Virtual reality and the prevention of falls in the real world

Falls are a leading cause of morbidity and mortality in older adults.[1,2] Studies conducted in Europe, the USA, and Australia show that roughly a third of community-living people aged 65 years or older fall at least once per year, with half of this number having multiple falls in this period.[2] Falls impose major social and economic burdens for individuals, their families, health services, and the economy. With the number of older people increasing across the world, the costs associated with falls will increase substantially in the coming decades,[3] making the prevention of falls an urgent public health challenge.

The Article by Anat Mirelman and colleagues[4] reported in *The Lancet* presents positive findings of an innovative fall prevention strategy. Their study was a multicentre, randomised controlled trial that compared a combined treadmill training and virtual reality (VR) intervention with treadmill training alone in 302 participants aged 60–90 years at high risk of falls. The VR component consisted of motion capture of the participants' feet, which was then projected onto a screen, with challenges in the form of obstacles, pathways, and distractors that required continual adjustment of steps.

The groups were well matched at baseline, and the incident rate of falls was similar in both groups before training, with 10·7 (SD 35·6) falls per 6 months in the treadmill training group and 11·9 (39·5) falls per 6 months for the treadmill training plus VR group. The main finding, assessed in a modified intention-to-treat sample of 282 (93%) participants, was that falls were reduced by 42% in the treadmill training plus VR group compared with the treadmill training group in the 6 month period following the end of training (incident rate ratio 0·58, 95% CI 0·36–0·96; p=0·033). Furthermore, important secondary outcome measures, including gait variability during obstacle negotiation, functional balance and gait, and quality of life were significantly improved in the treadmill training plus VR group after training compared with the treadmill training group, with some gains retained at the 6 month follow-up.

The finding of a 42% reduction in falls is in line with the most effective fall preventions that have assessed more traditional group-based and homed-based exercise interventions in older people and well above the average reduction of 17% for exercise interventions reported in systematic reviews.[5] It is also notable that the reduction in falls reported in the current trial is made in comparison to a treadmill walking intervention of similar intensity, as opposed to no intervention or usual care.

Unlike traditional exercise where the principle of "use it or lose it" is assumed, the intervention was of short duration (ie, 6 weeks). The 6 month retention of improved functional balance and gait and improved obstacle negotiation suggests that task-specific learning relevant for negotiating hazards and avoiding trips in the real world might have contributed to the reduction of falls seen in the treadmill training plus VR group. This mechanism is consistent with complementary research that has shown short-term trip and slip training can have lasting benefits for fall prevention in older people.[6,7]

A major difference in the two interventions compared in this trial was the cognitive component included in the treadmill training plus VR group, yet no differential improvement in executive function was detected in participants assigned to this group (p=0·40 for executive function index, p=0·61 for attention index score). It could be that pen-and-paper cognitive tests are not sensitive enough to detect differences, but might also suggest that the intervention effects were quite specific and restricted to improved gait adaptability in situations requiring focused attention and planning.

Participants with Parkinson's disease (who represented more than 40% of the study population) benefited the most from the combined intervention (incident rate ratio 0·45, 95% CI 0·24–0·86; p=0·015). This finding is encouraging because, despite evidence for remediation of physical fall risk factors, there is little evidence of translation of these improvements into the prevention of falls in this group.[8] Notably, secondary analyses of a recent trial examining the effects of the cholinesterase inhibitor rivastigmine on falls in people with Parkinson's disease suggest the beneficial effect may also have been related more to reducing gait variability than to improving cognition.[9]

Mirelman and colleagues' findings have important implications for clinical practice. No serious adverse events occurred and adherence was good. A health economic analysis was not presented, and although it is the case that VR training is not substantially more resource-intensive than treadmill training, one-on-one supervision was used in this study. It is conceivable,

Suzanne Grala/Science Photo Library

Published Online August 11, 2016 http://dx.doi.org/10.1016/S0140-6736(16)31347-2

See Online/Articles http://dx.doi.org/10.1016/S0140-6736(16)31325-3

however, that treadmill training with a VR component could be administered in community gyms and rehabilitation clinics, and since the intervention is relatively short term in nature, throughput of many people would be possible.

As with all studies, the findings need confirmation in additional populations. It also needs to be established whether beneficial effects are retained beyond 6 months and whether older people with a history of multiple falls and those with mild cognitive impairment benefit from this intervention approach (subgroup analysis suggested that this was not the case in this trial). Finally, related research has shown the importance of gait adaptability in ageing and fall risk[10,11] and the incorporation of such adaptive stepping responses along with other exergame attributes such as brain training, engaging recreation, and performance feedback[12] require further research and application more generally to exercise programmes for older people.

Stephen R Lord
NeuRA, University of New South Wales, Randwick, NSW 2031, Australia
s.lord@neura.edu.au

I have received honorarium from Osteoporosis Australia, a not-for-profit organisation, for drafting their fall prevention section for guidelines for falls and fracture prevention.

1 Alamgir H, Muazzam S, Nasrullah M. Unintentional falls mortality among elderly in the United States: time for action. *Injury* 2012; **43:** 2065–71.
2 Rubinstein L. Falls in older people: epidemiology, risk factors and strategies for prevention. *Age Ageing* 2006; **35** (suppl 2)**:** ii37–41.
3 Murray C, Vos T, Lozano R, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012; **380:** 2197–223.
4 Mirelman A, Rochester L, Maidan I, et al. Addition of a non-immersive virtual reality component to treadmill training to reduce fall risk in older adults (V-TIME): a randomised controlled trial. *Lancet* 2016; published online Aug 11. http://dx.doi.org/10.1016/S0140-6736(16)31325-3.
5 Sherrington C, Whitney JC, Lord SR, Herbert RD, Cumming RG, Close JC. Effective approaches to exercise in the prevention of falls—a systematic review and meta-analysis. *J Am Geriatr Soc* 2008; **56:** 2234–43.
6 Pai YC, Bhatt T, Yang F, Wang E. Perturbation training can reduce community-dwelling older adults' annual fall risk: a randomized controlled trial. *J Gerontol A Biol Sci Med Sci* 2014; **69:** 1586–94.
7 Okubo Y, Schoene DS, Lord SR. Step training improves reaction time, gait and balance and reduces falls in older people: a systematic review and meta-analysis. *Br J Sport Med* 2016; published online Jan 8. DOI:10.1136/bjsports-2015-095452.
8 Canning CG, Paul SS, Nieuwboer A. Prevention of falls in Parkinson's disease: a review of fall risk factors and the role of physical interventions. *Neurodegener Dis Manage* 2014; **4:** 203–21.
9 Henderson EJ, Lord SR, Close JCT, et al. Rivastigmine to stabilise gait in Parkinson's disease (ReSPonD): a phase 2, randomised, double blind, placebo controlled trial to evaluate the effect of rivastigmine on gait in patients with Parkinson's disease with a history of a fall. *Lancet Neurol* 2016; **15:** 249–58.
10 Caetano MJD, Lord SR, Schoene D, Pelicioni PH, Sturnieks DL, Menant JC. Age-related changes in gait adaptability in response to unpredictable obstacles and stepping targets. *Gait Posture* 2016; **46:** 35–41.
11 Houdijk H, van Ooijen MW, Kraal JJ, et al. Assessing gait adaptability in people with a unilateral amputation on an instrumented treadmill with a projected visual context. *Phys Ther* 2012; **92:** 1452–60.
12 Schoene D, Valenzuela T, Lord SR, de Bruin ED. The effect of interactive cognitive-motor training in reducing fall risk in older people: a systematic review. *BMC Geriatr* 2014; **14:** 107.