Session 7B Concurrent Understanding balance

Keith Hill is Professor of Allied Health at La Trobe University and Northern Health, and a senior researcher at the National Ageing Research Institute. He is a physiotherapist with almost 30 years experience in practice, and 15 years in research related to improving health and other outcomes for older people.

Dr Daina Sturnieks is a Senior Research Officer at Neuroscience Research Australia. She completed her PhD in biomechanics, specialising in gait mechanics and knee osteoarthritis. Dr Sturnieks now works with Prof Stephen Lord and Dr Richard Fitzpatrick, conducting research to better understand physiological and biomechanical aspects of human balance systems.

Dr Jennifer Nitz leads the research team investigating postural stability and balance decline with ageing in men and women. Her research over the past 10 years has additionally focused on falls prevention in residential aged care and interventions to improve functional balance in adults of all ages, various medical conditions and community environments.

Marcella Kwan has just completed her PhD in public health at University of New South Wales, looking at falls risk factors in Chinese older people.

Karol Connors is an experienced physiotherapist who has worked in Rehabilitation in a variety of settings. Since completing the Feldenkrais training, she has undertaken research into the Feldenkrais Method and balance. She is currently working as the Physiotherapy Manager in a facility which specialises in palliative care and progressive neurological diseases.

Martin Spink is a podiatry graduate from La Trobe University, Melbourne and works in a private podiatry practice. He is also part of the musculoskeletal research centre at La Trobe University, working towards his PhD with a RCT on the efficacy of a multifaceted podiatry intervention to improve balance and prevent falls.

Anna Hatton is a Research Fellow at University of Salford. She received her BSc (Hons) Physiotherapy and recently completed her PhD at Teesside University. Anna will be conducting research at NeuRA towards the end of 2010, having received an Endeavour Award. Her research interests include footwear, sensorimotor function and balance performance.

Dr Stephanie Woodley is a lecturer in the Otago School of Medical Sciences at the University of Otago. She is a physiotherapist with a PhD in Anatomy and Structural Biology. She delivered the Otago Exercise Programme in the VIP trial. Her research interest is clinical anatomy of the musculoskeletal system, with a particular interest in its application to physiotherapy practice.

BALANCE IMPAIRMENT – AN UNRECOGNISED CONTRIBUTOR TO FALL RISK IN ANTI-EPILEPTIC MEDICATION USERS

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Background:
Anti-epileptic drugs (AEDs) are used for common health problems including epilepsy, migraine, trigeminal neuralgia, neuropathic pain syndromes and psychiatric disorders, which all increase in prevalence with age. Patients taking AEDs have increased fracture risk. The contribution of balance impairment to increased fracture risk with AED use remains poorly explored.

Aim:
To determine the effect of AEDs on balance and related physical performance falls risk factors, using an AED-discordant twin/sibling pairs sample.

Methods:
Fifty-eight participants were recruited (29 people taking AEDs, 12 male, mean age 45 years; and their twin [5 monozygous and 5 dizygous twins], or same gender sibling [± 3 years, n = 19]). Balance and related measures were assessed using detailed laboratory and clinical assessment, including the Chattecx Balance Platform, Lord's balance test, KinCom, muscle dynamometer, Step Test, Coordinated Stability Test, activity and gait measures. Falls, fractures and medical history data were collected. Mean within-pair differences were examined using paired t-tests; and independent t-tests to compare mean within-pair differences between sub-groups.

Results:
Significant mean within-pair differences were seen between AED users and non-users for several static and dynamic balance measures, with AED users having poorer performance ($p < 0.0125$). AED users also had significantly lower activity, but there were no significant differences in leg strength or gait measures. Sub-group analyses indicated significant differences on several balance measures for those on AED polytherapy, longer duration therapy, and those with a fall in the previous year ($p < 0.0125$). Five AED users, and no AED non-users had a history of low-trauma fracture (McNemar's chi square $p = 0.037$).

Conclusion:
AED users had impaired balance compared to their non AED-user twin/sibling. AED users taking polytherapy, having longer therapy duration or with recent falls, had poorer balance performance. Practitioners need to consider options to manage balance impairment and falls risk when prescribing AEDs, particularly with older people with other falls risk factors.

THE PHYSIOLOGY AND BIOMECHANICS OF PROTECTIVE STEPPING IN YOUNG AND OLDER ADULTS

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Aim:
Stepping is an important strategy by which the brain controls balance and inappropriate stepping has been identified as a risk factor for falls in older people.[1,2] Velocity and displacement thresholds for stepping have previously been determined using position-controlled systems. However, the level of force of the perturbation would also influence the "decision" to step. This study used perturbations of controlled force, to examine the capacity of the balance system to mount an opposing force and determine individual's stepping thresholds.

Methods:
Sixteen young and 243 older adults were connected to a motor via cables extending from their pelvis. The motor applied a constant force for 0.5 sec in different directions. Subjects were told to try not to step. Balance, strength, reaction time, proprioception and visual examinations were conducted in the older adults.

Results:
In successful (non-step) trials, the young adult's centre of mass moved further towards the base of support border, compared to older adults. Significantly lower anterior force thresholds for stepping were found in older adults (50.3 ± 14.0 N), compared with young adults (81.1 ± 17.6 N), controlling for body weight ($F(1,254) = 85.5$, $p < 0.001$). Older adults also had significantly lower lateral thresholds (71.7 ± 21.4 N), compared with young adults (94.0 ± 21.5 N), controlling for body weight ($F(1,248) = 20.4$, $p < 0.001$). Knee strength and postural sway variables predicted anterior ($F(3,234) = 13.7$, $p < 0.01$) and lateral ($F(2,165) =$

21.3, $p < 0.01$) force thresholds, explaining 13.9% and 19.6% of the variance, respectively. Reaction time and postural sway predicted posterior thresholds ($F(4,232) = 12.3$, $p < 0.01$), explaining 16.1% of the variance.

Conclusion:
Less forceful perturbations are required to induce steps in older people. Stepping thresholds were associated with physiological factors, suggesting that force-controlled perturbations produce a response based on the ability to generate an effective reaction. Data from a 12-month falls follow-up study will be available to investigate stepping performance as a predictor of future falls. This information will be used to design an exercise intervention to improve stepping performance.

References:
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CONTRIBUTION SENSORIMOTOR FUNCTION MAKES TO BALANCE AND POSTURAL STABILITY IN MEN

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Aim:
To investigate the relationship between sensory and motor function and balance and postural stability decline in men as they age.

Methods:
A cross-section observational study measured quadriceps, hip adductor and abductor strength, vision (high and low contrast acuity, edge perception), somatosensation (tactile acuity, vibration sense, joint position sense), vestibular (dynamic visual acuity (DVA)) function, reaction time, functional (FR) and lateral reach (LR), timed up and go (TUG), step test (ST), modified clinical test for sensory interaction of balance (mCTSIB) and single limb stance (SLS) in 106 men aged 30 to 80 years.

Results:
All sensorimotor, reaction time, balance and postural stability measures showed significant decline ($p < 0.05$) by the 60s. Regression analyses revealed a significant contribution from sensory and strength factors with reaction time also contributing in most instances to the decline in FR (50.4%), LR (38%), TUG (55.2%), ST (53.3%), mCTSIB (29.7%, 32.8%, 40.7%, 27.2%) and SLS (32.8%) performance.

Conclusion:
Balance and postural stability decline in men mirrors previous findings in women. The decline in sensori-motor function and their contribution to these findings have been confirmed. The results emphasise the importance of pre-emptive screening of balance in younger men, especially those working in industries such as the construction industry where falls risk is high and the current number of falls is not being curtailed by occupational health and safety legislative requirements. Results also suggest pre-emptive exercise programs for fall prevention should include aspects that challenge the sensory systems, fast recruitment elements and functional strengthening to address the incidence of men's falls.

MCH STANDING ABILITY IS AN INDEPENDENT PREDICTOR OF FALLS IN ELDERLY TAIWANESE PEOPLE

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Aim:
To identify physiological and functional performance factors associated with falls in community dwelling older people living in Taiwan.

Methods:
Two hundred and eighty participants, aged between 65 and 91 years (mean age 74.9 years), underwent the Physiological Profile Assessment (PPA) and a range of functional balance and mobility tasks including the minimum chair height (MCH) test. This test measures the lowest chair height from which a participant can stand up.

Results:
In the 12 months prior to the study, 81 participants (28.9%) experienced one or more falls and 57 (20.4%) suffered a fall-related injury. The fallers had significantly higher PPA fall risk scores than the non-fallers and performed significantly worse

in the PPA tests of depth perception, finger-press reaction time and coordinated stability. With regard to functional performance, the fallers performed significantly worse than non-fallers in the MCH test, near tandem stand, single leg stand and Berg alternate stepping test. Discriminant factor analysis revealed that poor performance in the MCH test was a significant predictor of falls after adjusting for PPA fall risk score. The best multivariate model for discriminating between fallers and non-fallers in this sample included the MCH and depth perception tests, which together correctly classified 61.4% of participants into faller and non-faller groups.

Conclusion:
In this study, MCH test was found to be an independent risk factor for falls. It is a functional test similar to deep squatting and requires joint flexibility, strength and balance when performed well. As the MCH test is quick to administer it may have scope for clinical application.

WHAT CAN WE LEARN FROM THE FELDENKRAIS METHOD ABOUT BALANCE RETRAINING?

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Aim:
The Feldenkrais Method has been found to be effective in improving balance,[1] but there has been little research into the possible mechanisms behind the effectiveness of these classes. The aim of this study was to analyse a series of Feldenkrais Method balance classes to improve understanding of the content of these classes, and also identify features of the classes which may be of value to be included in standard balance retraining programs.

Methods:
The lessons were transcribed and the content analysed using a qualitative methodology approach (content analysis).

Results:
Key findings which distinguished these balance classes were the use of exploratory learning strategies, repetition with extensive variability, a focus on body awareness training, strategies to improve inter-segmental control between the head and pelvis using the trunk and a lack of external feedback.[2]

Conclusion:
The Feldenkrais Awareness Through Movement lessons contained many elements consistent with current theories of motor skill acquisition and postural control, providing a sound theoretical basis for the effectiveness of the Feldenkrais approach in improving balance. There were several key strategies used in the classes that could be incorporated into standard balance classes which may enhance their effectiveness. The methodology used in this study may provide a useful model for similar investigations into other balance training approaches.

References:
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FOOT STRENGTH AND RANGE OF MOTION ASSOCIATED WITH BALANCE AND FUNCTION IN OLDER ADULTS

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Aim:
To determine the relative contribution of foot and ankle strength and range of motion (ROM) to performance in a range of balance and functional ability tests.

Methods:
Three hundred and five community-dwelling people (94 men and 211 women, mean age 73.9 years, standard deviation 5.9 years) completed a battery of tests to assess their balance, functional ability, and foot and ankle strength and range of motion. Statistical analysis was conducted to assess the relationship between foot and ankle strength and range of motion variables and performance in the balance and functional tests.

Results:
Most foot and ankle strength and range of motion characteristics were associated with performance on the balance and functional tests in univariate analyses. Hierarchical regression analysis identified that hallux plantarflexion strength and ankle inversion-eversion range of motion were the most common significant and independent predictors of balance and functional test performance, explaining up to 25% of the variance in the test scores.

Conclusion:
Foot and ankle characteristics, particularly plantarflexor strength of the hallux and ankle inversion-eversion flexibility are important determinants of balance and functional ability in older people. Intervention programs to improve foot and ankle strength and range of motion may achieve improvements in balance and functional ability for older people, thereby potentially reducing the risk of falls.

THE EFFECT OF TEXTURED FOOT INSOLES ON STANDING BALANCE IN OLDER FALLERS

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Aim:
Textured surfaces and foot insoles have been shown to improve balance performance in healthy young[1] and older adults,[2] possibly by providing enhanced plantar tactile stimulation. This study aimed to explore the effect of textured foot insoles on postural sway variables during quiet standing in older fallers – a new area of investigation.

Methods:
In a within-subject design, 30 community-dwelling older adults (21 female; age mean 79.0, SD 7.1 years) with a history of ≥ 2 falls in the previous year, conducted tests of bilateral quiet standing (30 seconds) with eyes open and eyes closed under each of two randomised conditions - wearing, within usual footwear, textured insoles (intervention) and smooth insoles (control). Centre of pressure (CoP) velocity (mm s^{-1}), anterior-posterior and mediolateral sway range and standard deviation (mm), were extracted from a Kistler force platform and analysed over three different time intervals: the first 10, latter 20 and overall 30 seconds of standing.
Results:
A paired t-test showed a statistically significant increase in CoP velocity for textured insoles versus control during the first 10 seconds of quiet standing with eyes closed (mean increase 6.5 mm s^{-1}, 95% CI 0.5 to 12.1, p = 0.035). No significant differences were reported for any other postural sway variables.

Conclusion:
The CoP results provide evidence that the textured insoles in this study have a short-term de-stabilising effect on standing balance in older fallers, immediately after rising from sitting. Conclusions from the other variables are less clear possibly because of the large variance in measurements. Further investigation, including during dynamic balance activities, is necessary.

References:
1. Hatton AL, Dixon J, Martin D et al. The effect of textured surfaces on postural stability and lower limb muscle activity. J Electromyogr Kinesiol. 2009:19(5):957-64.
2. Palluel E, Nougier V, Olivier I. Do spike insoles enhance postural stability and plantar-surface cutaneous sensitivity in the elderly? Age 2008; 30(1):53-61.

OEP GROUP CLASSES ± HIP ABDUCTOR EXERCISES: RANDOMISED CONTROLLED TRIAL

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Aims:
(i) To assess the effectiveness of group Otago Exercise Programme (OEP) classes on falls risk factors
(ii) To measure the impact on falls risk of adding exercises aimed at strengthening the hip abductor muscles.

Methods:
We recruited 44 women aged ≥75 years who were randomised into one of two groups to receive: (i) the OEP or (ii) the OEP Plus, which included additional hip strengthening exercises. A physiotherapist delivered the programmes twice weekly for 12 weeks to groups of up to nine women, in a Dunedin community hall. Measurements to compare falls risk (balance and muscle strength) between the two groups were taken before and after completing the classes. We used paired t-tests to compare the baseline and follow-up measures, and linear regression to evaluate group differences.

Results:
The mean age of participants was 79.7 years (SD 3.3). On average, participants were taking 8 (SD 1) prescription medications, and 20 (45%) reported falling in the previous year. All participants improved in their performance of routine clinical measures (complete short physical performance battery, step test, repeated chair stand test, timed up and go test, 3 metre walk), and right and left hip abductor strength ($p < 0.05$). Physical function measures did not differ between the two types of classes except for improvement in the left hip abductor strength and left lateral

reach in the OEP Plus group ($p < 0.05$). All participants agreed or strongly agreed with the statements that the exercise classes were beneficial and enjoyable.

Conclusion:
The OEP delivered by a physiotherapist in a group setting was effective in reducing falls risk. The OEP Plus programme further increased hip abductor strength and lateral reach but was not associated with further improvement in other physical function measures. The findings from this pilot study are preliminary and need to be repeated in a larger trial.