Virtual reality rehabilitation improves dual-task walking ability in older women with mixed urinary incontinence

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Hypothesis and Aim of the study

Recent research suggests that women with mixed urinary incontinence (UI) demonstrate poorer executive function (EF) than women with stress UI or continent women. [1] Poor EF has been associated with dual-task walking deficits and an increased risk of falls. [2] Accordingly, this could suggests that women with mixed UI, hence poor EF, have a greater risk of falls (e.g., when walking while talking).

The **aim** of this pilot study was to evaluate the effect of pelvic floor muscle (PFM) training, using a virtual reality rehabilitation (VRR) component, on the ability of older women with mixed UI to perform a cognitive task while walking.
Given the association between EF and mixed UI, we **hypothesized** that VRR, which requires executive control decisions, combined with a PFM training programme would improve dual-task walking ability among older women with mixed UI.

Study design and Population

Study Design:quasi-experimental, pre-test, post-test design
Population: Twenty-four community-dwelling women were recruited from a bank of potential participants operated by a research centre.

Inclusion criteria
•Be 65 or older
•Be able to walk indoor/outdoor without any assisted devices
•Understand French and English
•Suffer from mixed UI: experience urinary leakage secondary to urgency, physical exertion, coughing or sneezing more than twice a week in the 3 months prior to the evaluation, at a minimum (determined by the UDI[3]).

•*Exclusion criteria*
•Resides in an institution
•Is at risk of dementia (MMSE<26)
•Presents risks factors that could interfere with training of the PFM, such as chronic constipation and obesity (BMI>35)
•Presents risk factors that could interfere with the gynaecological evaluation, such as perineal pain or prolapse.

Methodology

The ability of participants to perform a cognitive task while walking was measured during the 1h modified pad test with standardised bladder volume on three separate occasions: two pre-training evaluations (Pre-1, Pre-2) and one post-training evaluation (Post-test). To assess the test-retest improvements in the cognitive tasks, the first two pre-training evaluations (Pre-1, Pre-2) were conducted two weeks apart. The second pre-training evaluations (Pre-2) was followed by a12-week PFM/VRR training programme and a post-training evaluation.

During the evaluation, each participant was assessed on her ability to perform a cognitive task while walking. For the cognitive task, participants performed a 2-back task[4] in which participants were presented with a series of random single-digit numbers (e.g., 8, 2, 5, 1) and asked to report out loud, in an uninterrupted and unprompted flow, the number they heard 2 numbers back (e.g., when they hear 5 they should say 8; when they hear 1 they should say 2). The 2-back task was undertaken in both a seated position (single task) and while walking (dual task). The total number of response errors were tabulated for both the single- and dual-task conditions and a 2-back error dual-task cost (DTC) score was computed for each participant (2-back error DTC = single task errors – dual task errors). [5]

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 involved in the evaluations. Each class session comprised a 10-minute education period on UI, a 30-minute session of static PFM training in different positions and a 20-minute period of VRR training using the 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 instrumental songs, 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 over the screen to cue a move in one of four cardinal directions. When the arrows reached the top of the screen, the participant had to make the corresponding 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 from the three evaluations were normally distributed, thus the 2-back error DTC outcome measures for each participant were assessed with repeated measures analysis of variance (ANOVA).

Results

Twenty-four participants completed the study; however, one participant was unable to complete the walking assessment of the post-intervention evaluation because of an acute ankle injury (n=23). The 23 participants had the following means and standard deviation (SD): age 70.7 (3.5) years, body mass index of 26.0 (3.6) kg/m^2, hysterectomy 0.7 (0.5) and pregnancy 1.6 (1.4), including 1.2 (1.2) vaginal deliveries and 0.1 (0.3) Caesarean sections. Not all participants reached the required bladder volume for the pad testing. However, there were no differences in the 2-back error DTC between those who reached the expected volume and those who did not; therefore, we completed our analysis on the whole group (p = 0.231).
The means and SD of the 2-back error DTCs, prior to and after the PFM/VRR programme, are presented in Table 1.

Table I: Mean and SD of the 2-back error DTC at Pre1, Pre2 and Post-test (n=23)

	Pre1 Mean ± SD	Pre2 Mean ± SD	Post Mean ± SD
2-back error DTC	-0.22 ± 1.64	-1.07 ± 1.22	0.30 ± 1.88

Note: A negative DTC indicates that more errors were made in the dual task than the single task.

The 2-back error DTC diminished significantly over time for the entire sample [F (2, 21) = 3.667; p = 0.034; η^2 = 0.14]. Comparisons of the three evaluations (Pre-1, Pre-2, Post-test) revealed no significant improvements in 2-back error DTCs between Pre-1 and Pre-2 (p = 0.14). Significant improvement in 2-back error DTCs occurred only after the training was completed, between Pre-2 to Post-test (p = 0.022).

Interpretation of results

Subsequent to the PFM/VRR training programme, participants demonstrated improvement in their cognitive dual-task cost scores independent of bladder volume, suggesting that the combined training had an effect on executive function. Ultimately, the inclusion of a training component specifically targeting executive control seemed to improve the participants' ability to perform a cognitive task while walking, immediately following training.

Concluding message

Study results suggest that a combined, more dynamic PFM/VRR training programme addressing both cognitive functions and physical rehabilitation could facilitate the ability to manage dual-task situations encountered in everyday life (i.e., walking and talking) among older women with mixed UI. Larger studies, as well as additional longitudinal research, is needed to determine whether this type of training, in the long-run, reduces the number of falls in the target population.

References

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