Research Paper: The Relationship Between Urinary Incontinence and Anthropometric Indices in Obese Women

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ABSTRACT

Introduction: Urinary Incontinence (UI) is a common problem in obese women affected by different parameters such as weight, Body Mass Index (BMI), type of delivery, etc. This study aimed to investigate the relationship between the lumbar lordosis, anthropometric characteristics, and the incidence of urinary incontinence in obese women.

Materials and Methods: This cross-sectional study was conducted on 193 obese women (BMI>30 kg/m^2) with and without UI. Anthropometric characteristics and lordosis angle were measured in participants, and then they were asked to fill out demographic information and urinary incontinence questionnaires. The obtained data were analyzed by SPSS V. 23 using statistical tests, including the Independent t test, Spearman correlation, and logistic regression.

Results: Women who suffered from UI had a lower lumbar lordosis angle, were younger, and shorter, with a higher number of natural deliveries.

Discussion: Based on the findings of this study, a direct relationship exists between natural delivery and UI. However, an indirect relationship is observed between UI and age, lumbar lordosis angle, and height. Because of the effect of lumbar lordosis on the incidence of urinary incontinence in obese people, spine alignment, and changes in abdominal biomechanical parameters might also have an impact on UI.

1. Introduction

Based on the definition of the International Continence Society (ICS), urinary incontinence is any involuntary leakage of urine that leads to impairment in the quality of life, personal hygiene, and social relationships [1]. Three common types of UI are stress Urinary Incontinence (SUI), Urgency Urinary Incontinence (UUI), and Mixed Urinary Incontinence (MUI) [1].

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The prevalence of UI ranges from 15% to 69%, depending on its definition and study population [2]. Only a few studies on the prevalence of UI have been conducted in Iran. Ahmadi et al. reported the prevalence of UI to be 38.4% in 40- to 50-year-old women [3]. UI has several negative consequences for women. It creates various forms of disability in life and affects social, psychological, occupational, physical, and even sexual aspects of the affected individual in 15% to 30% of the cases [4].

Studies show that several environmental and underlying factors are involved in the UI prevalence and its increase, including age, gender, ethnicity, body mass index, physical activity, sex hormones, type 2 diabetes, smoking, jumping sports, frequency, and type of delivery, etc. [5-9]. In modern societies, obesity is a widespread phenomenon that is still growing. The prevalence of obesity (BMI≥30.0 kg/m^2) has been reported to be approximately 36.5% in Europe and the US over the past decade [10, 11]. The prevalence rates of overweight and obesity were estimated at 10.8% and 5.1% in Iran in the 2000s [12]. Obesity is a significant risk factor in the development of UI [13, 14].

Today, the two main roles of pelvic floor muscles are identified as providing trunk stability, and urinary and stool continence [15]. Maximal contraction of the pelvic floor muscles will activate abdominal muscles [15]. When a gentle contraction occurs in the pelvic floor, transversus abdominis produces a dominant response regardless of the lumbar position [16]. Increased abdominal pressure due to heavyweight will impose stress on the pelvic floor muscles and may lead to more UI in overweight or obese people [17]. Also, a clinical relationship is observed between the pelvic floor muscles and the lumbar multifidus deep fibers [15]. According to Sapsford, changes in the lumbar position during body movements alter the participation of the abdominal muscles [18].

So that, in lumbar spine flexion, external oblique shows more activity, and in lumbar extension, transversus abdominis has a stronger contraction [18]. There is an epidemiological connection between lumbopelvic disorders and UI in women [19]. The lumbopelvic posture can affect pelvic floor muscle activity. Also, the coordination of these muscles with trunk muscles is considered an essential factor in treating women with UI [20]. One of the most important components of the lumbopelvic posture is the lumbar lordosis angle [21]. The inward curve of the lumbar spine is called lumbar lordosis and is created by the intervertebral disks and the wedge shape of the vertebra [22].

This angle differs among various people [23]. Abdollahi et al. examined the relationship between Lumbar Lordotic Angle (LLA) and the ultrasonic thickness of the abdominal muscles and found a significant negative relationship between the thickness of the transversus abdominis in standing position and the LLA [22]. Higher BMI changes the thickness of the internal oblique, transversus, and rectus abdominis muscles.

The relationship between the transversus abdominis in lying and standing positions and BMI can reflect the effect of abdominal body fat and heavyweight on these muscles [22]. Since the relationship between the abdominal and pelvic floor muscles has already been established and the voluntary activation of the abdominal muscles is associated with the increased pelvic floor muscle activity [16], the LLA might indirectly affect the pelvic floor muscles. But the question is whether these results can be extended to obese people with a BMI>40 kg/m^2.

This study hypothesized that obesity changes the lumbar lordosis and may relate to the conditions that will lead to UI. Because of the adverse effects of UI on physical, social, and emotional functioning and generally the quality of life of women [24], the purpose of this study was to investigate the relationship between the lumbar lordosis, anthropometric characteristics, and the incidence of urinary incontinence in obese women.

2. Participants and Methods

This cross-sectional study was conducted on 193 obese women (BMI≥30 kg/m^2) with and without urinary incontinence admitted to the Obesity Clinic of Rasoul Akram Hospital and the Pelvic Floor Clinic of the Rehabilitation Faculty of Iran University of Medical Sciences from October to February 2016. The sample size for the present study was calculated according to the following formula for logistic regression of 200 people, though due to the fall in the number of patients, 193 was the final sample size (Formula 1):

1. N=10.k/p (k=number of independent variables; p=minimum proportion of negative or positive cases in society)

After completing the demographic information and UI questionnaires (International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form [ICIQ-UI SF] and the Bristol Female Lower Urinary Tract Symptoms Questionnaire [BFLUTS]) [25], the subjects were divided into two groups: with and without UI based on their responses to the questionnaires, regardless of their type of UI. The inclusion criteria were having a BMI≥30 kg/m^2, being married and 25 to 65 years old, no UI due to neurological and functional causes, no spinal mal-alignments such as scoliosis, and no history of spinal surgery. The exclusion criteria were an inability to stand independently for the measurements and unwillingness to continue the study. The subjects were selected through convenience sampling method from October to February 2016.

At first, anthropometric indices, including height, weight, Waist Circumference (WC), Hip Circumference (HC), and Neck Circumference (NC), were carefully measured by a tape measure and a standard weighing scale. The subjects were asked to stand next to a tape measure mounted on the wall without shoes to have their height measured. The WC was measured at the navel level and the HC at the widest point of the hips with the least clothing [26]. The Waist-to-Hip Ratio (WHR), Waist-to-Height Ratio (WHtR) and BMI were then calculated. The NC was measured by placing the tape measure around the neck perpendicular to the neck axis just below the laryngeal prominence or Adam's apple [27].

A 50-cm flexible ruler was used to measure lumbar lordosis using the Hart and Rose method [28]. In brief, after determining the spinous processes of L1 and S2, one end of the flexible ruler was placed on the spinous process of L1 and the other end on S2 and the ruler was placed carefully to fully touch the skin to take the form of the lumbar lordosis. Then the number in front of the S2 spinous process was read. The ruler was removed from the body without disrupting its form and then laid on a piece of paper to draw its shape.

To measure lumbar lordosis, S2 and L1 points were marked on the curve and connected with a straight line and the midpoint of the line was marked and a line perpendicular to the curve was drawn from that point. These lines were named L and H, respectively. The lumbar lordosis angle (LLA) was measured using the following equation: $\theta=4$ [arc tag (2H/L)]. The validity and reliability of this method have already been proven [28]. The patients' information, i.e, the history of enuresis during childhood, was also collected and recorded.

The results are presented as the mean and standard deviation. The obtained data were analyzed in SPSS V. 23 using statistical tests, including the Independent t test, Spearman correlation, and logistic regression. $P<0.05$ was regarded as the level of statistical significance.

3. Results

Table 1 presents the demographic and anthropometric characteristics of the participants. According to the results, some variables show a significant difference between obese women with and without UI.

A significant relationship was found in the logistic regression model between age, the number of natural deliveries, height, lumbar lordosis angle, and UI in obese women. The first variable with a significant effect on UI was the number of natural deliveries with an odds ratio of 1.75, and the second one was the lumbar lordosis angle with an odds ratio of 0.948.

Mean age, height, and lumbar lordosis was lower in those with UI. There was a significant positive relationship between the number of natural deliveries and UI, meaning that UI increased with a higher number of natural deliveries in obese women (Table 2).

Also, the subjects were classified into two groups based on their type of delivery: cesarean or natural delivery. In those who had only natural deliveries, there was a significant relationship between UI and enuresis, and women with UI had more history of enuresis in childhood (P=0.008). But without this classification, there was no significant relationship between enuresis in childhood and obese women who had in UI in adulthood (Table 3).

4. Discussion

The purpose of this study was to find the relationship between major anthropometric indices, lumbar lordosis angle, and UI in obese women. According to the results, the number of natural deliveries was higher, but lumbar lordosis angle, height, and age were significantly lower in obese subjects with UI compared to obese women without UI.

Changes in abdominal pressure are suggested as a mechanism causing incontinence [29]. It appears that abdominal pressure is different in various positions, and changes in abdominal pressure in different positions can cause incontinence in these positions. High intra-abdominal pressure is proposed as one of the causes of UI in obese people as it can impose stress on the pelvic floor muscles [17]. Pelvic floor muscle contraction is an essential mechanism of continence [21]. Abdominal muscles contraction may be an efficient mechanism to start the pelvic floor muscle contraction [30].

Table 1. Demographic and anthropometric characteristics of obese women (the Independent t test)

Variables	With UI (n=103)			Without UI (n=90)			P
	Min	Max	Mean±SD	Min	Max	Mean±SD	
Age (y)	28	65	49.18±8.78	25	63	41.99±9.50	0.000
Height (cm)	140.00	174.50	158.14±6.53	148.00	176.70	161.48±6.15	0.000
Weight (kg)	63	201.90	99.42±24.13	79.00	169.00	110.74±16.47	0.000
BMI (kg/m^2)	30.10	73.32	39.62±8.51	31.59	61.43	42.44±5.63	0.009
WC (cm)	90.00	165.00	116.50±18.42	101.00	160.00	124.82±13.50	0.000
HC (cm)	100.00	176.00	121.70±15.4)	107.00	175.00	128.42±10.38	0.000
NC (cm)	32.00	44.00	37.63±2.98	32.50	48.00	38.24±2.51	0.132
WHR	0.77	2.00	0.97±0.15	0.80	1.17	0.97±0.09	0.588
WHtR	0.58	1.00	0.73±0.11	0.62	1.03	0.77±0.08	0.025
Lordosis	30.45	156.70	69.46±22.12	35.46	163.17	86.39±24.19	0.000
Cesarean delivery (n)	0	6	0.99±1.14	0	5	1.12±1.17	0.537

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BMI: Body Mass Index; WC: Waist Circumference; HC: Hip Circumference; NC: Neck Circumference; WHR: Waist-Hip Ratio; WHtR: Waist-Height Ratio.

Danforth et al. (2006) examined the factors affecting the incidence of UI in 83355 women. According to their results, UI was more prevalent among overweight women with BMI>30 kg/m^2 than those with 22-24 kg/m^2, and therefore they concluded that BMI alone is strongly associated with UI [31]. A study conducted by Subak on the effect of weight loss on UI showed that women with higher waist circumference have higher intra-abdominal and intra-bladder pressure and face a higher risk of incontinence than others [32]. In another study, the same author treated women for weight loss. After their treatment, the weight loss group showed a significant improvement in UI.

The considerable point was that the subjects' weight and BMI increased in the 9-month follow-up, but this increase was not associated with a change in incontinence frequency [33]. In 2008, Auwad et al. examined 64 women treated for weight loss and found no relationship between BMI and improvement in the pad test. However, they found a weak but essential relationship between improvement in the pad test and reduction in abdominal diameter [34]. The relationship between improved leakage of urine (pad test) and reduced waist circumference supports the hypothesis that the improved UI after weight loss is due to the reduction in abdominal fat and intra-bladder pressure.

Table 2. Relationship between anthropometric indices and vaginal delivery with UI (logistic regression)

Variables	B	S.E	P	Exp B (OR)	95% CI
Natural delivery	0.560	0.148	0.00	1.750	1.311-2.337
Lordosis	-0.054	0.011	0.00	0.948	0.928-0.968
Age	-0.088	0.024	0.00	0.916	0.874-0.960
Height	-0.097	0.034	0.004	0.908	0.850-0.969

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Table 3. Women's enuresis in childhood and UI in their adulthood in the group that had only vaginal delivery (Chi-square test)

Enuresis in Childhood	Urinary Incontinence				Missing	Total	P
	Yes		No				
	Count	Expected Count	Count	Expected Count			
Yes	27	27	20	20	23	47	0.231
No	57	57	66	66		123	

JMR

The authors then proposed weight distribution as a more influential factor than BMI and concluded that people with a higher WHR would benefit more from weight loss than others [34]. Vatandoost et al. reported a significant positive relationship between weight and the spontaneous loss of urine in athletes, but no significant relationship between BMI and UI [24]. In the current study, no relationship was found between anthropometric indices and UI, except the lumbar lordosis angle and height that were less in obese women with UI. This finding might be due to the presence of only obese individuals in the study samples and the inability to compare anthropometric characteristics between obese and normal-weight women.

In the early and mid-1900s, scientists, anatomists, and gynecologists examined the role of the pelvic inlet and the curvature of the spine concerning their potential performance in genital support [35]. According to Elftman et al., the forward curvature of the lumbar spine in humans creates a shelf beneath the abdominal viscera [36], and according to Lind et al., the pelvic inlet orientation and curvature of the spine have a supportive role for the viscera by absorbing lower vector forces [37]. Changes in body position can cause UI by affecting the intra-abdominal pressure and the activity of the pelvic floor muscles [38].

Because of the connection between the pelvic floor muscles and the coccyx and the passage of their fibers through the sacroiliac joint, an increase in the lower lumbar angle will lead to the posterior rotation of the coccyx in relation to the pubis and ultimately pulling the pelvic floor muscles back. Whereas, when lordosis decreases, the anterior rotation of the coccyx and the tightness of the pelvic floor muscles reduce the contraction of these muscles [38]. Levine et al. examined the relationship between lumbar lordosis and pelvic tilt and suggested that increased anterior pelvic tilt may increase lumbar lordosis with the same intensity [23]. Dehghan et al. showed that the posterior pelvic tilt engages the abdominal muscles and thus activates the pelvic floor muscles and increases the stability of the pelvic floor by changing the forced closure [38].

However, the higher incidence of UI in the subjects with a lower lumbar lordosis might indicate that lordosis and pelvic position have an impact on the forces entering the pelvic floor and bony pelvic that reduce pelvic floor muscles performance in controlling the urine output [39]. Recent studies have led to an increased understanding of the synergy between the abdominal and pelvic floor muscles and generally all the muscle groups that surround the abdominal capsule. Tampson et al. stated that the abdominal muscles are more active than the pelvic floor muscles in people with UI [39].

It can, therefore, be concluded that the abdominal muscles contract more than the pelvic floor muscles in UI patients, which will lead to their lower lumbar lordosis angle over time. The same pattern was observed in a study on athletes with and without UI, as the lumbar lordosis angle was lower in the athletes with UI than in the athletes without it [24]. Similar to the report, this study has found lower lumbar lordosis in patients with urinary incontinence than those without UI.

Sapsford examined the EMG activities of the pelvic floor muscles in slump supported sitting, upright unsupported, and unsupported sitting positions in 8 healthy women, and showed that increased lordosis increases the pelvic floor muscle activity and also leads to a slight increase in the activity of the abdominal muscles [40]. In another study, Sapsford showed that the increased activity of the pelvic floor muscles is associated with increased activity of the transversus abdominis muscles [18]. Increased activity in the pelvic floor and abdominal muscles was also observed in positions with more lordosis when evaluating the resting tone changes of the pelvic floor and abdominal muscles in different sitting postures in women without UI [16].

Capson (2010) examined the effect of the lumbopelvic posture on pelvic floor muscles activity in healthy women and stated that the resting tone of the pelvic floor muscles was higher in all standing postures compared with the supine position, and pelvic floor muscle activity was higher in hyperlordosis than in normal lordosis and hyperlordosis [20]. According to these results, the incidence of UI in obese people with decreased lumbar lordosis may be due to their decreased pelvic floor muscle performance. Considering the role of lordosis on the incidence of UI, it appears that spine alignment and changes in biomechanical abdominal parameters might have a greater impact on the incidence of UI than anthropometric indices. It seems that an independent study using electromyography may be required to reveal the function of the postural muscles involved in the lumbopelvic posture in obese people.

In the present study, there was a significant positive relationship between the number of natural deliveries and UI. Rortveit et al. stated that delivery is an important risk factor for UI among young and middle-aged women [41]. Pregnancy itself may lead to mechanical and or hormonal changes that may lead to UI [41]. Vaginal delivery is a major contributing factor for UI because it is associated with the possibility of damage to the muscular or nervous tissues [42].

The inconsistency of results about this could be due to studies that have examined the effect of type of delivery on UI, which are often methodologically weak. For example, they have a poor outcome measurement, are prone to bias, have a small sample size, and do not care about matching their subjects' age with their BMI [43]. Nonetheless, UI is known to be a common problem during pregnancy. The UI that starts during pregnancy doubles the chances of this problem three months after delivery, whether the delivery is a vaginal or cesarean section [44]. The present study failed to ask the subjects about the amount and frequency of UI during their pregnancies.

Some studies have shown that enuresis in childhood causes UI in adulthood [45-47]. However, in this study, no relationship was found between enuresis in childhood and UI in adulthood, but when the subjects were classified based on the type of delivery, women with a history of only natural birth suffering from UI had more history of enuresis in childhood. In a 2019 study, Fitzgerald studied the relationship between urinary symptoms in childhood and adulthood in middle-aged women and found that those who had frequent urination in their childhood were more likely to have frequent urination in adulthood too. Besides, enuresis in children was strongly associated with nocturia in adulthood [45]. The inconsistency between the results of this study and other studies may be due to the smaller sample size of the current research and also the questions dealing with enuresis rather than urinary disorders in childhood.

Based on the findings of this study, there is a direct relationship between natural delivery and UI. However, an indirect relationship is observed between age, lumbar lordosis angle, height, and UI. Because of the effect of lumbar lordosis on the incidence of urinary incontinence in obese people, spine alignment, and changes in abdominal biomechanical parameters might also contribute to UI.

Ethical Considerations

Compliance with ethical guidelines

The research project was ethically approved by Iran University of Medical Sciences (Code: IR.IUMS.REC.1394.9311340001).

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Authors contributions

Project development, data collection, manuscript writing: Seyedeh Saeideh Babbazadeh-Zavieh; Project development, manuscript writing, management data analysis: Behnoosh Vasaghi-Gharamaleki; Data collection, project development: Afsaneh Nikjaooy; Manuscript writing, management data analysis, review and editing: Seyed Mohammad Jafar Haeri; Manuscript writing: Amirhossein Shamsi Ardekani.

Conflict of interest

The authors declared no conflict of interest.

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