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Fernanda K Romio

**Exploring the impact of desire-to-void and lower
urinary tract symptoms (LUTS) on dual-task
performance in aging women: a cross-sectional study**

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RESUMO

Introdução: Mulheres idosas com incontinência urinária (IU) têm maior risco de cair do que mulheres idosas sem IU. A IU pode interferir na marcha cortical fornecendo distração atencional e aumentando o custo cognitivo (CC) durante a caminhada. **Objetivos:** O objetivo geral deste estudo é estabelecer se o desejo de urinar influencia o desempenho de tarefas funcionais em situações de dupla-tarefa. Os objetivos são: (1) avaliar a diferença no desempenho de dupla tarefa entre duas condições experimentais: sem desejo de urinar e com desejo de urinar; e (2) determinar se existe correlação entre os STUI e desempenho de dupla-tarefa durante a marcha em idosas. **Material e métodos:** Este estudo caracteriza-se como um estudo observacional transversal. Mulheres acima de 60 anos foram convidadas a participar do presente estudo através de anúncios públicos na comunidade. As participantes foram solicitadas a realizar o teste “Timed up and go” (TUG) associado à duas tarefas secundárias: uma motora, o teste de Transferência de Moedas (TM), e uma cognitiva, o teste de Fluência Verbal Fonética (FVF). Ainda, essas condições foram realizadas em duas condições de desejo miccional: (1) nenhum desejo (bexiga vazia); e (2) desejo miccional (bexiga cheia). O grau de IU foi avaliado através do International Consultation on Incontinence Questionnaire: Short Form (ICIQ- SF). Para comparar o custo cognitivo durante as diferentes condições experimentais, foi utilizada análise de variância de medidas repetidas (ANOVA). Para avaliar a correlação entre ICIQ e DTE foi utilizada a correlação de Kendall. **Resultados e conclusões:** Participaram deste estudo 42 mulheres (72.90 ± 5.81 anos) com graus variáveis de IU: nenhuma incontinência (n=13), incontinência leve (n=10), moderada (n=13) e grave (n=6). Nossos resultados confirmam que experimentar uma sensação de bexiga cheia ao caminhar impacta negativamente o desempenho da marcha em mulheres idosas. O desejo miccional durante a caminhada proporcionou um maior custo cognitivo quando comparado com condições de bexiga vazia ($p < 0,01$). Não houve correlação significativa entre os dados apresentados pelo ICIQ e a performance do TUG em nenhuma das condições experimentais. Manter uma marcha consistente e estável e evitar quedas requer recursos cognitivos e processos de pensamento conscientes. Com tarefas adicionais, o desempenho funcional da marcha diminui, indicando um custo cognitivo da dupla tarefa (motora ou cognitiva) e um custo cognitivo adicional da sensação de bexiga cheia. Isso significa que lidar com a sensação de bexiga cheia pode ser uma fonte de desvio de atenção. Dessa forma pode concluir-se que o desejo miccional impacta negativamente o desempenho da caminhada em dupla tarefa em mulheres idosas independente do grau de IU.

Palavras-chave: Idosas, Desejo Miccional, Dupla Tarefa

ABSTRACT

Introduction: Elderly women with urinary incontinence (UI) have a higher risk of falling than elderly women without UI. UI may interfere with cortical gait by providing attentional distraction and increasing cognitive cost (CC) during walking. **Objectives:** The overall aim of this study is to determine whether the urge to urinate influences the performance of functional tasks in dual-task situations. The specific objectives are: (1) to assess the difference in dual-task performance between two experimental conditions: without the urge to urinate and with the urge to urinate; and (2) to establish whether there is a correlation between UI symptoms and dual-task performance during walking in elderly individuals. **Materials and Methods:** This study is characterized as a cross-sectional observational study. Women over the age of 60 were invited to participate in the current study through community public advertisements. The participants were asked to perform the "Timed up and go" (TUG) test associated with two secondary tasks: a motor task, the Coin Transfer Test (CTT), and a cognitive task, the Phonetic Verbal Fluency (PVF) test. Additionally, these conditions were conducted under two micturition desire conditions: (1) no desire (empty bladder); and (2) micturition desire (full bladder). The degree of UI was assessed using the International Consultation on Incontinence Questionnaire: Short Form (ICIQ-SF). To compare the cognitive cost during the different experimental conditions, repeated measures analysis of variance (ANOVA) was employed. Kendall's correlation was used to assess the correlation between ICIQ and DTE. **Results and Conclusions:** Forty-two women (72.90 ± 5.81 years) with varying degrees of UI participated in this study: no incontinence ($n=13$), mild incontinence ($n=10$), moderate ($n=13$), and severe ($n=6$). Our results confirm that experiencing a full bladder sensation while walking negatively impacts the gait performance in elderly women. Micturition desire during walking incurred a higher cognitive cost compared to empty bladder conditions ($p<0.01$). There was no significant correlation between the data provided by the ICIQ and TUG performance in any of the experimental conditions. Maintaining a consistent and stable gait and preventing falls require cognitive resources and conscious thinking processes. With additional tasks, functional gait performance decreases, indicating a cognitive cost of dual-tasking (motor or cognitive) and an additional cognitive cost of the full bladder sensation. This suggests that dealing with the sensation of a full bladder can be a source of attentional distraction. Thus, it can be concluded that micturition desire negatively impacts dual-task gait performance in elderly women regardless of the degree of UI.

Keywords: Gait, Dual-task, Older Adults, Urinary Incontinence, Desire-to-void

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LISTA DE ABREVIATURAS E SIGLAS

LUTS	Lower urinary tract symptoms
UI	Urinary incontinence
ICIQ-SF	International Consultation on Incontinence Questionnaire – Short Form
MoCA	The Montreal Cognitive Assessment
ABC-16	Balance Confidence Scale
TUG	Timed up-and-go
CTT	Coin Transference test
PVF	Verbal Fluency Test
USS	Urinary sensation scale
DTE	Dual-task effect
ANOVA	Repeated measures analysis of variance
PFC	Prefrontal cortex
SMA	Supplementary motor area
DMN	Default mode network
TUGb	Timed up-and-go baseline
TUGme	Timed up-and-go - motor dual-task empty bladder
TUGmf	Timed up-and-go - motor dual-task full bladder
TUGce	Timed up-and-go - cognitive dual-task empty bladder
TUGcf	Timed up-and-go - cognitive dual-task full bladder

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ARTIGO

Exploring the impact of desire-to-void and lower urinary tract symptoms (LUTS) on dual-task performance in aging women: a cross-sectional study

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ARTIGO NA ÍNTEGRA

Exploring the impact of desire-to-void and lower urinary tract symptoms (LUTS) on dual-task performance in aging women: a cross-sectional study

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Abstract

Introduction: Older women with urinary incontinence (UI) have a higher risk of falling than older women without UI. UI may interfere with cortical gait by providing attentional distraction and increasing cognitive cost (CC) during walking. **Objectives:** The overall aim of this study is to determine whether the urge to urinate influences the performance of functional tasks in dual-task situations. The specific objectives are: (1) to assess the difference in dual-task performance between two experimental conditions: without the urge to urinate and with the urge to urinate; and (2) to establish whether there is a correlation between UI symptoms and dual-task performance during walking in older adults. **Materials and Methods:** This study is characterized as a cross-sectional observational study. Women over the age of 60 were invited to participate in the current study through community public advertisements. The participants were asked to perform the "Timed up and go" (TUG) test associated with two secondary tasks: a motor task, the Coin Transfer Test (CTT), and a cognitive task, the Phonetic Verbal Fluency (PVF) test. Additionally, these conditions were conducted under two micturition desire conditions: (1) no desire (empty bladder); and (2) micturition desire (full bladder). The degree of UI was assessed using the International Consultation on Incontinence Questionnaire: Short Form (ICIQ-SF). To compare the cognitive cost during the different experimental conditions, repeated measures analysis of variance (ANOVA) was employed. Kendall's correlation was used to assess the correlation between ICIQ and DTE. **Results and Conclusions:** Forty-two women (72.90 ± 5.81 years) with varying degrees of UI participated in this study: no incontinence (n=13), mild incontinence (n=10), moderate (n=13), and severe (n=6). Our

results confirm that experiencing a full bladder sensation while walking negatively impacts the gait performance in older women. Micturition desire during walking incurred a higher cognitive cost compared to empty bladder conditions ($p < 0.01$). There was no significant correlation between the data provided by the ICIQ and TUG performance in any of the experimental conditions. Maintaining a consistent and stable gait and preventing falls require cognitive resources and conscious thinking processes. With additional tasks, functional gait performance decreases, indicating a cognitive cost of dual-tasking (motor or cognitive) and an additional cognitive cost of the full bladder sensation. This suggests that dealing with the sensation of a full bladder can be a source of attentional distraction. Thus, it can be concluded that micturition desire negatively impacts dual-task gait performance in older women regardless of the degree of UI.

Keywords: Walking, Dual-task, Aged, Urinary Incontinence, Urinary Desire.

INTRODUCTION

Lower urinary tract symptoms (LUTS), such as urinary incontinence (UI) and overactive bladder, affect approximately 50% of the global population.¹ These symptoms are particularly prevalent in older women, with an incidence ranging from 40% to 50% among women aged 60 to 90 years.² Women suffering from LUTS often report a decrease in quality of life, increased levels of depression and anxiety^{3,4}, and face a significantly higher risk of falls compared to older women without LUTS. Specifically, older women experiencing urinary urgency have an increased risk of falls (OR = 1.5 to 2.3) and injuries.⁵

There is a clear association between LUTS and an increased risk of falls, leading to greater frailty, hospitalizations, mortality, and morbidity.⁶ The underlying mechanisms of this association are not yet fully understood. It is likely that a combination of factors, such as medication use, activity restriction, frailty, decline in cognition and executive function, play fundamental roles in this context.⁷ Evidence suggests that LUTS may interfere with gait control, as these symptoms are linked to changes in gait patterns in adult women^{8,9}, resulting in deficits in executive control, particularly during dual-task performance.¹⁰

For independent activities, such as walking, we rely on executive function, which can be described as "a variety of cognitive processes that use and modify information from many cortical sensory systems in the anterior and posterior brain regions to modulate and produce behavior".¹¹ Older women with LUTS have higher rates of decline in executive function.¹⁰ Furthermore, the decline in executive function is directly related to an increased risk of falls.¹² Therefore, when individuals with LUTS are performing functional tasks, such as walking, they may need to direct part of their attention to bladder control. LUTS imposes a cognitive cost on these individuals due to the additional demand for attention while performing a task. Thus, in older adults, LUTS may be a contributing factor to the increased risk of falls.¹³

The study conducted by Paquin identified that both older women with LUTS symptoms and those without these symptoms, when experiencing situations of strong urinary urgency, demonstrate an alteration in gait pattern characterized by a decrease in speed.¹⁴ There is also evidence that even in young and healthy women, strong urinary urgency can have negative effects on cognition, affecting gait patterns.¹⁵ It is important to emphasize that the common explanation that urinary urgency leads to falls due to a rush to the bathroom is intuitive but not supported by evidence. The response to a strong urge to urinate appears to be a decrease in speed rather than an increase.⁹

Safe, real-life mobility may require the individual to walk faster, such as when rushing to toilet and attempt to negotiate obstacles. During those situations, it is crucial to understand the implication of walking on cognitive load imposed by either the execution of a secondary cognitive and/or motor tasks or a moderate desire to void as an efficient way to improve the assessment of gait and risk of falling among older adults. Evidence suggests an underlying mechanism connecting urinary urgency to falls. However, there is a gap in the literature regarding the potential role of the urge to urinate as a source of cognitive demand compared to dual-task performance.

To the best of the authors' knowledge, no study has yet compared the impact of motor and cognitive dual-task conditions under a moderate desire to void on walking ability and their contributions to older adults with urinary incontinence. With the aim of gaining a deeper understanding of this relationship, the present study aims to (a) explore the effects of two different attention-demanding cognitive and motor tasks on gait performance in older women, (b) establish whether a moderate desire to void influences walking performance during dual-task conditions and (c) determine the correlation between UI severity, walking performance and dual-tasks effects during gait in older. The authors hypothesized that divided attention during dual tasking will impact gait performance. Also, it is plausible that an increase in distraction whilst attempting dual task walking and simultaneously maintain continence may demand a greater cognitive resource impacting gait. Finally, we expect to observe a positive correlation between de UI severity and dual-tasks effects during a fast walking with a moderate desire to void.

METHOD

Study design

This is a cross-sectional, repeated measures, laboratory-based study composed by community-living older women. This study was approved by the Research Ethics Committees from University of Otago (H21/150 and 27093419.7.0000.5345 respectively). Participants did not receive any incentive to participate in this study.

Participants

Potential participants from Brazil and New Zealand were recruited by public advertisements in the community and on social media between September 2022 and March 2023. Participants were included if they were: (a) aged 65 years and over; (b) community-living, independent in activities of daily living; (c) could walk without assistance; (d) able to provide self-reported data and (e) could understand and sign an informed consent. Participants were excluded if they presented musculoskeletal, metabolic or cardiac disorders or visual or hearing impairments that could interfere with the experiment. Participants were also excluded if they presented with lower urinary tract infection symptoms (i.e., burning sensation and pain during urination).

Sample size determination

Our previous research suggests that exposing participants to dual-task situations has a moderate effect (i.e., 0.55) on gait performance in older women. We calculated the sample size for a two-tailed paired t-test, with alpha set at 0.05 and power set at 0.8. Based on this, the minimum sample is 28 participants

Data collection

After confirming the eligibility of participants and prior to data acquisition, all participants provided informed consent in accordance with Helsinki declaration. Next, all participants completed a short sociodemographic factors questionnaire and questionnaires related to continence

status/severity, cognition, history and balance confidence. Briefly, the International Consultation on Incontinence Questionnaire - Short Form (ICIQ-SF) was administered to assess the impact of UI on the quality of life and quantify the degree of urinary loss. The Montreal Cognitive Assessment (MoCA) test was used, aiming to assess mental function and detect mild cognitive impairments. Also, the Balance Confidence Scale (ABC-16) was used to evaluate confidence in balance.

Afterwards, each participant took part in a single 1-hour (maximum) gait laboratory experimentation and were tested under all following experimental protocols.

Walking performance protocol

As a primary walking task, participants were asked to perform the timed up-and-go (TUG) test. During TUG test, participants were asked to rise from a chair, walk a distance of 3 meters, turn, walk back to the chair and sit down to the starting position.¹⁶ During the walking task, participants were instructed to walk as fast as possible without running. A demonstration of the TUG test was given by the examiner, followed by a familiarization trial. The variable of interest is the time to complete the TUG in seconds. TUG test was chosen considering that mobility-related steps in daily activities consists in walking in different strategies such as straight line and turning. TUG test is validated and has been extensively used in geriatric medicine to examine balance, gait, and functional ability that is required for the performance of basic activities of daily living in older adults.¹⁷ Also, TUG test can be measured in an office setting without sophisticated technical equipment, which is ideal for widespread clinical utility.

Dual-task data collection protocol

Dual-task paradigm used in the present study consisted in the execution of the primary walking task performed separately and subsequently, with a secondary motor and a cognitive task. Coin Transference test (CTT) was chosen as a secondary motor task.^{18,19} For the CTT, participants were instructed to transfer 10 coins of 50 cents once at a time, with the dominant hand, from the pocket on the non-dominant side to the pocket on dominant side. A specific apron was made for this

test with two different sizes (50x61cm and 42x54cm) for better adaptation on participant's body, with pattern pocket (15x10cm). The parameter of interest was coin transference rate (coin/min). Cognitive secondary tasks included the Phonetic Verbal Fluency Test (PVF). For the PVF, participants were asked to recall as many words as possible beginning with the letters F, A or S for one minute.²⁰ The number of appropriate words generated in one minute was assessed. A great of words recalled indicate better performance.^{21,22} Selected motor and cognitive secondary tasks have previously been used to explore dual-task during mobility performance and were demonstrated to engage specific cognitive process.

Bladder conditions

Participants performed the primary walking task associated with secondary motor or cognitive tasks following two conditions of urinary urgency: (1) no desire-to-void (empty bladder), and (2) desire-to void (full bladder). To achieve the desire-to-void condition, participants were given 500ml of water to drink and then waited until they experienced moderate urgency. Desire-to-void was determined using the urinary sensation scale (USS), a 5-point validated scale developed to assess feelings of urinary urgency and recommended by the international consultation on incontinence (Coyne et al., 2011; Nixon et al., 2005). A score of 3/5 (moderate urgency: enough urgency discomfort, need to stop the usual activity or task, and go immediately to the bathroom) was considered as the desire-to-void condition. Participants scored of 1/5 (no urgency: no feeling of urgency; can continue activities until it is convenient to use the bathroom) were considered with no desire-to-void condition.²⁴ Prior to data collection disposable pads were offered for all participants to prevent discomfort in case participants presented any leakage during data collection protocol.

In total, participants underwent five attempts (baseline TUG, cognitive TUG with an empty and full bladder, and motor TUG with an empty and full bladder). The assessment protocol followed a pseudo-random order to prevent performance bias in primary and secondary tasks and to elucidate the likely effect of urinary urgency on the primary walking task.

Outcome measures

Primary outcomes measures included TUG performance (measured in seconds) and dual-task effects. Dual-task effect (DTE) on TUG performance was defined as a percent change of time needed to conclude the test compared to single-task condition. Considering TUG performance, the higher the value (more time to perform), the worse the performance, so DTE was calculated as following: $(([\text{single-task value} - \text{dual-task value}]/\text{single-task value}) \times 100\%)$.²⁵ Thus, a negative value indicates that TUG performance was worse of TUG in the dual-task condition compared to the single-task condition.

Secondary outcome measures considered for this study included the frequency, severity and impact on quality of life of UI [determined through the International Consultation of Incontinence Questionnaire-short form (ICIQ-SF)], cognition status [measured using the Montreal cognitive assessment) MoCA] and balance confidence [assessed by the Activities-Specific Balance Confidence Scale (ABC)].

Statistical Analyses

Age, MoCA score, years of education, number of falls, TUG performance and DTEs were presented as means and standard deviations. Data normality was verified with Shapiro-Wilk test. TUG performance and DTEs during different experimental conditions were analyzed following a repeated measures analysis of variance (ANOVA) with Bonferroni post-hoc test. Means between continence and incontinence participants were compared with a two-tailed, unpaired Student's t test. For all comparisons, alpha was set at 0.05. For assessing the correlation between ICIQ and DTE the Kendall correlation was used. For this analysis, a correlation of 0.10 to 0.19 = weak, 0.20 to 0.29 = moderate and ≤ 0.30 = strong. All data analyses were performed using the Statistical Package for the Social Sciences for windows (version 22; SPSS Inc., Chicago, IL).

To verify the interaction between motor and cognitive DTE during different void conditions and to understand the attentional strategy adopted by participants during dual-tasking, the conceptual

framework proposed by Plummer et al., was adopted for details see.²⁶ Interaction graphs contrasting DTE in primary and secondary tasks and also during both urgency conditions were performed by GraphPad Prism 6.0 software (GraphPad, Inc., San Diego, CA) and descriptively analyzed.

RESULTS

Participant Characteristics

Forty-two older women (72.90 ± 5.81 years) participated in this study. The MoCA scores show that 23 participants met the threshold for normal condition (25.00 ± 5.54). Although 19 participants scored below the 26 points cut off, they were all community-living, independent in their activities of daily living and could walk without assistance, thus, meeting the inclusion criteria of the present study. According to the ABC test, most of participants presented high or moderate level of physical functioning. Participants ICIQ scores ranged from no incontinence to severe incontinence. However, most of our participants had either slight incontinence or moderate incontinence. Detailed characteristics of all participants are summarized in Table 1.

Walking performance

Absolute values and dual-task condition's effects (mean \pm sd) of walking performance during all experimental conditions are shown in Table 2. Repeated measures ANOVA demonstrated a significant effect of the experimental conditions on TUG performance ($[F(4,164) = 41,93; p < 0.001]$) in older women. Post hoc comparisons showed that the time to perform TUG test increased significantly when performing a motor (MD=-3.01,95% CI [-3.88, -2.13], $p < 0.001$) or cognitive (MD=-3.53,95% CI [-5.74,-3.17], $p < 0.001$) secondary task compared to single task performance. Post hoc comparisons also indicated that a moderate desire to void significantly increased the time to perform TUG test compared to the equivalent motor (MD=-1.44,95% CI [-2.51, -0.37], $p < 0.01$) and cognitive (MD=-2.04,95% CI [-3.38, -0.71], $p < 0.001$) no-desire-to-void condition. In addition, post hoc comparisons also demonstrated that the TUG performance was significantly worsened during cognitive dual tasking with the desire to void compared to motor dual-task with no-desire-to-void

(MD=-2.56,95% CI [-4.19, -0.93], $p < 0.001$).

No differences among continence and incontinence participants were observed on TUG performance. Also, no correlations between the ICIQ scores and time to perform TUG nor motor and cognitive DTEs during both desire-to-void conditions were observed.

DISCUSSION

This study sought to establish whether maintaining urinary continence with a moderate desire to void impact dual-task walking performance in healthy community-dwelling older women. Although, evidence from clinical practice and research suggests a complex interaction between walking and bladder control, to our knowledge, this is the first study that have investigated dual task performance under such desire-to-void condition. Our results can be summarized as follow: (a) decrements in walking performance are observed during motor and cognitive dual-tasking (b) moderate desire-to-void incited a greater cognitive-motor interference impacting walking performance compared to the equivalent motor and cognitive no-desire-to-void condition; (c) neither differences among continence and incontinence participants nor correlations between the ICIQ scores and time to perform TUG nor motor and cognitive DTEs during both desire-to-void conditions were observed.

In daily life, older adults mobility involves walking while performing multiple tasks. The ability to perform two or more concurrent tasks enables individuals to communicate with others, manipulate objects, and respond to environmental stimuli when walking.²⁷ Although walking has long been considered an automated skill,²⁸ efficacious ambulation is partly reliant on cognitive processes.²⁹ Our results are in accordance with previous evidence on literature demonstrating that even when a simple motor task, such as walking, is coupled with a secondary task (cognitive or motor), performance of one or both tasks decreases.³⁰ In fact, different gait parameters such as gait speed, cadence, stride length, walking variability and stability has been demonstrated to be affected when simultaneously performed with cognitive demands^{31,32,33,8} suggesting that gait control areas are interlinked and share neural networks.^{34,35,36}

Besides the well-known evidence that cognitive and motor demands interfere with walking ability, our results indicate that the greatest impacts on gait are prominent following maintaining bladder control during a moderate desire-to void demand. Few research groups had studied the effect of desire to void on gait, more precisely in older adults.^{37,38} As proposed by Booth et al.,³⁸ bladder control during walking could be perceived in a dual-task paradigm perspective acting as a source of divided attention. In fact, bladder control seems to be a complex process that comprises cognition, emotion, self-reference, self-reflection, and making decisions about whether it is appropriate to void in the context of monitoring the external environment.³⁹ Thus, bladder filling with moderate desire-to-void and the attention required to maintain continence while walking could decrease the resources attributed to gait control and thus adversely impact walking ability. Distinct neuropsychological theories on information processing have been proposed trying to explain the decrements observed in dual-task performance. Both the capacity-sharing theory and bottleneck theory presume that the functional resources of the human brain are limited. While the capacity-sharing theory postulates that the brain is a limited-capacity parallel processor that divides resources among to-be-performed tasks, the bottleneck theory assumes that central processes occur for one task at a time.^{40,41,42} In addition, the theory of multiple resources suggests that if two tasks use shared functional resources or common structures, dual-task performance is more likely to be hampered.^{43,44}

In fact, recent data demonstrated that walking during dual-tasking and the desire to void might require activation of common functional networks. For instance, both desire-to-void and dual-tasking leads to greater prefrontal cortex (PFC) and supplementary motor area (SMA) activation.^{45,46,47} PFC plays an essential role in performing two or more tasks simultaneously. It is responsible for higher-order cognitive processes that includes attention shifting, working memory, inhibition and prospective memory,^{48,49,50,51} as well as in motor planning, motor execution and timing of future intentions.⁵² Much like the PFC, the SMA has been also demonstrated to play an important role in the maintenance of walking ability during dual-tasking. Increased activation of SMA was associated with declines in walking performance under dual task conditions.⁴⁷ SMA is a key structure

for the execution and control of voluntary movement, motor planning,⁵³ and for maintaining attention on a motor task.⁵⁴ Consequently, altered PFC and SMA activation patterns observed in older adults while dual-tasking and/or during desire-to void may lead to insufficient adaptation processes for walking task and a decline in dual-task performance. Thus, combining a motor or cognitive dual-task with a moderate desire-to-void could generate a greatest overlap activation pattern and thus, the greatest DTE observed when the tasks were performed simultaneously in this study.

Furthermore, Pang et al.,⁵⁵ reported increased activation of the default mode network (DMN) during the strong desire to void compared with the empty bladder state suggesting its important role in the brain-bladder control. A greater resting state DMN connectivity was also associated with a decrease in dual-task performance.⁵⁶ Usually, the DMN is activated during the resting state, and is strongly inhibited in goal-directed tasks aiming to maintain attention on task. Thus, the lack of deactivation of DMN, the during both desire-to void and dual-tasking, might compete for resources between the DMN and task-related brain regions (e.g., PFC and SMA), reducing the ability to maintain attention on task, enabling individuals to create motor plans with as much accuracy or efficiency. This would possibly result in reduced quality of gait control and subsequently, slowing gait speed and increasing risk of mobility disability in older adults.

We should highlight that normative TUG data for older adults have been reported as 8.1 seconds for those aged 60–69 years, 9.2 seconds for 70–79 years and 11.3 seconds for 80–99 years.⁵⁷ Also, according to the Centers of Disease Control and prevention from de Department of Health & Human Services (United's States of America), an older adult who takes more than 12 seconds to complete the TUG is at a greater risk of falling. Interestingly, our results demonstrated that during a moderate desire to void, our participants, who are on average 72.90 ± 5.90 years old, took on average 12.61 ± 5.58 and 13.73 ± 4.89 seconds to complete the TUG test during the cognitive and motor dual-task respectively. This score exceeds the normative values for their age range, indicating that they have an increased risk of falling when walking performing simultaneously a cognitive or motor dual task associated with a moderate desire to void.

Several studies have investigated the relationship between urinary incontinence and falls. A recent systematic review with metaanalysis highlighted the increased risk of falls in older adults with urinary incontinence and, more precisely, a predominant association with urgency urinary incontinence.⁵⁸ Although controversial,⁷ the association between urinary incontinence and falls is commonly attributed to the urgent need to reach the toilet. In fact, a recent study indicated that almost 85% older women reported that they had to rush to the toilet occasionally or more often when experiencing urinary urge.⁵⁹ As mentioned above, walking in everyday life is not performed as a single task. When older adults are exposed to challenging walking, such as while rushing to reach toilet, walking itself might become more cognitively demanding.

For instances, advancing age is related to loss of individual resources, which affects older adults physical health. We can highlight the reduction in muscle mass associated with aging, accompanied by changes in muscle function and strength or decrements on cognitive function. Furthermore, in the context of the women's health, the climacteric represents a stage in which the aging process is accentuated by the decrease in estrogen levels, which alters the function of the pelvic floor muscles. This results in changes in contractile performance and the production of force necessary to maintain continence. For women living with urinary incontinence, physical symptoms are only part of the problem. They often make adaptations to their lifestyle, such as restrictions in daily self-care activities and social participation, which induces sedentary behavior and enhances muscle dysfunction.⁶⁰ Also, many older women restrict fluid intake to reduce incontinent episodes.⁶¹ It is known that dehydration of 1-2% loss of body weight leads to a decline in cognitive capacity⁶² negatively affecting performance on focused attention, memory and executive function tasks.^{63,64} Also, older adults may have fewer resources to manage the effects of dehydration on cognitively demanding tasks.⁶⁵

In contrast to the decrease in individual resources, cognitive demands increase during bladder filling and with the presence of the desire-to-void. It's important to highlight that cognitive impairment appears to be greater when the motor activities are more demanding.⁶⁶ In real-life

situations, in addition to maintaining continence, older women may be involved in walking whilst simultaneously multitasking (i.e. such as rushing to reach the toilet and looking for the key in their bag to enter the house). Fast-pace gait speed decline with age.⁶⁷ By increasing walking speed, older adults impose greater demands on physiological and cognitive systems⁶⁸ to rapidly control postural adjustments.⁶⁹ By the other hand, walking while performing a secondary cognitive or motor task demands allocation of cognitive resources to tasks management.^{70,71,72}

Additional increased cognitive demands can be attributed to the urgent need to use the toilet and the anxiety associated with a failure to reach the toilet. For instances, the experience of urinary urgency itself acts as a source of divided attention.⁷³ Also, a variety of stimuli, such as arriving at their front door or being near a familiar bathroom, can enhance urinary urgency and activate bladder-related brain circuits.⁷⁴ Moreover, it is known that anxiety can elicit a shift in attention from goal-directed to stimulus-driven, thereby increasing the distribution of attentional resources toward threat-related stimuli at the expense of attention allocated to the task. Also, dual-task performance has been shown to be affected by anxiety created by disturbing environment.⁷⁵ Thus, worries on urine leakage could consume additional attentional resources, thereby increasing cognitive demands for a task execution.

Considering the stated above, we can hypothesized that relation of falls and urinary incontinence may not be a result of decreased individual resources in isolation (i.e balance or strength deficits, urinary incontinence, cognitive function), but the inability to effectively allocate cognitive resources to walking performance and postural stability when a high cognitively demand task situations is required (i.e rushing to toilet to avoid leaking). Thus, as a result of combining decreased individual resources to increased cognitive demands, task efficiency will decrease, sometimes followed by a drop in performance and finally leading to falls.

Understanding the desire to void in a dual-task perspective has an important application in older women health. Promising applications of our results embrace a variety of human performance tasks, including walking on the street while talking on a mobile telephone with the need to maintain

continent or any other daily situation where older women experiences a moderate desire to void. If we can comprehend the availability and overlap of these resources to various tasks, we can predict overload and design coping strategies for women with urinary incontinence that are less likely to result in overload and consequently prevent falls. In the same perspective, considering that practice could be associated with decreased cortical activations, decreased overlaps in activity between the tasks and thus presumably decrease interference,⁷⁶ improving either one of the two tasks in isolation (e.g. obstacle crossing, attentional gait and toilet training or bladder control) could free some attentional resources and probably help to properly deal with the increased cognitive load in dual-task situations. Further studies must be performed to test such hypothesis.

Limitations

There are some limitations to the present study, which can inform future directions in this line of research. First, the findings cannot be generalized, this study included both continent participants and older women with different types and severity of urinary incontinence. Further research is needed to examine the influence of moderate desire on dual-task parading for older adults with different types of urinary incontinence and to compare type or incontinent vs continent older women. Second, we assessed a perceived desire to void only with a subjective scale in a laboratory environment. As proposed by Paquin et al.,⁷⁷ this could have induced some participants to fear urine leakage and therefore not achieve true moderate desire to void, especially for the incontinent older women with reduced self-confidence in holding urine. Finally, our study is limited by its small sample size, although we over-recruited based on the sample size calculation, the small number of continent participants may impacted subgroup analysis by presence or absence of urinary incontinence.

Limitations notwithstanding, this work is innovative by investigating the desire to void effects on older women walking ability during dual-tasking. The dual task paradigm used in the present study (walking as fast as possible without running concomitant with moderate desire to void) could be associated with replicating the demands of the environment whilst rushing to toilet. Findings from the current study indicate that older women with and without urinary incontinence are unable to meet

the cognitive demands required to maintain walking performance in everyday life due to a lack of resources available and reduced ability to maintain attention on the walking task. It is plausible that an increase in distraction whilst attempting dual task walking and simultaneously maintain continence may contribute to the association of urinary incontinence and falls risk seen in older adults.

CONCLUSION

Our results demonstrated that experiencing a full bladder sensation while walking negatively impacts gait performance in aging women, acting as a source of diverted attention during dual-tasking in older women. Maintaining a consistent and stable gait and avoiding falling requires cognitive resources and conscious thought processes. With additional tasks, functional gait performance declines indicating a cognitive cost from dual-tasking (motor or cognitive) and an added cognitive cost from the full bladder sensation.

Authors Contribution

DA and FS were involved in designing the study. DA, FS, AS and FR were involved in performing the study. All authors contributed to the data analysis. DA and FS were involve in the interpretation of results. AS and FR wrote the first draft of the manuscript. DA and FS wrote portions of the manuscript and critically reviewed the manuscript. All authors have read and approved the manuscript.

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Table 1. Characteristics of the study population.

Characteristics	n = 42
Age in years, Mean (SD)	72.90 (5.81)
MoCA Score, Mean (SD)	24.00 (5.54)
no. participants < 26	19
no. participants ≥ 26	23
ABC Score, Mean (SD)	81.16 (18.85)
no. participants 81-100%	26
no. participants 51-80%	12
no. participants < 50%	4
ICIQ Score, Mean (SD)	5.45 (5.26)
no. participants 0 (none)	13
no. participants 1-5 (slight)	10
no. participants 6-12 (moderate)	13
no. participants 13-18 (severe)	6
no. participants 19-21 (very severe)	0

ABC, Activities-Specific Balance Confidence Scale, ICIQ, International Consultation on Incontinence Questionnaire – Urinary Incontinence Short Form; MoCA, Montreal Cognitive Assessment; SD, standard deviation

Table 2. Dual-task interference on walking performance during empty and full bladder conditions.

Variable	Single-task Performance	Dual-task Performance	
		Motor CT Task	Cognitive PVF Task
Empty Bladder Condition (no desire-to-void)			
TUG (s), Mean (SD)		11.16 (2.8) ^a	11.69 (3.66) ^{a,b}
DTE, Mean (SD)	8.15 (1.64)	-37.04 (22.93)	-42.13 (26.14)
Full Bladder Condition (moderate desire-to-void)			
TUG (s), Mean (SD)		12.61 (5.58) ^a	13.73 (4.89) ^{a,b,c}
DTE, Mean (SD)		-54.72 (33.33) ^b	-66.37 (40.25) ^b

CT, Coin Transference Task; DTE, Dual-Task Effect on TUG Time: [(dual-task – single-task)/single-task]x100; PVF, Phonetic Verbal Fluency Task; SD, standard deviation.

^a Significantly different from single-task performance $p < 0.001$

^b Significantly different from respective empty bladder condition $p < 0.001$

^c Significantly different from motor empty bladder condition $p < 0.001$

Figure 1. Impact of all experimental conditions on walking task. Participants (A) Timed-up and Go (TUG) performance and (B) dual-task effect on five experimental conditions: TUGb, TUG baseline; TUGme, TUG motor dual-task empty bladder; TUGmf, TUG motor dual-task full bladder; TUGce, TUG cognitive dual-task empty bladder; TUGcf, TUG cognitive dual-task full bladder.

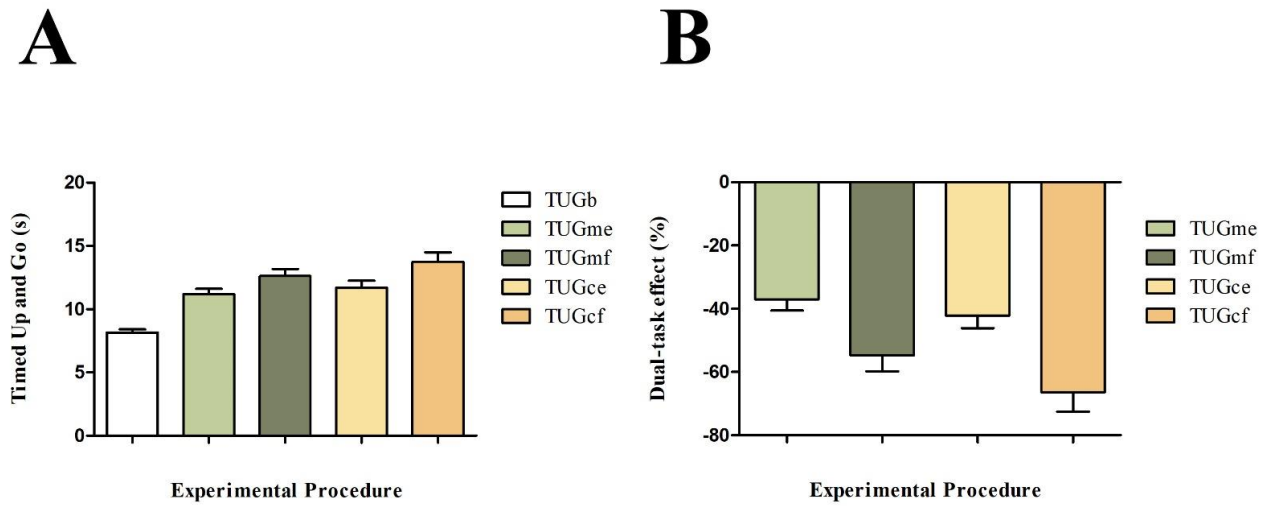
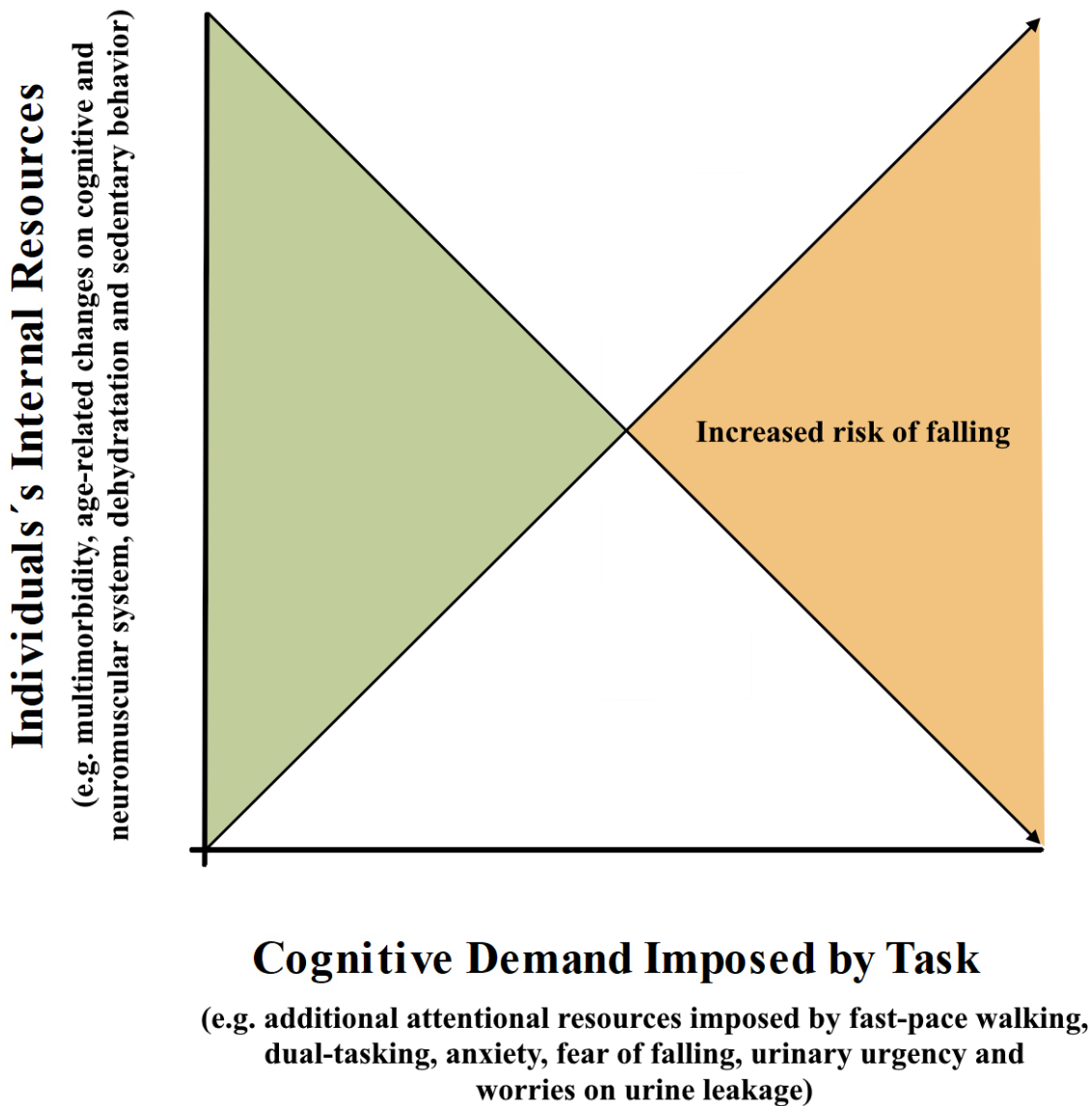


Figure 2. Theoretical framework demonstrating the relationship between the individual's internal resources and the cognitive demands imposed by a task such as rushing to reach toilet. Older adults increasingly rely on cognitive brain processes for motor control due to declines in internal resources. At the same time, additional cognitive demands are imposed by differential sources of attentional load. As a result of combining decreased individual's resources to increased cognitive demands of a particular task, task efficiency will decrease, impacting walking ability performance and finally leading to increased risk of falling.



ANEXOS

ANEXO A. Normas da revista escolhida para submissão do artigo.

https://academic.oup.com/biomedgerontology/pages/General_Instructions_1