

**This item is the archived peer-reviewed author-version of:**

Exploring associations between lower urinary tract symptoms (LUTS) and gastrointestinal (GI) problems in women : a study in women with urological and GI problems vs a control population

**Reference:**

Wyndaele Michel, de Winter Benedicte, Pelckmans Paul, de Wachter Stefan, van Outryve Marc, Wyndaele Jean-Jacques.- Exploring associations between lower urinary tract symptoms (LUTS) and gastrointestinal (GI) problems in women : a study in women with urological and GI problems vs a control population

BJU international / British Association of Urological Surgeons - ISSN 1464-4096 - 115:6(2015), p. 958-967

Full text (Publishers DOI): <http://dx.doi.org/doi:10.1111/bju.12904>

Handle/Permalink: <http://hdl.handle.net/10067/1225830151162165141>

# TITLE PAGE

## TITLE

Exploring associations between LUTS and GI problems in women: a study in women with urological and GI problems versus a control population

## AUTHORS

M. Wyndaele<sup>a</sup> ([michel.wyndaele@gmail.com](mailto:michel.wyndaele@gmail.com)) – submitting author

B.Y. De Winter<sup>b</sup> ([benedicte.dewinter@uantwerpen.be](mailto:benedicte.dewinter@uantwerpen.be))

P.A. Pelckmans<sup>b, c</sup> ([paul.pelckmans@uantwerpen.be](mailto:paul.pelckmans@uantwerpen.be))

S. De Wachter<sup>a</sup> ([stefan.dewachter@uantwerpen.be](mailto:stefan.dewachter@uantwerpen.be))

M. Van Outryve<sup>c</sup> ([mark.vanoutryve@uza.be](mailto:mark.vanoutryve@uza.be))

J.J. Wyndaele<sup>a</sup> ([jeanjacques.wyndaele@uantwerpen.be](mailto:jeanjacques.wyndaele@uantwerpen.be))

<sup>a</sup> *Laboratory of Translational Neurosciences, Division of Urology, Antwerp University Hospital and University of Antwerp, Faculty of Medicine, Antwerp, Belgium*

<sup>b</sup> *Laboratory of Experimental Medicine and Paediatrics, Division of Gastroenterology, University of Antwerp, Antwerp, Belgium*

<sup>c</sup> *Department of Gastroenterology, Antwerp University Hospital, Antwerp, Belgium*

## **CORRESPONDING AUTHOR**

Wyndaele Michel, MD, PhD

Department of Urology - University of Antwerp

10 Wilrijkstraat

B 2650 Edegem

Tel.: +32 0 3 8213511

Fax: +32 0 3 8214479

Email: [michel.wyndaele@gmail.com](mailto:michel.wyndaele@gmail.com)

## **WORD COUNT**

Manuscript: 3981 / 4000 words

Abstract: 345 words

References: 49 references

## ABSTRACT

*Objectives:* First, to study the prevalence of self-reported LUTS in women consulting a Gastroenterology clinic with complaints of functional constipation (FC), fecal incontinence (FI) or both, compared to a female control population. Secondly, to study the influence of FC, FI, or both on self-reported LUTS in women attending a Urology clinic.

*Patients and methods:* We present a retrospective study of data collected through a validated self-administered bladder and bowel symptom questionnaire in a tertiary referral hospital from three different female populations: 104 controls, 159 gastroenterological patients and 410 urological patients. Based on the reported bowel symptoms, patients were classified as having FC, FI, a combination of both, or, no FC or FI. LUTS were compared between the control population and the gastroenterological patients, and between urological patients with and without concomitant gastroenterological complaints. Results were corrected for possible confounders through logistic regression analysis.

*Results:* The prevalence of LUTS in the control population was comparable to large population-based studies. Nocturia was significantly more prevalent in gastroenterological patients with FI compared to the control population (OR 9.1). Female gastroenterological patients with FC more often reported straining to void (OR 10.3), intermittency (OR 5.5), need to immediately revoid (OR 3.7) and feeling of incomplete emptying (OR 10.5) compared to the control population. In urological patients, urgency (94%) and UUI (54% of UI) were reported more often by patients with FI than by patients without gastroenterological complaints (58% and 30% of UI

respectively), whereas intermittency (OR 3.6), need to immediately revoid (OR 2.2) and feeling of incomplete emptying (OR 2.2) were reported more often by patients with FC than by patients without gastroenterological complaints.

*Conclusion:* As LUTS are reported significantly more often by female gastroenterological patients than by a control population, and as there is a difference in self-reported LUTS between female urological patients with different concomitant gastroenterological complaints, we suggest that general practitioners, gastroenterologists and urologists should always include the assessment of symptoms of the other pelvic organ system in their patient evaluation. The clinical correlations between bowel and LUT symptoms may be explained by underlying neurological mechanisms.

## INTRODUCTION

The prevalence of lower urinary tract symptoms (LUTS) in the general population is high. A large population-based survey, the epiLuts study, showed that LUTS occur “at least sometimes” in 76% of women and “often” in 53% of women (1). The EPIC study reported a similar prevalence of 67% for LUTS in women (2). Furthermore, LUTS have a substantial, multidimensional impact on patients, as their presence negatively affects quality of life, activity and work productivity, and also leads to increased healthcare use (e.g. specialist consultations and hospitalizations) (3).

Recent studies have illustrated that bowel pathology is frequently correlated with pathology of the lower urinary tract (LUT). This is clinically important as bowel pathology is also prevalent in the general population: the prevalence of fecal incontinence (FI) ranges from 2-15% (4), and the prevalence of chronic constipation from 4-35% (mean 17%) (5).

The concomitance of bowel symptoms and LUTS is illustrated by the high prevalence of *colorectal storage symptoms* in female patients with LUTS and with different types of urinary incontinence (UI) (6). The prevalence of FI in people with UI has been widely documented, which is in contrast to the low number of studies that have been published on the prevalence of UI in people with FI. A community-based study in Olmsted County, Minnesota, USA, reported a high prevalence of 60% for concurrent UI in women with FI (7). A French study showed similar results with a prevalence of 48% for associated UI in women with FI (8).

Constipation on the other hand, a *colorectal evacuation disorder*, has been associated with LUTS as well (9). UI is also more prevalent in chronically constipated

women (9), and looking at UI subtypes, a Danish study showed that constipation was associated with both urgency and urgency UI [Odds Ratio (OR) 1.8], and stress UI (OR 1.6) (10). The same study reported an association of constipation with urinary evacuation disorder (OR 3.9) (10). Indeed, constipation is also frequently associated with impairment of bladder emptying in women with overactive bladder (11). Urodynamic studies have shown an increased bladder capacity and sometimes an acontractile bladder in chronically constipated women (12).

The correlation of bowel and LUT pathology has important therapeutical implications as well: treatment of one organ system can improve or worsen symptoms in the other. It was for instance shown that resolution of constipation significantly improves LUTS in the elderly (13). Treating UI in children on the other hand can result in a significant decrease in concomitant FI (14).

Due to the high prevalence of symptoms of bladder and bowel in the general population, and due to their clinical and therapeutical correlations, we believe that further knowledge on the concomitance of symptoms and disorders of both organ systems is necessary and clinically relevant for both general practitioners and specialists in urology and gastroenterology. In the first part of this study we compared the occurrence of a wide spectrum of self-reported LUTS between a female control population and women consulting a Gastroenterology clinic with complaints of functional constipation (FC), FI or both. In the second part, we evaluated the influence of FC, FI, or both on self-reported LUTS in women attending a Urology clinic.

# **PATIENTS AND METHODS**

## **Study population**

The present study is a retrospective evaluation of data collected in a tertiary referral hospital from three different female populations:

- 1) Control population: 104 patients recruited from the Orthopedic and General Internal Medicine consultations, and from volunteer co-workers of different clinical and administrative services of the hospital. Women with a urological or gastroenterological history were excluded.
- 2) Gastroenterological population: 159 patients attending the Gastroenterology clinic with complaints of lower bowel dysfunction.
- 3) Urological population: 410 patients attending the Urology clinic with complaints of LUT dysfunction.

## **Materials, parameters and definitions**

All patients completed a validated self-administered bladder and bowel symptom questionnaire in Dutch at the initial visit. This questionnaire was constructed based on the International Consultation on Incontinence Questionnaire (15), the Pelvic Floor Disorders Distress Inventory and the Pelvic Floor Disorders Impact Questionnaire (16), and was updated to the current standards in urology (17) and gastroenterology (18;19). The questionnaire was not designed as a condition-specific outcome measure, but was created to serve a scientific purpose: to assess the prevalence, the characteristics as well as the risk factors of concomitant functional bladder and bowel complaints. An extensive psychometric evaluation has

been published (20). The questionnaire (in Dutch) is available on request at the corresponding author. A signed informed consent was obtained from the control population (EC 7/15/89) (20). Informed consent was obtained from each gastroenterological and urological patient by completion of the questionnaire without signature.

The following possible confounders were evaluated: age, a patient history of pregnancy, vaginal delivery, hysterectomy, and parity.

Based on the reported bowel symptoms, patients were classified as having FC, FI, a combination of both, or, no FC or FI. FC was defined according to the Rome III criteria as reporting at least two symptoms of the following: straining during defecation, evacuation of lumpy or hard stools, sensation of incomplete evacuation, sensation of anorectal blockage, use of manual maneuvers to facilitate defecation, and fewer than three defecations per week (21). FI was defined as the complaint of involuntary loss of feces, solid or liquid (22).

The following LUTS were evaluated, according to the definitions of the International Urogynecological Association and International Continence Society joint report on terminology for female pelvic floor function (22):

- 1) Storage symptoms: daytime and nighttime urinary frequency, urgency, and UI. The cause of UI was also questioned: stress (SUI), urgency (UUI) or both (mixed - MUI).
- 2) Voiding symptoms: hesitancy, straining to void, and intermittency.
- 3) Postmicturition symptoms: need to immediately revoid, and feeling of incomplete emptying

Nocturia was defined as the complaint of interruption of sleep one or more times because of the need to micturate (22). Increased urinary frequency was defined according to the National Institutes of Health definition, and considered present when the patient reported eight or more voids per 24 hours (23).

### **Exclusion criteria and study groups**

In six patients of the female control population missing responses did not allow classification of FC or FI. Furthermore, 32 patients of the control population were classified as having FC, two as having FI and four as having both. These 44 patients were excluded from the study, leaving a control group of 60 patients (CTRL).

Twenty patients from the female gastroenterological population were excluded as missing responses did not allow classification into the study categories. Thirteen other gastroenterological patients could not be classified as having either FC or FI. Finally, one person was excluded due to having more than 50% missing responses. Therefore the gastroenterological study group consisted of 125 patients, divided into three study groups: patients with FC (GCONST), patients with FI (GFINC) or patients with both (GCONFI).

Finally, 53 patients were excluded from the female urological population, as missing responses did not allow classification of these patients into one of the four urological study groups: patients with FC (UCONST), patients with FI (UFINC), patients with both (UCONFI), or, patients with neither FC nor FI (UNONE). Three persons were excluded from this population due to having more than 50% missing responses.

## **Statistical analysis**

Statistical analysis was performed with SPSS V 20 (SPSS Inc., Chicago, IL, USA) for Windows.

All categorical variables were compared between groups by the Pearson Chi Square test. Yate's correction was applied where expected frequencies were less than 5 in a 2X2 contingency table. Unpaired two-sample Student's t-tests or One-Way ANOVA were used to compare continuous variables between two or more study groups respectively. A post-hoc Dunnett's test was used to compare continuous variables between the control groups (CTRL and UNONE) and the other study groups. Finally, OR's and a 95% Confidence Interval (95% CI) for LUTS were calculated in the gastroenterological patients and in the urological patients with gastroenterological complaints.

Due to potential confounders, multivariate analysis (logistic regression) was performed with each of the categorical LUTS questions as dependent variable. A comparison was made between the CTRL group and the gastroenterological subgroups (GCONST, GFINC, GCONFI), and, between the UNONE and the three other urological study groups (UCONST, UFINC, UCONFI). To determine which confounding variables had to be included in the logistic regression models, a backward stepwise technique was used. The significant confounders for each dependent variable were entered in the model together with the dependent variable. An adjusted OR and a 95% CI were estimated to evaluate the correlations.

Statistical significance was set at  $p < 0.05$ .

## RESULTS

### **First study: LUTS in a female control population and in female patients attending a Gastroenterology clinic**

The demographic characteristics of the CTRL and gastroenterological study groups are shown in table I. A history of pregnancy ( $p=0.062$ ) or vaginal delivery ( $p=0.482$ ), and parity ( $p=0.455$ ) did not differ significantly between the CTRL group and all the gastroenterological patients combined. Significantly more gastroenterological patients underwent a hysterectomy than CTRL patients ( $p=0.000$ ). Gastroenterological patients were also significantly older than CTRL patients ( $p=0.008$ ), which was mainly attributable to the higher age of patients with FI (GFINC and GCONFI patients).

A comparison of self-reported LUTS between the CTRL group and the gastroenterological study groups is shown in figure 1. LUTS, apart from hesitancy, were reported significantly more often by all gastroenterological patients combined than by the CTRL group (indicated by # in figure 1). Except for UI, these differences remained significant for the GCONST patients (indicated by \* in figure 1). GFINC patients on the other hand only reported more nocturia and UI in comparison to the CTRL group (indicated by \* in figure 1). Comparing the gastroenterological study groups with each other, there was no significant difference in LUTS between GCONST and GFINC patients, apart from straining to void, which was reported significantly more often by GCONST patients ( $p=0.015$ , indicated by + in figure 1).

The OR's and adjusted OR's for LUTS in gastroenterological patients are presented in table II. A difference between GCONST and GFINC patients can be

noted after logistic regression analysis: in contrast to GFINC patients, GCONST patients have high statistically significant adjusted OR's for voiding and postmicturition LUTS. GFINC patients on the other hand have a high statistically significant adjusted OR for nocturia. Only GCONFI patients have a high statistically significant adjusted OR for urgency and for postmicturition LUTS.

### **Second study: LUTS in female urological patients with or without concomitant gastroenterological complaints**

The demographic characteristics of the four urological study groups are shown in table III. Age ( $p=0.802$ ), a history of pregnancy ( $p=0.466$ ) or vaginal delivery ( $p=0.586$ ), and parity ( $p=0.185$ ) did not differ significantly between UNONE and the other urological study groups combined. However, urological patients with concomitant gastroenterological complaints more often had a history of hysterectomy than UNONE patients ( $p=0.009$ ), which was mainly attributable to the higher prevalence in patients with FI.

A comparison of LUTS occurrence between UNONE and the other urological subgroups is shown in figure 2. Urgency, intermittency and postmicturition LUTS were reported significantly less by UNONE patients than by the urological patients with gastroenterological complaints combined (all  $p<0.01$ , indicated by # in figure 2). For urgency this difference was mainly attributable to patients with FI (UFINC and UCONFI, indicated by \* in figure 2), whereas for intermittency and postmicturition LUTS it was mainly attributable to patients with FC (UCONST and UCONFI, indicated by \* in figure 2). There was no significant difference in LUTS between UCONST and

UFINC patients, apart from urgency which was reported significantly more often by UFINC patients ( $p=0.026$ , indicated by + in figure 2).

There was a significant difference in type of UI between the different urological study groups ( $p=0.030$ ): UNONE and UCONST patients with UI respectively reported 55% and 56% SUI and 30% and 28% UUI. On the other hand, UFINC and UCONFI patients with UI reported 23% and 22% SUI and 54% and 48% UUI respectively.

The OR's and adjusted OR's for LUTS in urological patients with gastroenterological complaints are presented in table IV. A difference between UCONST and UCONFI patients and UFINC patients can be noted after logistic regression analysis: in contrast to UFINC patients, UCONST and UCONFI patients have high statistically significant adjusted OR's for intermittency and for postmicturition LUTS. Only UCONFI patients have a high statistically significant adjusted OR for urgency.

## DISCUSSION

The prevalence of bladder and bowel symptoms in the general population is high (1;2;4;5), and there is increasing evidence that symptoms and disorders of both pelvic organs frequently coincide (6;7;9). This concomitance can further reduce the quality of life in patients (24). As treatment of one organ system can alter the symptoms in the other (13;14), the concomitance of bladder and bowel pathology is clinically relevant and requires further investigation.

In a *first study* we retrospectively described and compared the prevalence of LUTS between a female control population and a population of women consulting a Gastroenterology clinic with complaints of FC, FI, or both. Interestingly, our study showed that storage LUTS, voiding LUTS apart from hesitancy, and postmicturition LUTS were all reported significantly more often by female gastroenterological patients than by the control population.

The reported LUTS in the control population show that it is a good representation of the total population: the prevalence of hesitancy (5%), intermittency (8%) and the feeling of incomplete bladder emptying (5%) is low. The prevalence of some LUTS (increased micturition frequency: 27%, nocturia: 62%, urgency: 32%, UI: 25%) in our control population is high, but comparable to the prevalence in recent large population based studies, the EPIC and the epiLUTS study (1;2). The findings in our control population also confirm that some LUTS are prevalent in non-consulting patients, which should be taken into account when evaluating patients that do consult a Urology or Gastroenterology outpatient clinic. Furthermore, bowel symptoms are also prevalent in non-consulting patients, as 44 patients (42%) of the recruited control

population were classified as having FC, FI or both, and were excluded from the study.

Looking at the specific patient groups, the first study showed that UI and nocturia are significantly more prevalent in gastroenterological patients with FI compared to the control population (55 vs 25% and 91 vs 62% respectively). Both study groups differed in age and history of hysterectomy, which are known risk factors for UI (25). Logistic regression analysis indeed showed that these parameters were significant confounding variables (data not shown), and after adjustment for these parameters only nocturia had an increased OR in gastroenterological patients with FI, as shown in table II.

To our knowledge, few studies have reported the prevalence of LUTS in people with FI. An American community-based study in the elderly reported a prevalence of concurrent UI of 60% in women with FI (7), which is in line with our study. A study in the Netherlands showed an OR of 5.8 for UUI in women with anal incontinence (AI) (26). Most other studies focused on the opposite association and documented a high prevalence of FI in women with UI. No studies could be found that describe the prevalence of other storage LUTS and of voiding and postmicturition LUTS in women with FI.

On the other hand, we found that female gastroenterological patients with FC (with or without FI) more often had an increased urinary frequency, nocturia, urgency, straining to void, intermittency, need to immediately revoid and feeling of incomplete emptying in comparison to the control population. These findings are in line with previous studies (9;13;27;28). After adjustment for the significant confounders, logistic regression analysis showed that the OR's for voiding and postmicturition

symptoms remained increased in constipated patients without FI compared to the control group. The difference in storage symptoms was no longer significant after correction for age, which was the only significant confounder in this analysis (data not shown). Increasing age is indeed a bigger factor for storage symptoms than for voiding and postmicturition LUTS (2).

In a *second study*, we evaluated the influence of FC, FI, or both on self-reported LUTS in women attending a Urology clinic. The demographic data show that 51% of women attending our hospital's Urology clinic meet the criteria for FC and that 13% report FI. The prevalence of FI in our patient population is in line with previous reports (29;30). The prevalence of FC in women attending our Urology clinic on the other hand is higher than in previous studies (36-38%) (29;30).

Urology patients with FI (without FC) more often reported urgency compared to urology patients with FC or without FC and FI. After correction for the significant confounders (age, hysterectomy and vaginal delivery - data not shown), the OR for urgency remained high in patients with FI compared to patients without gastroenterological complaint. We also showed a clear association between the presence of FI and the reported type of UI: patients with FI reported more UUI, whereas patients without FI reported more SUI. To our knowledge, the association between FI and urgency and type of UI has never been studied. However, the opposite relation has been documented, and showed that female urology patients with UUI or MUI have a higher prevalence of FI compared to patients with SUI (6).

FI may be either urgency-related or passive, and both types differ in pathophysiology. It was shown that urgency FI is associated with reduced squeeze pressures and squeeze duration (31;32), external anal sphincter (EAS) defects (31),

reduced rectal capacity and increased perception of rectal balloon distension (32). The lower volume and pressure thresholds for the desire to defecate, and the smaller rectal capacity indicate rectal hypersensitivity (32) which has been associated with urgency FI (33-35). In contrast, passive incontinence (i.e., incontinence without awareness of the desire to defecate) is associated with lower resting pressures (31;32), internal anal sphincter (IAS) defects (31) and rectal hyposensitivity (35;36). Our questionnaire includes a question on the types of FI in patients, allowing differentiation between urgency FI and other types of FI. In the urological patient group, 91% of patients with FI reported urgency as the main cause for FI.

Our study showed that urgency was reported more often by urological patients with FI, and that these patients also reported more UUI. In a previous study it was shown that fecal urgency and FI were reported significantly more often by urological patients with UI related to urgency (UUI and MUI) than by urological patients without (6). Urinary urgency is the pivotal symptom of the overactive bladder (OAB) syndrome (35), which is defined by the presence of urgency, with or without UUI (22). Urinary urgency is a pathological sensation and therefore does not necessarily involve the same mechanisms as those underlying the physiologic desire to void upon bladder filling (35). Two possible mechanisms have been defined for OAB symptoms or urgency: a decreased capacity to handle afferent signals in the brain, or abnormally increased afferent signals from the bladder and/or urethra. Both mechanisms may explain the bladder hypersensitivity found in patients with OAB (37;38).

Hypersensitivity of either the anorectum or the bladder has been shown to be a factor in urgency FI (33-35) and in UUI and MUI (37;38) respectively. The clinical correlation between urgency and UUI, and FI (which is mainly urgency-related in our

study population) therefore elicits the question whether this correlation is not based on a pelvic hypersensitivity syndrome, or on cross-organ sensitization. We believe that further investigation is needed to evaluate this possibility.

Our first study showed an increased prevalence of voiding and postmicturition LUTS in women with FC compared to a control population. Similarly, female urology patients with FC (with or without FI) reported more intermittency, need to immediately revoid and feeling of incomplete emptying compared to patients without gastroenterological complaints. This correlation was unaffected by logistic regression analysis. In contrast to the first study, storage symptoms did not differ between urological patients with and without gastrointestinal symptoms, which may be due to the fact that storage symptoms are inherently high in female urological patients.

Storage symptoms are believed to be correlated with underlying detrusor overactivity. Voiding symptoms and failure to empty on the other hand, can be related to either outlet obstruction or detrusor underactivity of the bladder, or to a combination of both (39). Our findings from both studies therefore suggest that detrusor overactivity as well as impaired detrusor contractility, with or without outlet obstruction, may be frequent in constipated women.

The LUT and anorectum have a common embryological origin, the cloaca. It is therefore not surprising that these pelvic organs have a close anatomical relationship and that a joint central and peripheral innervation coordinates their function of storage and evacuation. It was suggested before that the coincidence of constipation and voiding and postmicturition LUTS can be explained by the proximity of LUT and colorectum (9;40), as distension of the rectum by stool impaction can mechanically press the bladder wall, causing bladder outflow obstruction. However, although

constipation can be caused by mechanical obstruction (e.g. rectocele), it is more often a functional disorder. It was for instance shown that bowel dysfunction may cause overreactivity of the pelvic floor, which can result in dysfunctional elimination of urine (41) through an inappropriate contraction of the puborectalis muscle during micturition (42). In animals on the other hand, colorectal distension has been shown to have an inhibitory effect on bladder contractility, a phenomenon known as the inhibitory recto-vesical reflex (43). This inhibitory reflex may explain the need to strain to void, the intermittent stream, the feeling of incomplete emptying and therefore the need to immediately revoid and increased micturition frequency in constipated patients.

Furthermore, constipated patients frequently have a sensation of incomplete defecation and an urge to defecate, with recurrent defecations as a consequence. These symptoms may be the intestinal parallel of those of LUTS and might have the same pathways through mechanisms such as visceral hypersensitivity or hyper vigilance (9). Colorectal distension was indeed shown to have an excitatory effect on bladder afferent activity in animals (44), which may explain the increase in bladder sensation found in humans (45;46). This increase in afferent activity may in turn explain storage LUTS such as increased urinary frequency and urgency.

Our study has limitations due to its retrospective design, such as selection bias and the presence of missing responses. In our study we excluded patients that could not be categorized in one of the study groups due to missing responses, or that had more than 50% missing responses. The lack of objective testing of the reported symptoms and of the presence and type of urinary incontinence is also a study limitation. Survey questions for UI are thought to correlate poorly with subsequent

urodynamic diagnosis. However a recent review showed that a clinical history was found to have a sensitivity of 0.92 and specificity of 0.56 for diagnosing urodynamic SUI in women and a sensitivity of 0.61 and specificity of 0.87 for diagnosing detrusor overactivity in women (47). A final limitation is the lack of evaluation of pelvic organ prolapse (POP) in our patients. However, determining POP based on self-reported symptoms is difficult because of the lack of specificity and sensitivity of most symptoms attributed to pelvic organ prolapse (48) and the fact that prolapse above the level of the hymeneal ring is usually asymptomatic (49). Furthermore, although the influence of POP on the occurrence of LUTS and constipation has been documented, no relationship was found between the ultrasound diagnosis of POP and the presence of LUTS in constipated women (9).

In conclusion, our study showed that LUTS are reported significantly more often by female gastroenterological patients than by a control population. We also showed that female urological patients with FI report more urgency and more UUI than urological patients without FI. Urological patients with FC on the other hand report more voiding and postmicturition LUTS. Therefore, we suggest that general practitioners, gastroenterologists and urologists should always include the assessment of symptoms of the other pelvic organ system in their patient evaluation. Finally, we hypothesized that the correlations between bowel and LUT symptoms may be explained by underlying neurological mechanisms.

## **ACKNOWLEDGEMENTS**

We want to thank Prof. J. Weyler (department of epidemiology and medical statistics, University of Antwerp) for his advice on the statistical analysis of our data.

## REFERENCES

- (1) Coyne KS, Sexton CC, Thompson CL, Milsom I, Irwin D, Kopp ZS, et al. The prevalence of lower urinary tract symptoms (LUTS) in the USA, the UK and Sweden: results from the Epidemiology of LUTS (EpiLUTS) study. *BJU Int* 2009 Aug;104(3):352-60.
- (2) Irwin DE, Milsom I, Hunskaar S, Reilly K, Kopp Z, Herschorn S, et al. Population-based survey of urinary incontinence, overactive bladder, and other lower urinary tract symptoms in five countries: results of the EPIC study. *Eur Urol* 2006 Dec;50(6):1306-14.
- (3) Kannan H, Radican L, Turpin RS, Bolge SC. Burden of illness associated with lower urinary tract symptoms including overactive bladder/urinary incontinence. *Urology* 2009 Jul;74(1):34-8.
- (4) Nelson RL. Epidemiology of fecal incontinence. *Gastroenterology* 2004 Jan;126(1 Suppl 1):S3-S7.
- (5) Peppas G, Alexiou VG, Mourtzoukou E, Falagas ME. Epidemiology of constipation in Europe and Oceania: a systematic review. *BMC Gastroenterol* 2008;8:5.
- (6) Wyndaele M, De Winter BY, Pelckmans P, Wyndaele JJ. Lower bowel function in urinary incontinent women, urinary continent women and in controls. *Neurourol Urodyn* 2011 Jan;30(1):138-43.
- (7) Roberts RO, Jacobsen SJ, Reilly WT, Pemberton JH, Lieber MM, Talley NJ. Prevalence of combined fecal and urinary incontinence: a community-based study. *J Am Geriatr Soc* 1999 Jul;47(7):837-41.
- (8) Damon H, Schott AM, Barth X, Faucheron JL, Abramowitz L, Siproudhis L, et al. Clinical characteristics and quality of life in a cohort of 621 patients with faecal incontinence. *Int J Colorectal Dis* 2008 Sep;23(9):845-51.
- (9) Carter D, Beer-Gabel M. Lower urinary tract symptoms in chronically constipated women. *Int Urogynecol J* 2012 Dec;23(12):1785-9.
- (10) Alling ML, Lose G, Jorgensen T. Risk factors for lower urinary tract symptoms in women 40 to 60 years of age. *Obstet Gynecol* 2000 Sep;96(3):446-51.
- (11) Cardozo L, Robinson D. Special considerations in premenopausal and postmenopausal women with symptoms of overactive bladder. *Urology* 2002 Nov;60(5 Suppl 1):64-71.
- (12) Kerrigan DD, Lucas MG, Sun WM, Donnelly TC, Read NW. Idiopathic constipation associated with impaired urethrovesical and sacral reflex function. *Br J Surg* 1989 Jul;76(7):748-51.

- (13) Charach G, Greenstein A, Rabinovich P, Groskopf I, Weintraub M. Alleviating constipation in the elderly improves lower urinary tract symptoms. *Gerontology* 2001 Mar;47(2):72-6.
- (14) Bael AM, Benninga MA, Lax H, Bachmann H, Janhsen E, De Jong TP, et al. Functional urinary and fecal incontinence in neurologically normal children: symptoms of one 'functional elimination disorder'? *BJU Int* 2007 Feb;99(2):407-12.
- (15) Abrams P, Avery K, Gardener N, Donovan J. The International Consultation on Incontinence Modular Questionnaire: [www.iciq.net](http://www.iciq.net). *J Urol* 2006 Mar;175(3 Pt 1):1063-6.
- (16) Barber MD, Kuchibhatla MN, Pieper CF, Bump RC. Psychometric evaluation of 2 comprehensive condition-specific quality of life instruments for women with pelvic floor disorders. *Am J Obstet Gynecol* 2001 Dec;185(6):1388-95.
- (17) Donovan J, Bosch R, Gotoh M, Jackson S, Naughton M, Radley S, et al. Symptom and Quality of Life Assessment. In: Abrams P, Cardozo L, Khoury S, Wein A, editors. *Incontinence*. 3 ed. Paris: Editions 21; 2005. p. 519-84.
- (18) Bharucha AE, Wald A, Enck P, Rao S. Functional anorectal disorders. *Gastroenterology* 2006 Apr;130(5):1510-8.
- (19) Longstreth GF, Thompson WG, Chey WD, Houghton LA, Mearin F, Spiller RC. Functional bowel disorders. *Gastroenterology* 2006 Apr;130(5):1480-91.
- (20) Wyndaele M, De Winter BY, Van Roosbroeck S, Van Outryve M, De Wachter S, Van Hal G, et al. Development and psychometric evaluation of a dutch questionnaire for the assessment of anorectal and lower urinary tract symptoms. *Acta Gastroenterol Belg* 2011 Jun;74(2):295-303.
- (21) Longstreth GF, Thompson WG, Chey WD, Houghton LA, Mearin F, Spiller RC. Functional bowel disorders. *Gastroenterology* 2006 Apr;130(5):1480-91.
- (22) Haylen BT, de Ridder D, Freeman RM, Swift SE, Berghmans B, Lee J, et al. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for female pelvic floor dysfunction. *Neurourol Urodyn* 2010;29(1):4-20.
- (23) Weber AM, Abrams P, Brubaker L, Cundiff G, Davis G, Dmochowski RR, et al. The standardization of terminology for researchers in female pelvic floor disorders. *Int Urogynecol J Pelvic Floor Dysfunct* 2001;12(3):178-86.
- (24) Fialkow MF, Melville JL, Lentz GM, Miller EA, Miller J, Fenner DE. The functional and psychosocial impact of fecal incontinence on women with urinary incontinence. *Am J Obstet Gynecol* 2003 Jul;189(1):127-9.
- (25) Milsom I, Altman D, Cartwright R, Lapitan MC, Nelson R, Sillen U, et al. Epidemiology of Urinary Incontinence (UI) and Lower Urinary Tract Symptoms (LUTS), Pelvic Organ Prolapse (POP) and Anal Incontinence (AI). In: Abrams

- P, Cardozo L, Khoury S, Wein A, editors. Incontinence. 5 ed. ICUD-EAU; 2013. p. 15-108.
- (26) Slieker-Ten Hove MC, Pool-Goudzwaard AL, Eijkemans MJ, Steegers-Theunissen RP, Burger CW, Vierhout ME. Prevalence of double incontinence, risks and influence on quality of life in a general female population. *Neurourol Urodyn* 2010 Apr;29(4):545-50.
- (27) Cameron A, Fenner DE, DeLancey JO, Morgan DM. Self-report of difficult defecation is associated with overactive bladder symptoms. *Neurourol Urodyn* 2010 Sep;29(7):1290-4.
- (28) Klingele CJ, Lightner DJ, Fletcher JG, Gebhart JB, Bharucha AE. Dysfunctional urinary voiding in women with functional defecatory disorders. *Neurogastroenterol Motil* 2010 Oct;22(10):1094-e284.
- (29) Jelovsek JE, Barber MD, Paraiso MF, Walters MD. Functional bowel and anorectal disorders in patients with pelvic organ prolapse and incontinence. *Am J Obstet Gynecol* 2005 Dec;193(6):2105-11.
- (30) Manonai J, Wattanayingcharoenchai R, Sarit-Apirak S, Vannatim N, Chittacharoen A. Prevalence and risk factors of anorectal dysfunction in women with urinary incontinence. *Arch Gynecol Obstet* 2010 Jun;281(6):1003-7.
- (31) Engel AF, Kamm MA, Bartram CI, Nicholls RJ. Relationship of symptoms in faecal incontinence to specific sphincter abnormalities. *Int J Colorectal Dis* 1995;10(3):152-5.
- (32) Bharucha AE, Fletcher JG, Harper CM, Hough D, Daube JR, Stevens C, et al. Relationship between symptoms and disordered continence mechanisms in women with idiopathic faecal incontinence. *Gut* 2005 Apr;54(4):546-55.
- (33) Chan CL, Scott SM, Williams NS, Lunniss PJ. Rectal hypersensitivity worsens stool frequency, urgency, and lifestyle in patients with urge fecal incontinence. *Dis Colon Rectum* 2005 Jan;48(1):134-40.
- (34) Chan CL, Lunniss PJ, Wang D, Williams NS, Scott SM. Rectal sensorimotor dysfunction in patients with urge faecal incontinence: evidence from prolonged manometric studies. *Gut* 2005 Sep;54(9):1263-72.
- (35) Koelbl H, Igawa T, Salvatore S, Laterza RM, Lowry AC, Sievert KD, et al. Pathophysiology of Urinary Incontinence, Faecal Incontinence and Pelvic Organ Prolapse. In: Abrams P, Cardozo L, Khoury S, Wein A, editors. *Incontinence*. 5 ed. 2013. p. 261-359.
- (36) Burgell RE, Scott SM. Rectal hyposensitivity. *J Neurogastroenterol Motil* 2012 Oct;18(4):373-84.

- (37) Yamaguchi O, Honda K, Nomiya M, Shishido K, Kakizaki H, Tanaka H, et al. Defining overactive bladder as hypersensitivity. *Neurourol Urodyn* 2007 Oct;26(6 Suppl):904-7.
- (38) Lee SR, Kim HJ, Kim A, Kim JH. Overactive bladder is not only overactive but also hypersensitive. *Urology* 2010 May;75(5):1053-9.
- (39) Chapple CR, Wein AJ, Abrams P, Dmochowski RR, Giuliano F, Kaplan SA, et al. Lower urinary tract symptoms revisited: a broader clinical perspective. *Eur Urol* 2008 Sep;54(3):563-9.
- (40) Averbeck MA, Madersbacher H. Constipation and LUTS - How do they affect each other? *Int Braz J Urol* 2011 Jan;37(1):16-28.
- (41) De Paepe H, Renson C, Van Laecke E, Raes A, Vande Walle J, Hoebeke P. Pelvic-floor therapy and toilet training in young children with dysfunctional voiding and obstipation. *BJU Int* 2000 May;85(7):889-93.
- (42) Thorpe AC, Williams NS, Badenoch DF, Blandy JP, Grahn MF. Simultaneous dynamic electromyographic proctography and cystometrography. *Br J Surg* 1993 Jan;80(1):115-20.
- (43) Wyndaele M, De Wachter S, De Man J, Minagawa T, Wyndaele JJ, Pelckmans PA, et al. Mechanisms of pelvic organ crosstalk: 1. Peripheral modulation of bladder inhibition by colorectal distention in rats. *J Urol* 2013 Aug;190(2):765-71.
- (44) Minagawa T, Wyndaele M, Aizawa N, Igawa Y, Wyndaele JJ. Mechanisms of pelvic organ cross-talk: 2. Impact of colorectal distention on afferent nerve activity of the rat bladder. *J Urol* 2013 Sep;190(3):1123-30.
- (45) De Wachter S, Wyndaele JJ. Impact of rectal distention on the results of evaluations of lower urinary tract sensation. *J Urol* 2003 Apr;169(4):1392-4.
- (46) Panayi DC, Khullar V, Digesu GA, Spiteri M, Hendricken C, Fernando R. Rectal distension: the effect on bladder function. *Neurourol Urodyn* 2011 Mar;30(3):344-7.
- (47) Martin JL, Williams KS, Abrams KR, Turner DA, Sutton AJ, Chapple C, et al. Systematic review and evaluation of methods of assessing urinary incontinence. *Health Technol Assess* 2006 Feb;10(6):1-iv.
- (48) Ellerkmann RM, Cundiff GW, Melick CF, Nihira MA, Leffler K, Bent AE. Correlation of symptoms with location and severity of pelvic organ prolapse. *Am J Obstet Gynecol* 2001 Dec;185(6):1332-7.
- (49) Lukacz ES, Lawrence JM, Buckwalter JG, Burchette RJ, Nager CW, Luber KM. Epidemiology of prolapse and incontinence questionnaire: validation of a new epidemiologic survey. *Int Urogynecol J Pelvic Floor Dysfunct* 2005 Jul;16(4):272-84.

## TABLES

TABLE I: Demographic data of control and gastroenterological patients with functional constipation, fecal incontinence, or both

	<b>CTRL</b>	<b>GCONST</b>	<b>GFINC</b>	<b>GCONFI</b>
N	60	69	22	34
Age (years)	47.51 ± 12.23	50.13 ± 15.92	<b>62.05 ± 11.31 *</b>	<b>55.74 ± 14.86 *</b>
Pregnancy	69%	77%	89%	87%
Parity (number)	2.18 ± 0.90	1.96 ± 1.06	2.29 ± 0.77	2.04 ± 0.85
Vaginal delivery	65%	65%	77%	74%
Hysterectomy	0%	<b>44% #</b>	<b>55% #</b>	<b>29% #</b>

TABLE II: Odds ratios and adjusted odds ratios for lower urinary tract symptoms in gastroenterological patients with functional constipation, with fecal incontinence, or with both, compared to a control population

	GCONST		GFINC		GCONFI	
	OR (95% CI)	Adj. OR (95% CI)	OR (95% CI)	Adj. OR (95% CI)	OR (95% CI)	Adj. OR (95% CI)
Increased urinary frequency	2.4 (1.2 – 5.2)	1.7 (0.7 - 4.6)	2.1 (0.7 – 5.8)	3.0 (0.6 - 15.3)	2.0 (0.8 – 5.0)	1.4 (0.4 - 4.9)
Nocturia	2.9 (1.3 – 6.4)	2.2 (0.7 - 6.5)	5.9 (1.3 – 27.8)	<b>9.1* (1.0 - 79.0)</b>	5.8 (1.6 – 21.3)	3.6 (0.8 - 16.7)
Urgency	2.9 (1.4 – 6.1)	1.9 (0.7 - 5.2)	1.9 (0.7 – 5.3)	1.8 (0.2 - 15.1)	2.7 (1.1 – 6.6)	<b>5.8* (1.2 - 27.1)</b>
Urinary incontinence	2.1 (1.0 – 4.4)	1.4 (0.5 - 4.2)	3.6 (1.3 – 10.0)	2.4 (0.3 - 17.1)	3.0 (1.2 – 7.3)	2.9 (1.0 - 8.7)
Hesitancy	2.9 (0.8 – 11.3)	/	1.0 (0.1 – 10.2)	/	4.4 (1.0 – 18.9)	/
Straining to void	3.1 (1.4 – 7.1)	<b>10.3* (2.7 - 39.9)</b>	0.5 (0.1 – 2.7)	2.9 (0.4 - 21.3)	2.8 (1.1 – 7.2)	3.0 (0.8 - 11.6)
Intermittency	4.3 (1.3 – 13.9)	<b>5.5* (1.1 - 27.1)</b>	3.1 (0.6 – 15.6)	1.2 (0.1 - 14.2)	7.4 (2.0 – 27.3)	4.8 (0.8 - 28.5)
Need to immediately revoid	2.5 (1.1 – 5.9)	<b>3.7* (1.1 - 12.6)</b>	1.2 (0.3 – 4.5)	2.1 (0.4 – 10.0)	3.6 (1.4 – 9.5)	<b>3.8* (1.0 - 14.5)</b>
Feeling of incomplete emptying	6.0 (1.6 – 21.7)	<b>10.5* (1.3 - 85.7)</b>	3.2 (0.6 – 17.1)	1.8 (0.1 - 30.9)	6.8 (1.7 – 27.4)	<b>12.0* (1.4 - 10.3)</b>

TABLE III: Demographic data of urological patients without gastroenterological complaints, with functional constipation, with fecal incontinence or with both functional constipation and fecal incontinence

	<b>UNONE</b>	<b>UCONST</b>	<b>UFINC</b>	<b>UCONFI</b>
N	157	151	17	29
Age (years)	53.88 ± 17.18	51.81 ± 16.69	61.13 ± 14.22	<b>64.18 ± 14.51 *</b>
Pregnancy	82%	76%	80%	93%
Parity (number)	2.43 ± 1.21	2.20 ± 1.16	2.58 ± 1.08	2.28 ± 1.21
Vaginal delivery	73%	65%	65%	79%
Hysterectomy	26%	34%	<b>53% #</b>	<b>55% #</b>

TABLE IV: Odds ratios and adjusted odds ratios for lower urinary tract symptoms in urological patients with functional constipation, with fecal incontinence, or with both, compared to a urological population without gastroenterological complaints through logistic regression analysis

	UCONST		UFINC		UCONFI	
	OR (95% CI)	Adj. OR (95% CI)	OR (95% CI)	Adj. OR (95% CI)	OR (95% CI)	Adj. OR (95% CI)
Increased urinary frequency	1.0 (0.6 – 1.6)	1.4 (0.8 - 2.6)	0.8 (0.3 – 2.4)	0.6 (0.2 - 2.2)	1.7 (0.6 – 4.4)	3.5 (1.0 - 12.6)
Nocturia	1.3 (0.1 – 2.7)	2.1 (0.8 - 5.6)	2.5 (0.3 – 20.3)	1.5 (0.2 - 12.8)	/	/
Urgency	1.6 (1.0 – 2.5)	1.8 (1.0 - 3.2)	11.8 (1.5 – 91.4)	8.5 (1.0 - 74.4)	10.0 (2.3 – 43.4)	<b>11.2* (2.3 - 54.7)</b>
Urinary incontinence	0.8 (0.5 – 1.3)	0.9 (0.5 - 1.7)	1.4 (0.4 – 4.4)	0.6 (0.2 - 2.2)	2.0 (0.7 – 5.6)	1.2 (0.4 - 3.6)
Hesitancy	1.4 (0.8 – 2.5)	1.4 (0.7 - 2.7)	1.1 (0.3 – 4.1)	2.4 (0.6 - 10.3)	2.3 (1.0 – 5.5)	2.5 (1.0 - 6.8)
Straining to void	1.5 (1.0 – 2.5)	1.3 (0.7 - 2.4)	1.3 (0.4 – 3.6)	1.4 (0.4 - 5.2)	0.7 (0.3 – 1.9)	0.8 (0.3 - 2.5)
Intermittency	3.6 (2.1 – 6.0)	<b>3.6* (1.9 - 6.8)</b>	2.3 (0.7 – 7.9)	3.0 (0.7 - 12.7)	3.8 (1.6 – 9.1)	<b>3.6* (1.3 - 9.7)</b>
Need to immediately revoid	2.2 (1.4 – 3.5)	<b>2.2* (1.2 - 4.0)</b>	0.8 (0.3 – 2.4)	1.2 (0.3 - 4.6)	4.0 (1.6 – 9.7)	<b>2.9* (1.1 - 8.1)</b>
Feeling of incomplete emptying	1.9 (1.2 – 3.0)	<b>2.2* (1.2 - 4.0)</b>	1.4 (0.5 – 4.2)	2.9 (0.8 - 10.9)	4.1 (1.7 – 9.6)	<b>4.8* (1.8 - 12.7)</b>

## TABLE LEGENDS

TABLE I: Demographic data of control and gastroenterological patients with functional constipation, fecal incontinence, or both

CTRL = control population; GCONST = gastroenterological patients with functional constipation; GFINC = gastroenterological patients with fecal incontinence; GCONFI = gastroenterological patients with both functional constipation and fecal incontinence; N = number of patients; **BOLD** and \* =  $p < 0.05$  and indicates a significant difference from the CTRL group (One-Way ANOVA with post-hoc Dunnett's); **BOLD** and # =  $p < 0.05$  and indicates a significant difference from the CTRL group (Pearson Chi Square test)

TABLE II: Odds ratios and adjusted odds ratios for lower urinary tract symptoms in gastroenterological patients with functional constipation, with fecal incontinence, or with both, compared to a control population

OR = odds ratio; Adj. OR = adjusted odds ratio; 95% CI = 95% confidence interval; CTRL = control population; GCONST = gastroenterological patients with functional constipation; GFINC = gastroenterological patients with fecal incontinence; GCONFI = gastroenterological patients with both functional constipation and fecal incontinence; **BOLD** and \* =  $p < 0.05$  and indicates a significant difference from the CTRL group (logistic regression analysis); / = was not calculated due to the low prevalence of hesitancy

TABLE III: Demographic data of urological patients without gastroenterological complaints, with functional constipation, with fecal incontinence or with both functional constipation and fecal incontinence

UNONE = urological patients without functional constipation or fecal incontinence; UCONST = urological patients with functional constipation; UFINC = urological patients with fecal incontinence; UCONF1 = urological patients with both functional constipation and fecal incontinence; N = number of patients; **BOLD** and \* =  $p \leq 0.05$  and indicates a significant difference from the UNONE group (One-Way ANOVA with post-hoc Dunnett's); **BOLD** and # =  $p \leq 0.05$  and indicates a significant difference from the UNONE group (Pearson Chi Square test)

TABLE IV: Odds ratios and adjusted odds ratios for lower urinary tract symptoms in urological patients with functional constipation, with fecal incontinence, or with both, compared to a urological population without gastroenterological complaints through logistic regression analysis

OR = odds ratio; Adj. OR = adjusted odds ratio; 95% CI = 95% confidence interval; UNONE = urological patients without functional constipation or fecal incontinence; UCONST = urological patients with functional constipation; UFINC = urological patients with fecal incontinence; UCONF1 = urological patients with both functional constipation and fecal incontinence; **BOLD** and \* =  $p < 0.05$  and indicates a significant difference from the UNONE group (logistic regression); / = was not calculated due to the high prevalence of nocturia

## **FUNDING**

This study was supported by FWO (Fonds Wetenschappelijk Onderzoek Vlaanderen/ Research Foundation – Flanders). It provided the salary of Michel Wyndaele, a doctoral student.