

Functional Balance and Gait Characteristics in Men With Lower Urinary Tract Symptoms Secondary to Benign Prostatic Hyperplasia

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Abstract

The purpose of this cross-sectional study was to compare gait characteristics and functional balance abilities in men with LUTS secondary to benign prostatic hyperplasia (BPH) to those of community-dwelling older adults under different conditions of increasing difficulties, and to aid health-care providers to identify those patients with decreased level of activity and increased risk of falls. We recruited a group of 43 men diagnosed with symptomatic BPH and a control group of 38 older men. Participants performed the timed up and go and 10-m walking tests under different conditions—namely, single task, dual-task motor, and dual-task cognitive. Time to complete the tests and spatial and temporal gait parameters were compared between groups and conditions via mixed-design ANOVA. Under dual-task conditions, individuals in both groups performed significantly worse compared to the single functional balance and walking tasks. As the complexity of the walking task increased—from dual-task motor to dual-task cognitive—significant differences between groups emerged. In particular, men with BPH performed worse than older adults in tasks demanding increased attentional control. Results suggest that dual-task decrements in functional balance and gait might explain decreased level of physical activity and increased risk of falls reported in men with LUTS. Health-care providers for men with LUTS due to BPH should assess for abnormal gait and remain vigilant for balance problems that may lead to decreased mobility and falls. The dual-task approach seems a feasible method to distinguish gait and balance impairments in men with BPH.

Keywords

BPH, LUTS, older adults, gait, dual task, physical activity

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Benign prostatic hyperplasia (BPH) is one of the most common and devastating diseases in men worldwide. Up to 50% of men exhibit evidence of BPH by the age of 50 years, and by the eighth decade of life this number surpasses 80% (Chughtai et al., 2016). Given the aging population worldwide, an overall increase in the rates of BPH is inevitable (Vuichoud & Loughlin, 2015); therefore health-care providers must be able to recognize and manage BPH and its complications accordingly.

BPH is characterized by benign proliferation of the epithelial and stromal components of the prostate (Chughtai et al., 2016). This benign overgrowth pushes against the urethra and the bladder, causing increased

bladder outlet resistance (Kim, Larson, & Andriole, 2016; Sarma & Wei, 2012), and consequently the development

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of lower urinary tract symptoms (LUTS; Parsons, Sarma, McVary, & Wei, 2013). Therefore, BPH and LUTS become inextricable in managing older men with urinary symptoms (Kim et al., 2016).

While the exact mechanism for the development of BPH remains obscure (Kim et al., 2016), LUTS associated with BPH can be attributed to at least two mechanisms (Chughtai et al., 2016; Kim et al., 2016; Sarma & Wei, 2012). The first component is due to a static urethral obstruction caused by the increased epithelial tissue. The second is a dynamic component due to increased smooth muscle tone and resistance, which are determined by autonomic nervous system activity. Essentially, several lines of basic and clinical evidence point to the role of autonomic nervous system over activation in LUTS secondary to BPH (Choi, Lee, & Kim, 2010; Kim et al., 2016; McVary, Rademaker, Lloyd, & Gann, 2005; Platz et al., 1998).

BPH and associated LUTS have been linked to an increased risk of falls, decreased quality of life, impaired activity of daily living, and depression and sadness (Kim et al., 2016; Parsons et al., 2013; Sarma & Wei, 2012). Accumulating evidence suggests that modifiable metabolic and lifestyle factors are important in the etiology of BPH and LUTS including obesity, diabetes, diet and physical activity (Mongiu & McVary, 2009; Parsons et al., 2013; Raheem & Parsons, 2014). Physical activity of various intensities, including walking, has been reported not only to reduce BPH risk (Parsons & Kashefi, 2008; Platz et al., 1998), but also to delay its diagnosis and improve LUTS management (Park, Park, Chang, & Ryu, 2018; Wolin et al., 2015), presumably by decreasing autonomic nervous system over activation (Platz et al., 1998) and/or improving cardiovascular health (Parsons & Kashefi, 2008).

Walking is the most commonly reported mode of physical activity among the general population (Ham, Kruger, & Tudor-Locke, 2009). However, a large proportion of falls among older adults occurs during walking (Robinovitch et al., 2013; Stevens, Mahoney, & Ehrenreich, 2014). Therefore, it is important to consider gait and balance concerns when making treatment recommendations for older adults with BPH and LUTS. Physicians and health-care providers need to be aware of, and remain vigilant for, increasing falls risk and mobility impairment that may emerge from treatments including medications, bed rest, and occasional catheterization (Hsieh, Fleegle, & Arenson, 2014).

In line with this premise, gait and walking speed reflect health, well-being, and morbidity (Juen, Cheng, Prieto-Centurion, Krishnan, & Schatz, 2014; Studenski et al., 2011), with gait characteristics having been reported to predict fall (van Schooten et al., 2015; Weiss et al., 2013) and differentiate fallers from non-fallers (Howcroft, Kofman, & Lemaire, 2013; Rispen et al., 2015; Toebe,

Hoozemans, Furrer, Dekker, & van Dieen, 2012). For example, gait has been increasingly used to monitor individuals with various disorders affecting neurological, cardiovascular, metabolic, and musculoskeletal systems (Cimolin et al., 2011; Esser et al., 2018; Juen et al., 2014; Kuate-Tegueu et al., 2017; Michael, Allen, & Macko, 2005; Valkanova et al., 2018; Zago et al., 2018). In community-dwelling men, LUTS have been suggested to be a potential risk factor for falls (Soliman, Meyer, & Baum, 2016). This notion is supported by indirect evidence associating urgency, frequency, nocturia, and incontinence with increased likelihood of falls in the elderly (de Rekeneire et al., 2003; Soliman et al., 2016; Tromp et al., 2001). To date, no study has investigated gait characteristics in men with BPH and LUTS.

An increasingly utilized approach to measure gait and balance within a clinical context is the dual-task methodology (Belghali, Chastan, Cignetti, Davenne, & Decker, 2017; Fino et al., 2018). That is to assess gait or balance while performing an additional motor or cognitive task, where associated performance deficits are termed dual-task interference. The rationale behind this relatively simple approach is two-fold (Al-Yahya et al., 2011): balance and gait are not pure automatic motor activities; rather they require cognitive resources, and purposeful everyday balance and gait activities commonly involve cognitive components such as remembering a shopping list or attending to a conversation. In fact, experimental studies have consistently reported that dual-task related balance and gait deficits increase with age (Al-Yahya et al., 2011), and poor dual-task performance can predict falls (Beauchet et al., 2008, 2009). These deficits have been associated with the walking task, complexity of the additional task, and individual's age and balance capability (Al-Yahya et al., 2011; Shumway-Cook & Woolacott, 2000). The main purpose of this study was to explore functional balance and gait characteristics in men with LUTS secondary to BPH while performing under conditions of different complexities. This would aid health-care providers in identifying those patients with decreased level of activity and increased risk of falls. The first research hypothesis was that an additional motor or cognitive task would compromise motor performance in functional balance and walking activities in older males with or without BPH. Considering the observation that increased autonomic nervous system activity has been linked to performance deficits during challenging walking tasks (Clark, Rose, Ring, & Porges, 2014), which also corresponds to individual's functioning level (Chatterjee et al., 2018), it was hypothesized second that men with BPH and LUTS would exhibit marked functional balance and gait deviations when compared to community-dwelling older adults, and these deviations become more prominent under more challenging conditions.

Subjects and Methods

In this cross-sectional experimental study, gait characteristics and functional balance in men diagnosed with BPH were compared to those in community-dwelling older men. In total, 81 men participated in this study from August 2015 to June 2017 in Amman, Jordan. The study conforms to the ethical principles of the Declaration of Helsinki and the institutional review board of the Jordan University Hospital reviewed and approved the protocol (10/2015/1186). All participants gave written informed consent prior to participation.

Participants

Forty-three men diagnosed with BPH and 38 community-dwelling older men participated in this study. Participants with BPH were recruited from the outpatient urology clinic of the Jordan University hospital. Inclusion criteria for the BPH group were (a) adult males diagnosed with moderate to severe LUTS secondary to BPH as confirmed by a senior urologist; (b) able to give informed consent; (c) able to walk independently for at least 5 min with or without a walking aid; and (d) with no cognitive, sensory, or psychological impairments precluding full engagement with experimental paradigm. LUTS secondary to BPH diagnosis was based on relevant medical history, physical examination including digital rectal exam, assessment of symptoms severity via the Arabic version of the International Prostate Symptom Score (IPSS; Hammad & Kaya, 2010), and urodynamics including uroflowmetry and post-void residuals (Abrams, Chapple, Khoury, Roehrborn, & de la Rosette, 2009), as well as prostate size via ultrasonography.

Community-dwelling older men were recruited from shopping malls, local community centers, and personal contact. Older adults (a) were 60 or more years old and able to give informed consent; (b) able to walk independently for at least 5 min with or without an aid; (c) did not report a history of neurological and/or psychiatric illness; and (d) showed no cognitive, sensory, or psychological impairments precluding full engagement with experimental paradigm.

Procedure

Demographic data of age, weight, height, as well as level of education for all participants were obtained and recorded. The Arabic version of the SF-36 health survey (Sabbah, Drouby, Sabbah, Retel-Rude, & Mercier, 2003) was utilized to assess participants' health-related quality of life. Because the experimental procedures involved a cognitive component, participants' global cognitive function was also assessed using the Arabic version of the

Mini-Mental State Examination (MMSE; Al-Rajeh, Ogunniyi, Awada, Daif, & Zaidan, 1999).

Then different gait parameters were assessed by a modified version of the 10-m walk test (Graham, Ostir, Fisher, & Ottenbacher, 2008; Wade, Wood, Heller, Maggs, & Langton Hewer, 1987) for both groups. Participants completed the 10-m long path at their preferred speed in single task (ST) and under dual-task (DT)-motor and DT-cognitive conditions. During DT walking conditions, participants walked either while carrying a cup of water (DT-motor), or while counting backward by 2s, 3s, or 7s (based on their own preference) from a two- or three-digit number (DT-cognitive). The instructions before ST and DT trials were standardized for all participants and they were not given advice as to which task to prioritize during DT-counting while they were instructed to "try not to spill water" under DT-motor conditions. Gait spatial and temporal parameters were measured by using an inertial measurement unit (IMU) comprising a triaxial accelerometer, gyroscope, and magnetometer (MTx, Xsens, AN Enschede, the Netherlands) that was attached over the skin of the fourth lumbar vertebra (Esser, Dawes, Collett, & Howells, 2009) corresponding to the participant's projected center of mass during walking (Kerrigan, Vramontes, Corcoran, & LaRaia, 1995).

Participants' functional balance was evaluated using the Timed Up and Go (TUG) test (Podsiadlo & Richardson, 1991). In this test, the time (in seconds) required to stand up from an armed-chair, walk 3 m, turn, walk back and sit down again at preferred speed was measured using a stopwatch. Similar to the 10-m walk test, the time to complete the task was recorded in ST condition and two DT conditions; TUG-motor (i.e., while carrying a cup) and TUG-cognitive (i.e., while counting backward).

Each of the walking and functional balance tasks was repeated twice in a pseudo-random order, and for each related outcome the average of the two trials was considered for further analysis. So as to account for the probable effect of desire to void on gait functions (Booth, Paul, Rafferty, & Macinnes, 2013), LUTS/BPH patients were evaluated either when they did not report a strong desire to void or post void. Counting backward performance was assessed by rate (enumerated numbers per minute) and accuracy (percentage of correct answers).

Data Processing and Statistical Analysis

Postprocessing and analysis of the IMU was performed using a customized program written in LabVIEW version 15f (National Instruments, Austin, TX, USA) (Esser et al., 2009). Spatial and temporal gait parameters were then estimated according to the inverted pendulum gait model (Gonzalez, Alvarez, Lopez, & Alvarez, 2007; Zijlstra,

Table 1. Participants' Demographics.

	BPH/LUTS N = 43 (Mean \pm SD)	Older adults N = 38 (Mean \pm SD)	Independent sample t-test	
			t	Sig. (2-tailed)
Age	64.6 \pm 11.5	69.7 \pm 6.1	2.540	.013
Height (m)	1.71 \pm 0.07	1.71 \pm 0.06	0.018	.986
Weight (kg)	84.3 \pm 13.2	83.5 \pm 11.1	-0.295	.768
Number of medications	4.14 \pm 2.59	2.39 \pm 2.15	-3.275	.002
MMSE	27.5 \pm 2.4	27.7 \pm 1.9	-0.373	.710
SF-36				
Physical functioning	76.3 \pm 20.5	78.7 \pm 14.7	-0.612	.550
Role functioning/physical	20.3 \pm 34.2	73.7 \pm 38.1	-6.598	<.001
Role functioning/emotional	28.7 \pm 42.2	92.1 \pm 21.1	-8.706	<.001
Energy/fatigue	59.3 \pm 18.7	74.6 \pm 14.9	-4.083	<.001
Emotional well-being	71.0 \pm 18.3	84.8 \pm 13.5	-3.866	<.001
Social functioning	82.6 \pm 21.2	89.5 \pm 16.6	-1.647	.104
Pain	76.9 \pm 22.6	77.4 \pm 24.5	-0.098	.922
General health	60.1 \pm 16.5	64.3 \pm 19.7	-1.048	.298
Health change	56.4 \pm 22.6	51.9 \pm 21.3	0.908	.367

Note. BPH = benign prostatic hyperplasia; LUTS = lower urinary tract symptoms; MMSE = Mini-Mental State Examination. Significant *p* values at a prior .05 alpha are in bold.

2004). For the purpose of this analysis, the following parameters (Whittle, 2008) were measured during the 10-m walk test: step time, defined as the time in milliseconds from ground contact of one foot to consecutive ground contact of the other foot; stride length, defined as the distance in meters between ground contact of one foot to subsequent ground contact of the same foot; and cadence, defined as number of steps per minute. Variability for each of these parameters was measured by the standard deviation.

Statistical analysis was performed using IBM SPSS Statistics (version 25 IBM SPSS, Inc, Armonk, NY, USA). Behavioral and demographic data were compared by independent samples *t*-tests. Gait and balance data were analyzed by conducting a mixed-design (i.e., a mixture of between-group and repeated measures) analysis of variance (ANOVA), with task (three levels; ST, DT-motor, and DT-cognitive) as the independent within-subject's variable for each parameter separately, and participants' group (older adults vs. patients) as the between-subject factor. In order to account for individuals' variances at baseline age, number of medications and counting rate—since some individuals preferred to count backward by 3 s while others by 7 s—were entered as “covariates” to the ANOVA model. All further analyses and pairwise comparisons were performed on adjusted values for these covariates. For all statistical tests, alpha level was set at .05 a priori, and SPSS-generated Bonferroni adjusted *p* values are quoted.

Results

Groups' Baseline Characteristics

A total of 43 male patients with LUTS secondary to BPH who fulfilled the inclusion criteria, and 38 older men were evaluated. Table 1 summarizes participants' demographics, MMSE scores, and SF-36 scores in different domains. There was no significant difference in MMSE scores between groups, and all participants scored above the cut-off point of 24 suggesting no cognitive impairment (Crum, Anthony, Bassett, & Folstein, 1993). Patients with BPH were significantly younger, took more medications, and reported worse health-related quality of life as opposed to older adults in the following scales: role limitations due to physical health, role limitations due to emotional problems, energy or fatigue, and emotional well-being.

Table 2 summarizes clinical details of BPH patients with LUTS. Based on total IPSS scores, a majority of the patients (67.5%) reported severe symptoms. All patients were on alpha-blockers either alone (53%), in addition to 5-alpha reductase inhibitors (32.5%), or in addition to anticholinergics (14%). Only one patient was on the three medications.

Group and Task Effects on Functional Balance and Walking Time

Differences between LUTS/BPH patients and older adults in functional balance capability (i.e., TUG) and gait speed

Table 2. Patients With LUTS Details.

LUTS onset in months, ^a mean \pm SD	18.9 \pm 12.2
IPSS questionnaire	
Mean \pm SD	22 \pm 6
Median (Min–Max)	21 (8–33)
Moderate symptoms, N (%)	14 (32.5)
Severe symptoms, N (%)	29 (67.5)
LUTS/BPH medications	
Alpha-blockers, N (%)	43 (100)
5-Alpha reductase inhibitors, N (%)	14 (32.5)
Anticholinergics, N (%)	6 (14)
Urodynamics and ultrasonography	
Pre-void volume (ml), mean \pm SD (Min–Max)	385 \pm 152 (109–650)
Post void residual (ml), mean \pm SD (Min–Max)	105 \pm 69 (0–265)
Q-Max (ml/s), mean \pm SD (Min–Max)	14 \pm 4 (8–34)
Prostate size (ml), mean \pm SD (Min–Max)	56 \pm 14 (26–80)

Note. BPH = benign prostatic hyperplasia; LUTS = lower urinary tract symptoms; IPSS = International Prostate Symptom Score.

^aBased on their initial visit to JUH urology clinic.

Table 3. Functional Balance (TUG) and Gait Time (10 m).

	BPH/LUTS (N = 43)			Older adults (N = 38)			<i>p</i> for ANOVA results		
	Mean \pm SD			Mean \pm SD			Task	Group	Interaction
	ST	DT _{-motor}	DT _{-cognitive}	ST	DT _{-motor}	DT _{-cognitive}			
TUG (second)	12.1 \pm 2.7	12.7 \pm 3	15.3 \pm 4.3	11.1 \pm 2.7	13.5 \pm 3.7	14.4 \pm 4	.509	.684	.017
10 m (second)	9.8 \pm 1.9	9.9 \pm 2.3	13.2 \pm 4.2	9.7 \pm 2.1	10.3 \pm 2.4	11.2 \pm 2.6	.341	.476	.002

Note. TUG = Timed Up and Go; BPH = benign prostatic hyperplasia; LUTS = lower urinary tract symptoms; ANOVA = analysis of variance; ST = single task; DT = dual task. Significant *p* values at a prior .05 alpha are in bold.

(i.e., 10-m walk test) were examined first. Table 3 summarizes TUG and 10-m walk tests results for both groups while performing under different conditions. Whilst there was no significant main effect of group or task on either TUG or 10-m walk test, ANOVA revealed a significant interaction between task and group for TUG ($f[2, 73] = 4.170, p = .017$) as well as for the 10-m test ($f[2, 74] = 6.581, p = .001$). To further explore these interactions, a series of pairwise comparisons between and within groups were conducted. For the TUG test, there was no significant difference between groups at any of the test conditions. However, in the older adults group, ST differed significantly from DT-motor ($t = 2.829, p = .006$) and DT-cognitive ($t = 3.397, p = .001$) with no significant difference between DT-motor and DT-cognitive. In the BPH/LUTS patients group, DT-cognitive differed significantly from ST ($t = 4.327, p < .001$) and DT-motor ($t = 2.284, p = .007$) with no significant difference between ST and DT-motor.

For the 10-m test, there was a significant difference between groups only while walking under DT-cognitive conditions ($t = 1.995, p = .049$). In the older adults

group, there were no significant differences between tasks, while in the BPH/LUTS patients groups, DT-cognitive differed significantly from ST ($t = 4.590, p < .001$) and DT-motor ($t = 4.269, p < .001$) with no significant difference between ST and DT-motor.

Group and Task Effects on Gait Parameters

The effects of task and group on different spatial and temporal parameters of gait (i.e., step time, stride length, and cadence), as well as their variabilities, were examined while performing the 10-m test under different conditions. Table 4 summarizes these results.

ANOVA revealed significant main effects of task ($f[2, 73] = 7.464, p = .001$) on step time with no significant difference between groups or interaction between task and group. Further analysis showed significant differences between DT-cognitive and both of DT-motor ($p < .001$) and ST ($p < .001$) with no significant difference between DT-motor and ST (Figure 1a). In other words, participants in both groups demonstrated increased step time while walking under DT-cognitive condition

Table 4. Spatial and Temporal Parameters of Gait.

	BPH/LUTS (N = 43)			Older adults (N = 38)			p for ANOVA results		
	Mean \pm SD			Mean \pm SD			Task	Group	Interaction
	ST	DT -motor	DT -cognitive	ST	DT -motor	DT -cognitive			
Step time (ms)	591 \pm 66	590 \pm 70	677 \pm 118	559 \pm 47	564 \pm 62	637 \pm 82	.001	.156	.779
Step time variability	26.2 \pm 13.6	34.0 \pm 17.1	40.2 \pm 28.4	40.6 \pm 32.2	44.3 \pm 39.8	56.6 \pm 36.7	.382	.092	.709
Stride length (m)	1.41 \pm 0.12	1.37 \pm 0.11	1.32 \pm 0.11	1.43 \pm 0.12	1.36 \pm 0.11	1.39 \pm 0.11	.018	.425	<.001
Stride length variability (cm)	3.1 \pm 1.0	2.3 \pm 2.2	3.8 \pm 1.6	7.1 \pm 4.4	9.7 \pm 5.3	8.5 \pm 4.5	.311	<.001	.011
Cadence (step/min)	99.1 \pm 11.1	102.4 \pm 11.8	90.3 \pm 15.4	117.0 \pm 26.1	114.8 \pm 33.8	104.4 \pm 24.3	.218	.012	.609
Cadence variability	1.1 \pm 2.7	4.8 \pm 4.3	1.6 \pm 3.3	21.1 \pm 35	21.3 \pm 54.8	23.9 \pm 38	.833	.010	.581

Note. BPH = benign prostatic hyperplasia; LUTS = lower urinary tract symptoms; ANOVA = analysis of variance; ST = single task; DT = dual task. Significant *p* values at a prior .05 alpha are in bold.

compared to ST or DT-motor conditions. For step time variability, there was neither significant main effect of task or group nor an interaction between the two.

For stride length, there was a significant main effect of task ($f[2, 73] = 4.109, p = .018$), but not group, and there was a significant interaction between them ($f[2, 73] = 8.697, p < .001$). Further analysis of the task effect showed no significant difference between DT-cognitive and DT-motor, but both of them differed significantly from ST ($p < .001$ for both comparisons). For the group main effect, pairwise comparison revealed that BPH/LUTS patients and older adults differed significantly only under DT-cognitive ($t = 2.324, p = .023$; Figure 1b).

For stride length variability, there was a significant main effect of group ($f[1, 73] = 39.22, p < .001$) but not for task, with a significant interaction between them ($f[2, 73] = 4.697, p = .011$). Exploring the group effect further showed significant differences between groups in DT-motor ($t = 6.992, p < .001$) and DT-cognitive ($t = 5.129, p < .001$) conditions, with no significant differences between groups in ST.

Finally, there was a significant main effect of group on cadence ($f[1, 73] = 6.645, p = .012$) and cadence variability ($f[1, 73] = 7.030, p = .01$) with no significant main effect of task or significant interaction on either of them. Pairwise comparisons between groups showed significant differences in cadence at ST ($t = 3.319, p = .001$) and DT-cognitive ($t = 2.516, p = .014$) conditions (Figure 1c), while differences in cadence variability between groups were significant in all conditions (all *p* values $< .001$).

Discussion

This is the first study to explore balance and gait characteristics in men with LUTS due to BPH.

Measures of functional balance and gait have been increasingly used to distinguish and monitor individuals

with various disorders (Cimolin et al., 2011; Esser et al., 2018; Juen et al., 2014; Kuate-Tegueu et al., 2017; Michael et al., 2005; Valkanova et al., 2018; Zago et al., 2018). Gait and balance deficits are particularly compromised during dual-task requiring additional attention and may lead to decreased mobility and safety in community environments (Al-Yahya et al., 2011; Beauchet et al., 2008, 2009; Shumway-Cook & Woolacott, 2000). Therefore, investigating such deficits under dual-task conditions enables health-care providers to better recognize individuals with reduced mobility and physical activity, and might offer a framework for prophylactic interventions.

Time to execute a functional balance task as well as spatial and temporal gait parameters was compared in males with LUTS to those of older adult males while performing under different conditions of increasing complexities (i.e., ST, DT-motor, DT-cognitive). The research hypotheses were that individuals' performances in both groups would be affected by task complexity, and men with LUTS due to BPH would exhibit more prominent deviations than older adults as the complexity of the task increased. Results from the present study support these hypotheses. That is, men with LUTS due to BPH were more affected than community-dwelling older adults by the additional tasks, and differences between groups were more profound as the difficulty of the functional balance and gait activities increased.

Measuring gait and functional balance in individuals while performing a secondary attentional demanding task, the dual-task approach, has been increasingly used to assess the risk of falls among different populations (Beauchet et al., 2009; Belghali et al., 2017; Montero-Odasso, Verghese, Beauchet, & Hausdorff, 2012). In fact, DT-related deviations in balance and gait are well documented and vary according to difficulty of the walking task, complexity of the additional task, and the individual's age and balance capability (Al-Yahya et al., 2011; Shumway-Cook & Woolacott, 2000). For example, in a

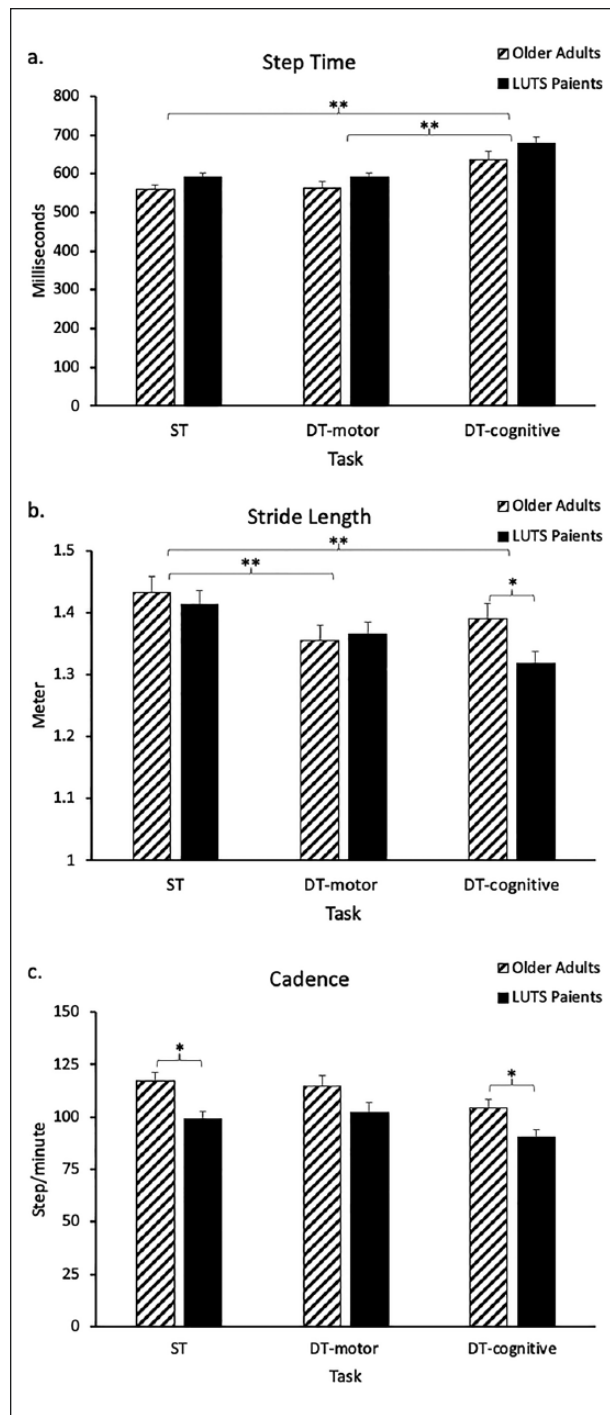


Figure 1. Group means (and standard errors) of different gait parameters (a. step time, b. stride length, and c. cadence) measured while performing the 10-m walking test under different conditions. Asterisks denote significant differences between groups. Double asterisks denote significant differences between tasks.

recent meta-analysis, it has been reported that gait performance was most affected when complex cognitive tasks

were concurrently performed, and that older age and poorer cognitive function were strongly associated with gait speed reduction under DT conditions (Al-Yahya et al., 2011). Therefore, present results advocate the utilization of simple DT paradigm to assess gait and balance performance in men with LUTS and older adults. This was evident by the significant task effect on step time observed in both groups while performing under different conditions, and the observation that task interference was more prominent for the cognitive task more than the motor task.

Intriguingly, DT interference for most of the main outcome measures was more prominent in men with BPH compared to older adults. That is, the effect of the additional task on balance and gait was more in men with BPH. Increased DT interference in men with BPH might reflect increased difficulties with gait and balance in them compared to older adults (Al-Yahya et al., 2011; Shumway-Cook & Woolacott, 2000), which might be attributed to the autonomic nervous system overactivation reported in men with BPH. In support for this explanation, it has been reported that autonomic nervous system activity, measured by skin conductance, was increased in older adults when they perform a complex walking task (i.e., obstacle negotiating and DT walking) compared to usual walking (Clark et al., 2014; Hadjistavropoulos et al., 2012), and such autonomic nervous system activity corresponded to the individual's functioning level (Chatterjee et al., 2018). Although the number of medications was adjusted for in the primary analysis, certain medications used in the treatment of BPH may be associated with gait and balance impairment (Woolcott et al., 2009), and adverse events could occur such as dizziness and orthostatic hypotension which could increase risk for falls (Hsieh et al., 2014). In particular, men on prostate-specific alpha antagonists have noticeable increased risks of falling and fracture, as well as increased risk of hypotension and head trauma (Welk et al., 2015). Whether the observed further DT decrements in gait and balance in men with BPH compared to older adults are related to autonomic nervous system activity, medication side effects, or combinations of these and other factors warrants future investigation.

Difficulties with gait and balance in older adults are often multifactorial and have been linked to increased risk of falls and decreased level of physical activity (Tinetti & Kumar, 2010). In particular, DT decrements in gait and balance have been linked to increased risk of falls (Springer et al., 2006). It is also plausible that difficulty completing a DT may be limiting individuals' abilities to be active when additional attention is required (Brustio, Magistro, Zecca, Rabaglietti, & Liubicich, 2017). Taken together, the present results suggest that DT decrements in functional balance and gait might

contribute to the decreased level of physical activity and increased risk of falls reported in men with BPH and associated LUTS. Health-care providers for men with LUTS due to BPH should assess for abnormal gait and for falls and maintain vigilant for gait and balance problems that may lead to decreased physical activity and mobility, as well as increased risk of falls. In line with this recommendation, current guidelines advocate that older persons should be screened for falls (Panel on Prevention of Falls in Older Persons, American Geriatrics Society and British Geriatrics Society, 2011). Dual-task approach provides a simple and clinically feasible method to test for functional decline and frailty in men with BPH, and consequently it aids to distinguish potential fallers among them at earlier stages allowing for preventive interventions (Smith, Cusack, & Blake, 2016).

The interpretation and potential practical application of present results should be considered in light of the following limitations. First, the present study was cross-sectional; the risks of falls in men with BPH and their relation to gait deficits and physical activity level have yet to be evaluated . Second, the onset of LUTS/BPH was estimated from the first visit to our clinic, which might not be accurate for all patients. Third, while data collected during the 10-m walking test may provide reliable temporal and spatial gait parameters, measuring their variability reliably may require longer walking distance, particularly under DT condition (Hollman et al., 2010). Finally, although individuals' variability in counting performance was adjusted for, the effect of dual tasking on the cognitive task—the effect of gait on counting rate and accuracy—not measured, which would have enabled ruling out the effect of task prioritization on DT performance.

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Abbreviations

BPH, benign prostate hyperplasia; LUTS, lower urinary tract symptoms; TUG, timed up and go; IPSS, international prostate symptom score; ST, single task; DT, dual task

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