The Relationship Between Body Mass Index and Lower Urinary Tract Symptoms in Men

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Abstract
Objective: The studies evaluating association between obesity and lower urinary tract symptoms (LUTS) are limited. Our study’s objective was to determine the correlation between obesity and LUTS in men.
Methods: Information of 639 patients who were aged between 37 and 92, had not been treated for BPH before, had moderate or severe LUTS, had International Prostate Symptom Score (IPSS) ≥8 and had prostate-specific antigen (PSA) value less than 4 ng/ml was evaluated retrospectively. Measured Body Mass Index (BMI) was classified in accordance with World Health Organization (WHO).
Results: A statistically significant difference was present between BMI groups with respect to post-void residual urine volume (PVR) (p=0.017). PVR level of the obesity group’s PVR level was found to be significantly lower when compared to the normal group (p<0.05). In patients with diabetes mellitus (DM), only PVR parameter among LUTS was found to differ significantly from BMI groups (p=0.037). In patients with DM, the mean of PVR of obese patients was detected to be significantly lower when compared to the mean of normal patients (p<0.05). In patients with cardiovascular disease (CD), only Qmax and Qave parameters were found to differ significantly from BMI groups. (p=0.001 and p<0.001, respectively). In patients with CD, the mean Qmax of obese patients was significantly higher than the average of normal-weight patients (p<0.05).
Conclusion: Although there is no association between obesity and LUTS except PVR, we think that the risk of obesity associated with DM and CD would significantly increase the risk of LUTS.
Key words: Lower urinary tract symptoms, Body mass index, Obesity, Urology

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et al., 2002);  
I. Symptoms of filling phase (urinary incontinence, nocturia, increase in the frequency of daytime urination, urinary compression)  
II. Symptoms of voiding phase (terminal drip, delayed urine initiation, forked-scattered urine flow, discontinuous urine flow, poor urine flow, forced urine discharge)  
III. Post-voiding symptoms (post-void drip, feeling of incomplete urinary excretion).

The prevalence of these symptoms detected in both males and females has been reported to be approximately 19.2% of males and 13.7% of females, although it has changed from country to country in the population screenings (Abrams et al., 2002). However, the high prevalence of disease and drug use accompanied by aging contributes to the increase in the prevalence of LUTS during the old age (Takeda et al., 2003).

Obesity has been defined as “excessive or abnormal increase of body fat content to disrupt health” by WHO. Obesity is a condition which the body fat ratio is 25% for men and 35% for women (Yuksel, 2016). The study of "Turkey Obesity Profile" performed on 13878 individuals over the age of 20 in 6 provinces (Gaziantep, Konya, Denizli, Kastamounu, Kirklareli and Istanbul) by Turkish Association for the Study of Obesity (TASO) between 2000-2005 years. It was found that 30.9% of the individuals had BMI> 25 kg/m². Obesity causes damage to the urethral mucosa, decrease in the amount of collagen and loss of urethra elasticity. However, obesity is an important predisposing factor for urinary incontinence and increases the severity of the condition. Chronic strains caused by pelvic muscles and nerves affected by excessive weight trigger stress, stretching and weakening. Body mass index showed significantly higher values in stress urinary incontinence (Bilge and Beji, 2016).

Obesity and LUTS are frequent in elder men and might significantly influence their quality of life. In the cohort studies, it was reported that there was a positive association between LUTS and anthropometric obesity measurements (Giovannucci et al., 1994; Gann et al., 1995). In addition, Hammarsten et al. suggested in a clinical-based study that an expanded prostate may be the consequence of prostate development, impaired insulin management and other sides of the metabolic syndrome according to the results of 158 patients more frequently identified in men with constituents of a metabolic syndrome like hypertension needing therapy, insulin-dependent diabetes mellitus (IDDM), low HDL-cholesterol levels, obesity and high fasting insulin levels (Hammarsten et al., 1998).

There are limited number of studies investigating the association between obesity-associated diseases and LUTS in the literature. Moreover, the number of studies emphasizing which LUTS are affected is much less. It is observed in the literature that there are different results between obesity and accompanying diseases, and LUTS development. The aim of our study is to determine the association between obesity and LUTS in men.

**Methods**

This study was a cross-sectional study conducted from January 2015 to June 2018. Data of 639 patients who admitted to Urology Clinic of Medical Faculty Hospital in Ordu University, were aged between 37 and 92, had not been treated for BPH before, had moderate or severe LUTS, had IPSS ≥8 and had PSA value less than 4 ng/ml was evaluated retrospectively. This planned research complies to the Declaration of Helsinki rules including patient’s rights and ethical guidelines and were confirmed by Local Ethics Committee of Ordu University (Date: Dec 2018, Number: 2018/265).

639 male patients between the ages of 37 and 92 were evaluated. BMI, which is calculated by dividing the weight in kilograms by the square of the height in meter, is classified according to WHO: underweight (<18.5 kg/m2), normal weight (18.5-24.9 kg/m2), overweight (25 to 29.9 kg/m2) and obese (≥ 30 kg/m2), however there wasn’t any underweight patient in this study.

The patients in the study were split into two groups as with or without hypertension (HT), diabetes mellitus (DM), cardiovascular disease (CD) and drug use (DU). Ages, IPSS values, prostate volumes, urinary flow rates (Qmax, Qaverage), PVR and PSA data of patients in each group were evaluated.

In patients with HT, DM, CD and positive DU, LUTS variables were examined in terms of BMI groups.

**Statistical Analysis**

For the continuous variables, Kolmogorov-Smirnov test for normal distribution control of the data and Levene test for the homogeneity of the group variances were performed. Independent samples t-test was utilized to compare two groups. One-way ANOVA and following Tukey post-hoc
test were used to compare the averages of more than two independent groups. Pearson correlation coefficients were calculated to evaluate the relationships among the continuous variables. Pearson's chi-square test ($\chi^2$) was used to determine the relationship between the categorical variables. The statistical significance level was accepted as 5% for calculations and interpretations. All data analyses were conducted using the SPSS (Demo version 25.0, IBM Corp., Armonk, NY, USA) statistical software.

**Results**

According to one-way ANOVA, no statistically significant difference was observed between BMI groups with respect to the mean age ($p=0.091$). When the prevalences were evaluated, the prevalence of normal weight, overweight and obese groups were 19.4% ($n = 124$), 49.5% ($n = 316$) and 31.1% ($n = 199$), respectively (Table 1).

### Table 1. Comparison of the prevalences and ages of the patients among BMI groups

| BMI Group      | n (%)  | Mean±SD       | Min.-Max. | p      |
|----------------|--------|---------------|-----------|--------|
| Normal weight  | 124 (19.4) | 63.00±10.64   | 44.0-92.0 | 0.091  |
| Overweight     | 316 (49.5) | 62.00±9.21    | 39.0-85.0 | NS     |
| Obese          | 199 (31.1) | 61.00±9.12    | 37.0-84.0 |        |
| **Total**      | 639 (100.0) | 62.00±9.52    | 37.0-92.0 |        |

NS; $p>0.05$

One-way ANOVA test was performed to detect statistically significant difference among BMI subgroups in terms of LUTS. No statistically significant difference was detected among BMI groups for all variables, except PVR ($p>0.05$). A statistically significant difference was observed among BMI groups with respect to PVR ($p=0.017$). According to Tukey test, no significant difference was found between the normal group and overweight group ($p>0.05$); however, PVR level of the obesity group was detected to be significantly lower than normal group ($p<0.05$) (Table 2).

IPSS was divided into mild (0-7), moderate (8-19) and severe (20-35) symptoms. Chi-square test was performed to analyze the frequency distribution of IPSS groups in BMI groups. It was observed that the frequency distribution of IPSS groups did not change in terms of BMI groups ($p=0.730$) (Table 3).

### Table 2. Descriptive statistics and comparison results for LUTS among BMI groups

| BMI Group      | Mean±SD       | Mean±SD       | Mean±SD       | p      |
|----------------|---------------|---------------|---------------|--------|
| IPSS-obstructive total | 6.28±5.94 | 5.63±4.84 | 5.44±4.96 | 0.333NS |
| IPSS-irritative total  | 6.09±3.16 | 6.27±3.64 | 6.26±3.31 | 0.879NS |
| IPSS total          | 11.94±6.74 | 11.74±6.85 | 11.60±7.18 | 0.913NS |
| Prostate volume     | 34.09±16.15 | 37.02±18.73 | 38.10±25.57 | 0.822NS |
| Qmax                | 14.38±6.54 | 15.88±7.53 | 16.66±9.89 | 0.229NS |
| Qave                | 6.27±3.68 | 7.09±4.39 | 6.87±3.07 | 0.051NS |
| PVR                 | 43.47±97.55 a | 33.94±51.41 ab | 23.54±38.95 b | 0.017* |
| PSA                 | 2.01±2.05 | 2.29±4.23 | 2.37±4.37 | 0.333NS |

NS; $p>0.05$, *; $p<0.05$; According to Tukey test, means that do not share a common letter are significantly different ($p<0.05$)

### Table 3. Frequency distribution of IPSS total score for the patients in BMI groups

| BMI Group | n (%)  | Mean±SD       | Minimum | Maximum | p      |
|-----------|--------|---------------|---------|---------|--------|
| Mild      | 36 (5.6%) | 108 (16.9%)   | 69 (10.8%) | 0.730NS |
| Normal    | 70 (11.0%) | 160 (25.0%)   | 97 (15.2%) |        |
| Severe    | 18 (2.8%) | 48 (7.5%)     | 33 (5.2%) |        |

NS; $p>0.05$
According to One-way ANOVA results, there was no statistically significant difference among BMI groups in terms of LUTS parameters in HT and DU positive patients (p>0.05). In patients with positive DM, only PVR parameter showed a significant change among BMI groups (p=0.037), yet there was no significant difference in the remaining parameters (p>0.05). In patients with DM, the mean PVR of obese patients was significantly decreased when compared to the average of normal patients (p<0.05). In the patients with positive CD, only Qmax and Qave parameters showed a significant change among BMI groups (p=0.001 and p<0.001, respectively). In patients having CD, the mean Qmax of obese patients was significantly increased when compared to that of normal-weight patients (p<0.05). The mean Qmax of overweight patients was not significantly different from normal and obese patients (p>0.05). In patients with CD, there was no significant difference between overweight and obese patients (p>0.05) while they had significantly higher Qave average than normal weight patients (p<0.05) (Table 4).

Table 4. Descriptive statistics and comparison results of the patients with HT, DM, CD and DU in BMI groups

| IPSS-obs. | HT + | DM + | CD + | DU + |
|----------|------|------|------|------|
| n | Mean±SD | p | n | Mean±SD | p | n | Mean±SD | p | n | Mean±SD |
| OW | 33 | 6.73±5.87 | 18 | 5.72±4.20 | 15 | 11.27±11.11 | A | 48 | 7.29±7.38 |
| 92 | 6.11±5.22 | 13 | 5.67±4.52 | 34 | 5.35±5.75 | B | 75 | 6.28±4.60 |
| OW | 33 | 6.18±3.14 | 18 | 6.3±3.30 | 15 | 6.47±4.02 | 238 | 6.77±5.34 |
| 92 | 6.48±3.26 | 13 | 6.73±3.13 | 34 | 7.03±3.40 | 115 | 6.46±3.32 |
| Total | 33 | 12.85±7.83 | 18 | 12.44±6.16 | 15 | 15.27±9.45 | 75 | 6.32±3.35 |
| 92 | 12.59±7.47 | 13 | 12.40±7.57 | 34 | 12.18±7.71 | 115 | 13.33±6.71 |
| Prostate volume | 33 | 35.76±15.72 | 18 | 38.78±17.64 | 15 | 34.27±14.86 | 75 | 12.57±6.85 |
| 92 | 40.85±31.04 | 13 | 39.96±27.08 | 34 | 38.62±30.76 | 115 | 41.10±21.28 |
| Qmax | 33 | 14.01±4.58 | 18 | 14.53±5.97 | 15 | 9.93±4.78 | B | 40.52±26.42 |
| 92 | 16.09±7.64 | 13 | 14.58±6.22 | 34 | 17.12±7.06 | A | 115 | 13.61±6.77 |
| Qave | 33 | 5.95±2.42 | 18 | 5.88±2.89 | 15 | 3.87±2.03 | B | 75 | 14.70±12.15 |
| 92 | 6.56±2.96 | 13 | 6.16±2.79 | 34 | 7.28±2.97 | A | 115 | 6.16±5.51 |
| PVR | 33 | 26.67±33.43 | 18 | 44.17±41.92 | 15 | 38.47±26.82 | 75 | 5.57±2.30 |
| 92 | 30.24±43.06 | 17 | 31.85±41.25 | 60 | 29.38±43.44 | 47 | 38.28±53.86 | 271 |
| PSA | 33 | 1.99±1.80 | 18 | 2.41±2.49 | 15 | 1.76±1.32 | 75 | 29.87±48.18 |
| 92 | 3.02±6.07 | 13 | 1.75±2.00 | 32 | 2.70±4.49 | 114 | 2.57±2.86 |

N; Normal weight, OW; Overweight; O; Obese, HT; Hypertension, DM; Diabetes mellitus, CD; Cardiovascular disease, DU; Drug use (Prostate), NS; p>0.05, *; p<0.05, **; p<0.01, ***; p<0.001, According to Tukey test, means that do not share a common letter are significantly different (p<0.05)

Pearson correlation coefficients were calculated to investigate the correlations between LUTS and BMI. The correlation coefficients given in Table 5 represent that LUTS variables are very weakly correlated with BMI and most of them have no statistically significant association (p>0.05). The correlation coefficients of some variables that are statistically significantly correlated with BMI are quite small (PVR, r=-0.105; p=0.008). These associations have emerged from the high sample size and are too weak to be considered in practice (Table 5).

Table 5. Correlation coefficients between BMI and LUTS(n=639)

| r | p |
|---|---|
| Age | -0.086 | 0.030* |
| IPSS-obstructive total | -0.075 | 0.058 |
| IPSS-irritative total | 0.075 | 0.058 |
| IPSS total | 0.002 | 0.956 |
| Prostate volume | 0.057 | 0.149 |
| Qmax | 0.093 | 0.019* |
| Qave | 0.036 | 0.358 |
| PVR | -0.105 | 0.008** |
| PSA | -0.100 | 0.012* |

r; Pearson correlation coefficient, *; p<0.05, **; p<0.01
LUTS and BMI

Discussion
Our study was realized to determine the association between BMI and LUTS in men. According to the results of our study, there was a statistically significant difference among BMI groups in terms of PVR (p=0.017). PVR level of the obesity group was found to be significantly decreased when compared to the normal group (p<0.05). Although many factors have been charged until now, the real causes of LUTS are not known precisely and LUTS is considered as a multifactorial event. The two risk factors taking role in the etiology of BPH are aging and the presence of functional testes (androgens). In recent years, the importance of metabolic syndrome, DM, obesity, smoking and lifestyle, heredity and genetic factors are stated as other etiological factors (Konwar et al., 2008; Parsons, 2010; Cetinkaya and Oztekin, 2011).

In many studies, a significant relationship was detected between obesity and LUTS (Altunkaynak and Ozbek, 2006). In a study conducted by Bart et al. in France, the prevalence of LUTS was found to be 44% (Bart et al., 2008). In addition, severe weight loss in morbidly obese patients with LUTS significantly was observed to reduce intravesical pressure. This is a step that emphasizes the importance of obesity-induced intra-abdominal pressure in the development of stress LUTS (Yalcin, 2009). In a case-control study performed on African-American men, Sarma et al. expressed that BMI was directly related to prostate volume (Sarma et al., 2002). No relation was found between BMI and LUTS in the studies realized in China and Greece (Signorello et al., 1999; Dahle et al., 2002). While obesity reduces free and total testosterone and serum globulin binding protein levels, it increases estrogen levels as well as free and total estradiol concentrations (Pasquali et al., 1991). Higher estrogen levels can affect prostate cell growth in the environment of low testosterone levels due to age-related and obesity. In particular, it increases the rate of estrogen/androgen in abdominal obesity and may increase the sympathetic nerve activity, which is known to affect both the development of BPH and the severity of LUTS (Giovannucci et al., 1994; Barqawi et al., 2005). In our study, no significant relationship was observed between prostate volume and obesity. However, a statistically significant difference was detected between obesity and PVR, which is one of LUTS (p=0.017).

Serum PSA levels can be affected by many factors such as age, prostate volume, and obesity. Nowadays, it has been reported in many studies that there has been a negative correlation between PSA levels and BMI (Barqawi et al., 2005; Kristal et al., 2006). However, Ochiai et al. expressed that anthropometric parameters were not directly correlated with PSA levels and BMI (Ochiai et al., 2005). Although obesity is an important anthropometric factor in the metabolic syndrome, there are complex associations among individual anthropometric parameters, partly due to their association with obesity. Crystal et al. declared that PSA levels were 0.2-0.4 ng/ml lower in obese patients compared to normal weight (Kristal et al., 2006). However, they informed that the magnitude of the association between serum PSA levels and the presence of each metabolic component could not be precisely determined. In our study, no significant relationship was detected between serum PSA level and BMI.

Obesity, which is a crucial risk factor of metabolic syndrome, causes hypertension, insulin resistance, hypertriglyceridemia and low HDL cholesterol. Metabolic syndrome of which prevalence has increased progressively in the world is seen in 28% of men over the age of 30 in Turkey (Onat et al., 2002). While LUTS in elderly men have made think direct benign prostate hyperplasia in previous years, later studies have proved that chronic illnesses such as diabetes, heart disease, and metabolic syndrome components, lifestyle factors such as alcohol, smoking and physical activity are effective in the development of LUTS (Chapple and Roehrborn, 2006; Fitzgerald et al., 2007).

In our study, it was found that only PVR parameter in LUTS was significantly different among BMI groups in patients with DM (p=0.037), however there was no significant difference in the remaining parameters (p>0.05). In patients with DM, the mean PVR of obese patients was significantly lower than the average of normal patients (p<0.05). In patients with CD, only Qmax and Qave parameters showed a significant difference among BMI groups (p=0.001 and p<0.001, respectively). In patients with CD, the mean Qmax of obese patients was significantly increased when compared to that of normal-weight patients (p<0.05).

Conclusion
All in all, although there is no relationship between obesity and LUTS except PVR, we believe that obesity associated diabetes mellitus
and cardiovascular diseases will increase the risk of LUTS development significantly. We think that our study will provide a significant contribution to the literature in terms of the high number of patients, the high number of parameters evaluated and the different results. In the future, more studies are needed to determine the etiology of LUTS development and contribute to the prevention of LUTS development.

**Ethics Committee Approval:** Ethics committee approval was received for this study from Ordu Clinical Research Ethics Committee of ORDU University. Ethics no: 2018/265

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**Author Contributions:** Concept- Y.K.A., A.A., AÇ, Design- AÇ, Y.K.A Supervision-Y.K.A., A.A., AÇ, Literature Review- A.A., AÇ, Writing-A.A., Y.K.A, Critical Review- AÇ.

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