Élliott V[1], Fraser S[1], Chaumillon J[1], de Bruin E D[2], Bherer L[1], Dumoulin C[1]
1. *Centre de recherche de l'institut universitaire de gériatrie de Montréal,* ***2.*** *Institute of Human Movement Sciences and Sport, ETH, Zurich, Switzerland.*

THE EFFECT OF VIRTUAL REALITY REHABILITATION ON THE GAIT PARAMETERS OF OLDER WOMEN WITH MIXED URINARY INCONTINENCE: A FEASIBILITY STUDY

Hypothesis / aims of study

Dual-task walking deficit and mixed urinary incontinence (UI) (1) are both associated with an increased risk of falls in older adults. Moreover, walking with a full bladder is recognised as a divided attention activity (i.e., a dual task) and the strong desire to void has been associated with increased gait variability in continent adults. Given that, the combined impact of trying to retain urine while walking (a dual task) has a negative impact on gait pattern (2), UI treatments based on dual-task training could prove to be an effective treatment for reducing UI and gait variability (linked to walking with full bladder) and, indirectly, preventing falls among the elderly. Virtual reality rehabilitation (VRR) is a proven dual-task treatment approach; one that could also prove to be effective in treating conditions linked to or acerbated by dual-task demands. Thus, the study's aim was to assess whether pelvic floor muscle (PFM) training using a dual-task training VRR approach could improve the gait parameters of older women with mixed UI when walking with full bladder.

Study design, materials and methods

This study employed a quasi-experimental pre-test, post-test design. Twenty-four community-dwelling women 65 and older with mixed UI symptoms were recruited from a bank of potential participants operated by a research centre. To be included in the study, women had to be 65 or older, live at home, be ambulatory (i.e., be able to walk indoors/outdoors without any assisted devices), understand French or English (verbal and written instruction), suffer from mixed UI and, at a minimum, experience urinary leakage secondary to urgency, physical exertion, coughing or sneezing more than twice a week in the 3 months prior to the evaluation. The presence of mixed UI was established through an affirmative answer to questions 3 and 4 on the Urogenital Distress Inventory (UDI). Participants' eligibility was assessed during a telephone interview through a standardised questionnaire.

Each woman participated in a pre-intervention evaluation, a 12-week PFM training programme that included a VRR component, and a post-intervention evaluation. The same experienced physiotherapist conducted the pre- and post-evaluations. The pre and post gait assessments measured gait velocity (total distance walked divided by the time it took), cadence (number of steps in one minute), step time (time between the heel strike of one foot to that of the opposite foot) and stride time (time between the heel strike of two consecutive footfalls of the same foot). The gait assessment took place in a hallway with taped markings at 1-metre intervals (to facilitate measurement), and was done concurrent to the 1-hour pad test. Velocity and cadence were calculated from a combination of data: walking distance, time and/or pedometer. In order to avoid the acceleration and deceleration phases of gait, a 5-meter segment was videotaped in the middle of the walking path to determine the step- and stride-time measurements. This videotape method was successfully used in a previous study.(3) Cyberlink PowerDVD™ software was used to calculate each participant's stride and step times. Specifically, each step and stride time in the 5-metre video segment was manually computed to obtain participant's mean stride and step times; the software also provided a reliability analysis for each calculation. The intra-class correlation coefficient (ICC) for the inter-evaluator variability ranged from 0.87 to 1.00 (p=0.000) and the test-retest ICC ranged from 0.88 to 1.00 (p=0.000). Finally, for the step and stride time parameters, both mean and standard deviation (SD) were calculated to determine gait variability.

The PFM/VRR training programme consisted of a weekly 60-minute exercise class, in groups of eight, for 12 consecutive weeks, supervised by an experienced physiotherapist not implicated in the evaluations. Each exercise class comprised a 10-minute education period on UI, a 30-minute session of static PFM training in different positions and a 20-minute VRR training session using a free open-source software dance game, StepMania. Participants were also given a 20-minute PFM exercise programme to do at home, five days a week.

Exercises in both the PFM and VRR components were progressed (increased in difficulty) every four weeks. The dance game stimuli included five songs with no lyrics, synchronized to dance steps. Songs were paired with visual cues instructing the participants on how to dance each of the music tracks. The dance game involved decision making: a scrolling display of arrows moved upwards on the screen to cue each move in the four cardinal positions (i.e., when the arrows reached the top of the screen), subsequent to which the participant had to make the correspondent step on the dance mat. The dance game also involved higher-level dual tasking: 1) the right and left feet were doing independent dance steps and 2) PFM contractions (represented by a red dot) were incorporated into the arrow sequences.

Data were normally distributed, thus the outcome measures (velocity, cadence, step and stride time, and standard deviation of step and stride times) for each evaluation were compared using paired t-tests.

Results

The analyses were done on a subgroup of participants (n=13); i.e., those who were able to reach the 300ml bladder volume required to start the pad test and, consequently, the gait assessment. The pre and post gait-parameter analyses were conducted on these 13 participants. They had the following means (SD): age 70.9 (3.2) years, body mass index 25.1 (3.7) kg/m^2, hysterectomy 0.7 (0.5), and pregnancies 1.8 (1.5), including 1.4 (0.5) vaginal deliveries and 0.1 (0.3) Caesarean sections. The mean score of the Short Form-12 Health Survey (SF-12) was 103.1 (8.7), which is above average compared to the general population.

Gait parameters prior to and after the PFM/VRR programme are presented in Table I.

Table I: Gait parameter outcomes on pre and post PFM/VRR programme evaluations using paired t-tests (n=13)

Gait parameters	Pre Mean ± SD	Post Mean ± SD	p-value
Velocity (m/s)	1.45 ± 0.14	1.46 ± 0.15	P = 0.929
Cadence (step/minute)	124.20 ± 17.09	125.50 ± 12.14	P = 0.840
Stride time (s)	0.97 ± 0.04	0.95 ± 0.05	P = 0.047*
Step time (s)	0.49 ± 0.02	0.48 ± 0.02	P = 0.029*
Standard deviation of stride time (s)	0.03 ± 0.03	0.01 ± 0.02	P = 0.024*
Standard deviation of step time (s)	0.03 ± 0.02	0.02 ± 0.01	P = 0.320

*Significance level was established at p≤0.05

Among the 13 participants, 10 demonstrated a significant clinical improvement (reduction > 50%) as measured by their post-intervention pad-test.

Interpretation of results

Subsequent to the PFM/VRR training programme, the 13 participants demonstrated decreased stride and step times as well as a decreased stride time SD (an indicator of gait variability). In other words, as there was less variability associated with their stride, the participants seemed to have a more stable gait, post-treatment. The improvement in step and stride times, as well as gait variability, could be explained by diminished competition for attentional brain resources as the participant is more confident in her PFMs' ability to retain urine. A significant clinical improvement on the pad test, post-intervention, also implies better bladder control, thus, fewer dual task demands.

Concluding message

The PFM/VRR training programme seems to be effective in reducing gait variability. Since gait variability is known to be associated with stability and the risk of falls, a PFM/VRR training programme could, indirectly, reduce the risks of falls among women aged 65 years and older with mixed UI. Larger studies are needed to assess the effectiveness of this new intervention in older women with mixed UI and balance problems.

References

1. Takazawa, K. and K. Arisawa, Relationship between the type of urinary incontinence and falls among frail elderly women in Japan. J Med Invest, 2005. 52(3-4): p. 165-71.
2. Booth. J. The relationship between urinary bladder control and gait in women. (Personnal communication).
3. Lovden, M., S. Schaefer, et al. (2008). "Walking variability and working-memory load in aging: a dual-process account relating cognitive control to motor control performance." Journals of Gerontology. Series B, Psychological Sciences and Social Sciences 63(3):121-128.

Disclosures

Funding: Le comité aviseur pour la recherche clinique de l'Institut universitaire de gériatrie de Montréal. Fonds de recherche en santé du Québec. **Clinical Trial:** No **Subjects:** HUMAN **Ethics Committee:** Ethics committee for Centre de recherche de l'Institut universitaire de gériatrie de Montréal. **Helsinki:** Yes **Informed Consent:** Yes