. *Spine* 2005; 30: 2614-2620.
- Hodges PW, Richardson CA. Inefficient muscular stabilization of the lumbar spine associated with low back pain. A motor control evaluation of transversus abdominis. *Spine* 1996; 21: 2640-2650.
- Barbic M, Kralj B, Cor A. Compliance of the bladder neck supporting structures: importance of activity pattern of levator ani muscle and content of elastic fibers of endopelvic fascia. *Neurourol Urodyn* 2003; 22: 269-276.
- Pool-Goudzwaard A, van Dijke GH, van Gurp M, Mulder P, Snijders C, Stoeckart R. Contribution of pelvic floor muscles to stiffness of the pelvic ring. *Clin Biomech (Bristol, Avon)* 2004; 19: 564-571.
- Lind LR, Lucente L, Kohn N. Thoracic kyphosis and the prevalence of advanced uterine prolapse. *Obstet Gynecol* 1996; 87: 605-609.
- Sapsford RR, Richardson CA, Maher CF, Hodges PW. Pelvic floor muscle activity in different sitting postures in continent and incontinent women. *Arch Phys Med Rehabil* 2008; 89: 1741-1747.
- Capson AC, Nashed J, Mclean L. The role of lumbopelvic posture in pelvic floor muscle activation in continent women. *J Electromyogr Kinesiol* 2011; 21: 166-177.
- Sapsford RR, Richardson CA, Stanton WR. Sitting posture affects pelvic floor muscle activity in parous women: an observational study. *Aust J Physiother* 2006; 52: 219-222.
- Mattox TF, Lucente V, McIntyre P, Miklos JR, Tomezsko J. Abnormal spinal curvature and its relationship to pelvic organ prolapse. *Am J Obstet Gynecol* 2000; 183: 1381-1384.
- Eliasson K, Elfving B, Nordgren B, Mattsson E. Urinary incontinence in women with low back pain. *Man Ther* 2008; 13: 206-212.
- Kulig K, Powers CM, Landel RF, Chen H, Fredericson M, Guillet M, Butts K. Segmental lumbar mobility in individuals with low back pain: in vivo assessment during manual and self-imposed motion using dynamic MRI. *BMC Musculoskelet Disord* 2007; 8: 8.

17. Grosdent S, Demoulin C, Souchet M, Tomasella M, Crielaard J, Vanderthommen M. Trunk muscle profile in elite tennis players with and without low back pain. *J Sports Med Phys Fitness* 2015; 55: 1354-1362.
18. Mannion AF, Knecht K, Balaban G, Dvorak J, Grob D. A new skin-surface device for measuring the curvature, and global and segmental ranges of motion of the spine: reliability of measurements and comparison with data reviewed from the literature. *Eur Spine J* 2004; 13: 122-136.
19. Uebersax JS, Wyman JF, Shumaker SA, McClish DK, Fantl JA. Short forms to assess life quality and symptom distress for urinary incontinence in women: the Incontinence Impact Questionnaire and the Urogenital Distress Inventory. Continence Program for Women Research Group. *NeuroUrol Urodyn* 1995; 14: 131-139.
20. Cam C, Sakalli M, Ay P, Cam M, Karateke A. Validation of the short forms of the incontinence impact questionnaire (IIQ-7) and the urogenital distress inventory (UDI-6) in a Turkish population. *NeuroUrol Urodyn* 2007; 26: 129-133.
21. Clark P, Lavielle P, Martínez H. Learning from pain scales: patient perspective. *J Rheumatol* 2003; 30: 1584-1588.
22. Yakut E, Duger T, Oksuz C, Yorukan S, Ureten K, Turan D, Firat T, Kiraz S, Kirdi N, Kayhan H et al. Validation of the Turkish version of the Oswestry Disability Index for patients with low back pain. *Spine (Phila Pa 1976)* 2004; 29: 581-585.
23. Troyanovich SJ, Harrison DE, Harrison DD. Structural rehabilitation of the spine and posture: rationale for treatment beyond the resolution of symptoms. *J Manipulative Physiol Ther* 1998; 21: 37-50.
24. Christensen, ST, Hartvigsen J. Spinal curves and health: a Systematic critical review of the epidemiological literature dealing with associations between sagittal spinal curves and health. *J Manipulative Physiol Ther* 2008; 31: 690-714.
25. Nakipoglu GF, Karagoz A, Ozgirgin N. The biomechanics of the lumbosacral region in acute and chronic low back pain patients. *Pain Physician* 2008; 11: 505-511.
26. Levine D, Whittle MW. The effects of pelvic movement on lumbar lordosis in the standing position. *J Orthop Sports Phys Ther* 1996; 24: 130-136.
27. Del Valle A, Thomas CK. Motor unit firing rates during isometric voluntary contractions performed at different muscle lengths. *Can J Physiol Pharmacol* 2004; 82: 769-776.
28. Smith MD, Russell A, Hodges PW. Do incontinence, breathing difficulties, and gastrointestinal symptoms increase the risk of future back pain? *J Pain* 2009; 10: 876-886.