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**A smart insole to promote healthy aging for frail elderly individuals: specifications, design, and preliminary results**

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**Abstract**

**BACKGROUND:** Older individuals frequently experience reversible "frailty syndrome," increasing incidence of disability. Although physical exercise interventions may delay functional decline, there are difficulties in implementing them and performing seamless follow-up at home. Very few technological solutions attempt to address this challenge and improve individual participation.

**OBJECTIVE:** Our objectives are to (1) develop a technological solution designed to support active aging of frail older persons, (2) conduct a first laboratory evaluation of the device, and (3) design a multidimensional clinical trial to validate our solution.

**METHODS:** We conducted a first phase of multidisciplinary meetings to identify real end users and health professional's unmet needs, and to produce specifications for the architecture of the solution. In a second phase, we performed laboratory tests of the first proposed prototype (a smart insole) with 3 healthy volunteers. We then designed an ongoing clinical trial to finalize the multidimensional evaluation and improvement of the solution.

**RESULTS:** To respond to the needs expressed by the stakeholders (frailty monitoring and adherence improvement), we developed a prototype of smart shoe insole to monitor key parameters of frailty during daily life and promote walking. It is a noninvasive wireless insole, which automatically measures gait parameters and transmits information to a remote terminal via a secure Internet connection. To ensure the solution's autonomy and transparency, we developed an original energy harvesting system, which transforms mechanical energy produced by the user's walking movement into electrical energy. The first laboratory tests of this technological solution showed good reliability measures and also a good acceptability for the users. We have planned an original iterative medical research protocol to validate our solution in real life.

**CONCLUSIONS:** Our smart insole could support preventive strategies against disability in primary care by empowering the older patients without increasing the busy health professional's workload.

**TRIAL REGISTRATION:** Clinicaltrials.gov NCT02316600;

<https://clinicaltrials.gov/ct2/results?term=NCT02316600&Search=Search>. Accessed: 2015-05-13.

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**PDF Y Endnote Y**

**Associations between mobility, cognition, and brain structure in healthy older adults**

Demnitz N, Zsoldos E, Mahmood A, Mackay CE, Kivimaki M, Singh-Manoux A, Dawes H, Johansen-Berg H, Ebmeier KP, Sexton CE.

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### Abstract

Mobility limitations lead to a cascade of adverse events in old age, yet the neural and cognitive correlates of mobility performance in older adults remain poorly understood. In a sample of 387 adults (mean age  $69.0 \pm 5.1$  years), we tested the relationship between mobility measures, cognitive assessments, and MRI markers of brain structure. Mobility was assessed in 2007-2009, using gait, balance and chair-stands tests. In 2012-2015, cognitive testing assessed executive function, memory and processing-speed; gray matter volumes (GMV) were examined using voxel-based morphometry, and white matter microstructure was assessed using tract-based spatial statistics of fractional anisotropy, axial diffusivity (AD), and radial diffusivity (RD). All mobility measures were positively associated with processing-speed. Faster walking speed was also correlated with higher executive function, while memory was not associated with any mobility measure. Increased GMV within the cerebellum, basal ganglia, post-central gyrus, and superior parietal lobe was associated with better mobility. In addition, better performance on the chair-stands test was correlated with decreased RD and AD. Overall, our results indicate that, even in non-clinical populations, mobility measures can be sensitive to sub-clinical variance in cognition and brain structures.

### PDF Y Endnote Y

#### **Beta-blocker use and fall risk in older individuals; original results from two studies with meta-analysis**

Ham AC, van Dijk SC, Swart KMA, Enneman AW, van der Zwaluw NL, Brouwer-Brolsma EM, van Schoor NM, Carola Zillikens M, Lips P, de Groot LCPGM, Hofman A, Witkamp RF, Uitterlinden AG, Stricker BH, van der Velde N.

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### Abstract

**AIMS:** To investigate the association between use of beta-blockers and beta-blocker characteristics - selectivity, lipid solubility, intrinsic sympathetic activity (ISA), and CYP2D6 enzyme metabolism - and fall risk.

**METHODS:** Data from two prospective studies were used, including community-dwelling individuals, N=7,662 (the Rotterdam Study) and 2,407 (B-PROOF), all aged  $\geq 55$  years. Fall incidents were recorded prospectively. Time-varying beta-blocker use was determined using pharmacy dispensing records. Cox proportional hazard models adjusted for age and sex were applied to determine the association between beta-blocker use, their characteristics - selectivity, lipid solubility, ISA, and CYP2D6 enzyme metabolism - , and fall risk. The results of the studies were combined using meta-analyses.

**RESULTS:** In total 2,917 participants encountered a fall during a total follow-up time of 89,529 years. Meta-analysis indicated no association between use of any beta-blocker, compared to non-use, and fall risk, HR=0.97 (95%CI 0.88; 1.06). Neither was use of a selective beta-blocker associated with fall risk, HR=0.92 (95%CI 0.83; 1.01). Use of a non-selective beta-blocker was associated with an increased fall risk, HR=1.22 (95%CI 1.01; 1.48). Other beta-blocker characteristics including lipid solubility and CYP2D6 enzyme metabolism were not associated with fall risk.

**CONCLUSION:** Our study suggests that use of a non-selective beta-blocker, contrary to selective beta-blockers, is associated with an increased fall risk in an older population. In clinical practice, beta-blockers have been shown effective for a variety of cardiovascular indications. Though, fall risk should be considered when prescribing a beta-blocker in this age group, and the pros and cons for beta-blockers classes should be taken into consideration.

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**PDF Y Endnote Y**

**Comparing executive function, evoked hemodynamic response, and gait as predictors of variations in mobility for older adults**

Halliday DWR, Hundza SR, Garcia-Barrera MA, Klimstra M, Commandeur D, Lukyn TV, Stawski RS, MacDonald SWS.

*J. Clin. Exp. Neuropsychol.* 2017; ePub(ePub): ePub.

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**Abstract**

**OBJECTIVE:** Falls represent a major concern for older adults and may serve as clinically salient index events for those presenting in the prodromal stages of mild cognitive impairment. Declines in executive function performance and in gait consistency have shown promise in predicting fall risk; however, associated neurophysiological underpinnings have received less attention. In this study, we used a multimodal approach to assess fall risk in a group of older adults with and without a previous fall history.

**METHOD:** Processing speed, inductive reasoning, verbal fluency, crystallized ability, episodic memory, and executive functioning were assessed using standardized neuropsychological tests. Cognitive interference was assessed using the Multi-Source Interference Task. Spatiotemporal gait parameters were assessed with and without cognitive load using a 6.4-m instrumented walkway. Hemodynamic responses were measured using functional near-infrared spectroscopy.

**RESULTS:** Whereas no group differences were observed in cognitive behavioral performance, during a cognitive interference task fallers displayed more oxygenated hemoglobin across the prefrontal cortex than nonfallers, suggesting that engaging in the cognitive task was more effortful for them overall, therefore eliciting greater cortical activation. Between-group differences in spatial as well as temporal gait parameters were also observed.

**CONCLUSIONS:** These results are in keeping with assertions that diminished executive control is related to fall risk. Notably, the group differences observed in prefrontal cortical activation and in gait parameters may ultimately precede those observed in cognitive behavioral performance, with implications for measurement sensitivity and early identification.

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**Effects of supervised vs. Unsupervised training programs on balance and muscle strength in older adults: a systematic review and meta-analysis**

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### **Abstract**

**BACKGROUND:** Balance and resistance training can improve healthy older adults' balance and muscle strength. Delivering such exercise programs at home without supervision may facilitate participation for older adults because they do not have to leave their homes. To date, no systematic literature analysis has been conducted to determine if supervision affects the effectiveness of these programs to improve healthy older adults' balance and muscle strength/power.

**OBJECTIVES:** The objective of this systematic review and meta-analysis was to quantify the effectiveness of supervised vs. unsupervised balance and/or resistance training programs on measures of balance and muscle strength/power in healthy older adults. In addition, the impact of supervision on training-induced adaptive processes was evaluated in the form of dose-response relationships by analyzing randomized controlled trials that compared supervised with unsupervised trials.

**DATA SOURCES:** A computerized systematic literature search was performed in the electronic databases PubMed, Web of Science, and SportDiscus to detect articles examining the role of supervision in balance and/or resistance training in older adults.

**STUDY ELIGIBILITY CRITERIA:** The initially identified 6041 articles were systematically screened. Studies were included if they examined balance and/or resistance training in adults aged  $\geq 65$  years with no relevant diseases and registered at least one behavioral balance (e.g., time during single leg stance) and/or muscle strength/power outcome (e.g., time for 5-Times-Chair-Rise-Test). Finally, 11 studies were eligible for inclusion in this meta-analysis. **STUDY APPRAISAL:** Weighted mean standardized mean differences between subjects (SMDbs) of supervised vs. unsupervised balance/resistance training studies were calculated. The included studies were coded for the following variables: number of participants, sex, age, number and type of interventions, type of balance/strength tests, and change (%) from pre- to post-intervention values. Additionally, we coded training according to the following modalities: period, frequency, volume, modalities of supervision (i.e., number of supervised/unsupervised sessions within the supervised or unsupervised training groups, respectively). Heterogeneity was computed using  $I^2$  and  $\chi^2$  statistics. The methodological quality of the included studies was evaluated using the Physiotherapy Evidence Database scale.

**RESULTS:** Our analyses revealed that in older adults, supervised balance/resistance training was superior compared with unsupervised balance/resistance training in improving measures of static steady-state balance (mean SMDbs = 0.28,  $p = 0.39$ ), dynamic steady-state balance (mean SMDbs = 0.35,  $p = 0.02$ ), proactive balance (mean SMDbs = 0.24,  $p = 0.05$ ), balance test batteries (mean SMDbs = 0.53,  $p = 0.02$ ), and measures of muscle strength/power (mean SMDbs = 0.51,  $p = 0.04$ ). Regarding the examined dose-response relationships, our analyses showed that a number of 10-29 additional supervised sessions in the supervised training groups compared with the unsupervised training groups resulted in the largest effects for static steady-state balance (mean SMDbs = 0.35), dynamic steady-state balance (mean SMDbs = 0.37), and muscle strength/power (mean SMDbs = 1.12). Further,  $\geq 30$  additional supervised sessions in the supervised training groups were needed to produce the largest effects on proactive balance (mean SMDbs = 0.30) and balance

test batteries (mean SMDbs = 0.77). Effects in favor of supervised programs were larger for studies that did not include any supervised sessions in their unsupervised programs (mean SMDbs: 0.28-1.24) compared with studies that implemented a few supervised sessions in their unsupervised programs (e.g., three supervised sessions throughout the entire intervention program; SMDbs: -0.06 to 0.41).

**LIMITATIONS:** The present findings have to be interpreted with caution because of the low number of eligible studies and the moderate methodological quality of the included studies, which is indicated by a median Physiotherapy Evidence Database scale score of 5. Furthermore, we indirectly compared dose-response relationships across studies and not from single controlled studies.

**CONCLUSIONS:** Our analyses suggest that supervised balance and/or resistance training improved measures of balance and muscle strength/power to a greater extent than unsupervised programs in older adults. Owing to the small number of available studies, we were unable to establish a clear dose-response relationship with regard to the impact of supervision. However, the positive effects of supervised training are particularly prominent when compared with completely unsupervised training programs. It is therefore recommended to include supervised sessions (i.e., two out of three sessions/week) in balance/resistance training programs to effectively improve balance and muscle strength/power in older adults.

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### **Falls are associated with lower self-reported functional status in patients after stroke**

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*Arch. Phys. Med. Rehabil.* 2017; ePub(ePub): ePub.

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#### **Abstract**

**OBJECTIVE:** To evaluate the association between falls and functional status after stroke.

**DESIGN:** Secondary analysis of data from the randomised, controlled FIT-Stroke trial. Outcomes were measured at the time of discharge from inpatient rehabilitation (T0) and after 12 weeks (T1). Between T0 and T1, all patients attended an outpatient rehabilitation program that included the FIT-Stroke intervention.

**SETTING:** Nine Dutch centres for rehabilitation medicine.

**PARTICIPANTS:** Outpatients after stroke with mild cognitive impairments (Mini-Mental State Examination [MMSE]  $\geq$  24), discharged home after inpatient rehabilitation and able to walk 10 meters independently.

**INTERVENTIONS:** Not applicable.

**MAIN OUTCOME MEASURES:** The primary outcome was the change in Stroke Impact Scale (SIS)-16 score. The independent variable was one or more falls after stroke. The outcome was corrected for type of outpatient rehabilitation (group allocation), severity of hemiplegia (Motricity Index; MI), and cognition (MMSE) at baseline using multiple regression analysis.

**RESULTS:** The study included 250 patients after stroke. Complete data were available for 199 patients with a mean age of 58 years (SD 10), MMSE of 28.1 (SD 2), and MI of 130 (SD 43). Fifty-five patients (28%) reported falls during the 12 weeks after discharge from inpatient rehabilitation. Falls were significantly associated with less improvement in functional status as assessed with the SIS-16

( $p=0.009$ ).

**CONCLUSION:** Almost 30% of this stroke population with minor cognitive deficits and moderate to high mobility scores reported falls during the 12 weeks of outpatient rehabilitation. Falls were negatively associated with self-reported functional status measured by the change in SIS-16 score. Therefore, it is important to identify patients with high risk of falls and implement strategies to reduce falls.

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#### PDF Y Endnote Y

#### **Frailty assessment in older adults using upper-extremity function: index development**

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#### **Abstract**

**BACKGROUND:** Numerous multidimensional assessment tools have been developed to measure frailty; however, the clinical feasibility of these tools is limited. We previously developed and validated an upper-extremity function (UEF) assessment method that incorporates wearable motion sensors. The purpose of the current study was, to: 1) cross-sectionally validate the UEF method in a larger sample in comparison with the Fried index; 2) develop a UEF frailty index to predict frailty categories including non-frail, pre-frail, and frail based on UEF parameters and demographic information, using the Fried index as the gold standard; and 3) develop a UEF continuous score (points scores for each UEF parameter and a total frailty score) based on UEF parameters and demographic information, using the Fried index as the gold standard.

**METHODS:** We performed a cross-sectional validation and index development study within the Banner Medical Center, Tucson, and Banner Sun Health Research Institute, Sun City, Arizona. Community-dwelling and outpatient older adults ( $\geq 60$  years;  $n = 352$ ; 132 non-frail, 175 pre-frail, and 45 frail based on Fried criteria) were recruited. For the UEF test, each participant performed a 20-s elbow flexion, within which they repetitively and rapidly flexed and extended their dominant elbow. Using elbow motion outcomes two UEF indexes were developed (categorical and score). The Fried index was measured as the gold standard.

**RESULTS:** For the categorical index, speed of elbow flexion, elbow range of motion, elbow moment, number of flexion, speed variability and reduction within 20 s, as well as body mass index (BMI) were included as the pre-frailty/frailty predictor parameters. Results from 10-fold cross-validation showed receiver operator characteristic area under the curve of  $0.77 \pm 0.07$  and  $0.80 \pm 0.12$  for predicting Fried pre-frailty and frailty, respectively. UEF score (0.1 to 1.0) was developed using similar UEF parameters.

**CONCLUSIONS:** We present an objective, sensor-based frailty assessment tool based on physical frailty features including slowness, weakness, exhaustion (muscle fatigue), and flexibility of upper-extremity movements. Within the current study, the method was validated cross-sectionally using the Fried index as the gold standard and the UEF categorical index and UEF frailty score were developed for research purposes and potentially for future clinical use.

## PDF Y Endnote Y

### Functional performance and balance in the oldest-old

Kafri M, Hutzler Y, Korsensky O, Laufer Y.

*J. Geriatr. Phys. Ther.* 2017; ePub(ePub): ePub.

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#### Abstract

**BACKGROUND AND PURPOSE:** The group of individuals 85 years and over (termed oldest-old) is the fastest-growing population in the Western world. Although daily functional abilities and balance capabilities are known to decrease as an individual grows older, little is known about the balance and functional characteristics of the oldest-old population. The aims of this study were to characterize balance control, functional abilities, and balance self-efficacy in the oldest-old, to test the correlations between these constructs, and to explore differences between fallers and nonfallers in this age group.

**METHODS:** Forty-five individuals living in an assisted living facility who ambulated independently participated in the study. The mean age was 90.3 (3.7) years. Function was tested using the Late-Life Function and Disability Instrument (LLFDI). Balance was tested with the mini-Balance Evaluation System Test (mini-BESTest) and the Timed Up and Go (TUG) test. Balance self-efficacy was tested with the Activities-Specific Balance Confidence (ABC) scale.

**RESULTS:** The mean total function LLFDI score was 63.2 (11.4). The mean mini-BESTest score was 69.8% (18.6%) and the mean TUG time was 12.6 (6.9) seconds. The mean ABC score was 80.2% (14.2%). Good correlation ( $r > 0.7$ ) was observed between the ABC and the function component of the LLFDI, as well as with the lower extremity domains. Correlations between the mini-BESTest scores and the LLFDI were fair to moderate ( $r$ 's range: 0.38-0.62). Age and ABC scores were significant independent explanators of LLFDI score ( $P = .0141$  and  $P = .0009$ , respectively). Fallers and nonfallers differed significantly across all outcome measures scores, except for TUG and for the "Reactive Postural Control" and "Sensory Orientation" domains of the mini-BESTest.

**DISCUSSION AND CONCLUSIONS:** The results of this study provide normative data regarding the balance and functional abilities of the oldest-old, and indicate a strong association between self-efficacy and function. These results emphasize the importance of incorporating strategies that maintain and improve balance self-efficacy in interventions aimed at enhancing the functional level of this cohort.

## PDF Endnote Y

### Inertial sensors to assess gait quality in patients with neurological disorders: a systematic review of technical and analytical challenges

Vienne A, Barrois RP, Buffat S, Ricard D, Vidal PP.

*Front. Psychol.* 2017; 8: e817.

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### Abstract

Gait disorders are major causes of falls in patients with neurological diseases. Understanding these disorders allows prevention and better insights into underlying diseases. InertialLocoGraphy (ILG) - the quantification of gait by using inertial measurement units (IMUs) - shows great potential to address this public health challenge, but protocols vary widely and normative values of gait parameters are still unavailable. This systematic review critically compares ILG protocols, questions features extracted from inertial signals and proposes a semiological analysis of clinimetric characteristics for use in neurological clinical routine. For this systematic review, PubMed, Cochrane and EMBASE were searched for articles assessing gait quality by using IMUs that were published from January 1, 2014 to August 31, 2016. ILG was used to assess gait in a wide range of neurological disorders - including Parkinson disease, mild cognitive impairment, Alzheimer disease, cerebral palsy, and cerebellar atrophy - as well as in the faller or frail older population and in people presenting rheumatological pathologies. However, results have not yet been driving changes in clinical practice. One reason could be that studies mainly aimed at comparing pathological gait to healthy gait, but there is stronger need for semiological descriptions of gait perturbation, severity or prognostic assessment. Furthermore, protocols used to assess gait using IMUs are too many. Likely, outcomes are highly heterogeneous and difficult to compare across large panels of studies. Therefore, homogenization is needed to foster the use of ILG to assess gait quality in neurological routine practice. The pros and cons of each protocol are emphasized so that a compromise can be reached. As well, analysis of seven complementary clinical criteria (springiness, sturdiness, smoothness, steadiness, stability, symmetry, synchronization) is advocated.

### PDF Y Endnote Y

#### Longitudinal falls data in Parkinson's disease: feasibility of fall diaries and effect of attrition

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### Abstract

**BACKGROUND:** Identifying causes of falls for people with Parkinson's disease has met with limited success. Prospective falls measurement using the "gold standard" approach is challenging. This paper examines the process and outcomes associated with longitudinal falls reporting in this population.

**METHODS:** Participants were recruited from ICICLE-GAIT (a collaborative study with ICICLE-PD; an incident cohort study). Monthly falls diaries were examined over 48 months for accuracy of data and rate of attrition. To further inform analysis, characteristics of participants with 36-month completed diaries were compared with those who did not complete diaries.

**RESULTS:** One hundred and twenty-one participants were included at baseline. By 12 months, falls diary data had reduced to 107 participants; to 81 participants by 36 months; and to 59 participants by 48 months. Key reasons for diary attrition were withdrawal from ICICLE-gait ( $n = 16$ ) (13.2%), and noncompliance ( $n = 11$ ) (9.1%). The only significant difference between the completed and non-completed diary groups was age at 36 months, with older participants being more likely to send in



diaries.

**CONCLUSIONS:** Prospective falls data is feasible to collect over the long term. Attrition rates are high; however, participants retained in the study are overall representative of the total falls diary cohort. Implications for Rehabilitation Understanding falls evolution in Parkinson's disease through consistent, personalized monitoring of falls events is critical to inform effective management. Our study shows that it is feasible to collect longitudinal falls data using "gold standard" methodology, although significant resources are required for implementation. We anticipate that our study methodology is broadly applicable to any at-risk falls cohort including older adults and diverse neurological conditions. Researchers and clinicians collating prospective falls data must ensure that participants understand what constitutes a fall, as per the World Health Organization definition. A second key point is to ensure prompt recording of any fall event.

#### **PDF Y Endnote Y**

#### **Medication use and fall-related hospital admissions from long-term care facilities: a hospital-based case-control study**

Ryan-Atwood TE, Hutchinson-Kern M, Ilomäki J, Dooley MJ, Poole SG, Kirkpatrick CM, Manias E, Mitra B, Bell JS.

Drugs Aging 2017; ePub(ePub): ePub.

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#### **Abstract**

**BACKGROUND:** Falls are a leading cause of preventable hospitalizations from long-term care facilities (LTCFs). Polypharmacy and falls-risk medications are potentially modifiable risk factors for falling.

**OBJECTIVE:** This study investigated whether polypharmacy and falls-risk medications are associated with fall-related hospital admissions from LTCFs compared with hospital admissions for other causes.

**METHODS:** This was a hospital-based, case-control study of patients aged  $\geq 65$  years hospitalized from LTCFs. Cases were patients with falls and fall-related injuries, and controls were patients admitted for infections. Conditional logistic regression was used to calculate adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for the associations between polypharmacy (defined as the use of nine or more regular pre-admission medications) and falls-risk medications (categorized as psychotropic medications and those that can cause orthostatic hypotension) with fall-related hospital admissions.

**RESULTS:** There was no association between polypharmacy and fall-related hospital admissions (adjusted OR 0.97, 95% CI 0.63-1.48); however, the adjusted odds of fall-related hospital admissions increased by 16% (95% CI 3-30%) for each additional falls-risk medication. Medications that can cause orthostatic hypotension (adjusted OR 1.25, 95% CI 1.06-1.46), but not psychotropic falls-risk medications (adjusted OR 1.02, 95% CI 0.88-1.18) were associated with fall-related hospital admissions. The association between medications that can cause orthostatic hypotension and fall-related hospital admissions was strongest among residents with polypharmacy (adjusted OR 1.44, 95% CI 1.08-1.92).

**CONCLUSION:** Polypharmacy was not an independent risk factor for fall-related hospital admissions;

however, medications that can cause orthostatic hypotension were associated with fall-related hospital admissions, particularly among residents with polypharmacy. Falls-risk should be considered when prescribing medications that can cause orthostatic hypotension.

#### PDF N Endnote Y

##### **Motor disturbances in elderly medical inpatients and their relationship to delirium**

Adamis D, McCarthy G, O'Mahony E, Meagher D.

*J. Geriatr. Psychiatry Neurol.* 2017; ePub(ePub): ePub.

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#### **Abstract**

Motor disturbances in delirious patients are common, but their relationship to cognition and severity of illness has not been studied. We examined motor subtypes in an older age inpatient population, their relationship to clinical variables including delirium, and their association with 1-year mortality in a prospective study, using the Confusion Assessment Method, Acute Physiology and Chronic Health Evaluation II, Montreal Cognitive Assessment (MoCA), Barthel Index, and Delirium Rating Scale-Revised 98 (DRS-R98). Motor subtypes were evaluated using 2 items of DRS-R98. Mortality rates were investigated 1 year later. Two hundred participated (mean age 81.1 [6.5]; 50% female). Thirty-four (17%) were identified with delirium. Motor subtypes were none: 119 (59.5%), hypoactive: 37 (18.5%), hyperactive: 29 (14.5%), and mixed: 15 (7.5%). Hypoactive and mixed subtypes were significantly more frequent in delirious patients. Regression analysis showed that hypoactive subtype was significantly associated with lower MoCA. No relationship between motor subtypes and mortality was found. Motor disturbances are not unique to delirium, with hypoactivity particularly associated with impaired cognition.

#### PDF Y Endnote Y

##### **Observational study of 180° turning strategies using inertial measurement units and fall risk in poststroke hemiparetic patients**

Barrois RP, Ricard D, Oudre L, Tlili L, Provost C, Vienne A, Vidal PP, Buffat S, Yelnik AP.

*Front. Neurol.* 2017; 8: e194.

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#### **Abstract**

**OBJECTIVE:** We analyzed spontaneous 180° turning strategies in poststroke hemiparetic patients by using inertial measurement units (IMUs) and the association of turning strategies with risk of falls. **METHODS:** We included right paretic (RP) and left paretic (LP) post-stroke patients, and healthy controls (HCs) from a physical and rehabilitation department in France between July 2015 and October 2015. All subjects were right-handed and right-footed for mobilization tasks. Participants were instructed to turn 180° in a self-selected direction after a 10-m walk while wearing three IMUs on their trunk and both feet. We defined three turning patterns based on the number of external steps (pattern I = 1; II = 2-4 steps; and III ≥ 5) and four turning strategies based on the side chosen to

turn (healthy or paretic) and the stance limb used during the first step of the turn (healthy or paretic). Falls in the 6 months after measurement were investigated.

**RESULTS:** We included 17 RP [mean (SD) age 57.5 (9.5) years (range 43-73)], 20 LP patients [mean age 60.7 (8.8) years (range 43-63)], and 15 HCs [mean age 56.7 (16.1) years (range 36-83)]. The LP and RP groups behaved similarly in turning patterns, but 90% of LP patients turned spontaneously to the paretic side versus 59% of RP patients. This difference increased with turning strategies: 85% of LP versus 29% of RP patients used strategy 4 (paretic turn side with paretic limb). Patients using strategy 4 had the highest rate of falls.

**CONCLUSION:** We propose to consider spontaneous turning strategies as new indicators to evaluate the risk of fall after stroke. IMU could be routinely used to identify this risk and guide balance rehabilitation programs.

#### PDF Y Endnote Y

#### **Polyneuropathy relates to impairment in daily activities, worse gait, and fall-related injuries**

Hanewinkel R, Drenthen J, Verlinden VJA, Darweesh SKL, van der Geest JN, Hofman A, van Doorn PA, Ikram MA.

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#### **Abstract**

**OBJECTIVE:** To extensively investigate the association of chronic polyneuropathy with basic and instrumental activities of daily living (BADL and IADL), falls, and gait.

**METHODS:** A total of 1,445 participants of the population-based Rotterdam Study (mean age 71 years, 54% women) underwent a polyneuropathy screening involving a symptom questionnaire, neurologic examination, and nerve conduction studies. Screening yielded 4 groups: no, possible, probable, and definite polyneuropathy. Participants were interviewed about BADL (Stanford Health Assessment questionnaire), IADL (Instrumental Activities of Daily Living scale), and frequency of falling in the previous year. In a random subset of 977 participants, gait was assessed with an electronic walkway. Associations of polyneuropathy with BADL and IADL were analyzed continuously with linear regression and dichotomously with logistic regression. History of falling was evaluated with logistic regression, and gait changes were evaluated with linear regression.

**RESULTS:** Participants with definite polyneuropathy had more difficulty in performing BADL and IADL than participants without polyneuropathy. Polyneuropathy related to worse scores of all BADL components (especially walking) and 3 IADL components (housekeeping, traveling, and shopping).

Participants with definite polyneuropathy were more likely to fall, and these falls more often resulted in injury. Participants with polyneuropathy had worse gait parameters on the walkway, including lower walking speed and cadence, and more errors in tandem walking.

**CONCLUSIONS:** Chronic polyneuropathy strongly associates with impairment in the ability to perform daily activities and relates to worse gait and an increased history of falling.

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#### PDF N Endnote Y

### **Relationships between neighborhood social capital and the occurrence of outdoor falls in Canadian older adults: a multilevel analysis**

Vafaei A, Pickett W, Zunzunegui MV, Alvarado BE.

*J. Aging Health* 2017; ePub(ePub): ePub.

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#### **Abstract**

**OBJECTIVE:** The aim of this study was to examine whether neighborhood-level social capital is a risk factor for falls outside of the home in older adults.

**METHODS:** Health questionnaires were completed by community-dwelling Canadians aged +65 years living in Kingston (Ontario) and St-Hyacinthe (Quebec), supplemented by neighborhood-level census data. Multilevel logistic regression models with random intercepts were fit. Variations in the occurrence of falls across neighborhoods were quantified by median odds ratio and 80% interval odds ratio.

**RESULTS:** Between-neighborhood differences explained 7% of the variance in the occurrence of falls; this variance decreased to 2% after adjustment for neighborhood-level variables. In the fully adjusted models, higher levels of social capital increased the odds of falls by almost 2 times: (odds ratio [OR] = 2.10, 95% confidence interval [CI] = [1.19, 3.71]).

**DISCUSSION:** Living in neighborhoods with higher levels of social capital was associated with higher risk of falling in older adults, possibly through more involvement in social activities.

**PDF Y Endnote Y**

### **Resting-state fMRI associated with stop-signal task performance in healthy middle-aged and elderly people**

Lee HH, Hsieh S.

*Front. Psychol.* 2017; 8: e766.

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(Copyright © 2017, Frontiers Research Foundation)

**DOI** 10.3389/fpsyg.2017.00766 **PMID** 28553253 **PMCID** PMC5427072

#### **Abstract**

Several brain regions and connectivity networks may be altered as aging occurs. We are interested in investigating if resting-state functional magnetic resonance imaging (RS-fMRI) can also be valid as an indicator of individual differences in association with inhibition performance among aged (including middle-aged) people. Seventy-two healthy adults (40-77 years of age) were recruited. Their RS-fMRI images were acquired and analyzed via two cluster-analysis methods: local synchronization of spontaneous brain activity measured by regional homogeneity (ReHo) and fractional amplitude of low-frequency fluctuations (fALFF) of blood oxygenation level-dependent signals. After the RS-fMRI acquisition, participants were instructed to perform a stop-signal task, in which the stop signal reaction time (SSRT) was calculated based on the horse-race model. Among participants, the ReHo/fALFF and SSRT were correlated with and without partialling-out the effect of age. The results of this study showed that, although aging may alter brain networks, the spontaneous activity of the age-related brain networks can still serve as an effective indicator of individual differences in association with inhibitory performance in healthy middle-aged and elderly

people. This is the first study to use both ReHo and fALFF on the same dataset for conjunction analyses showing the relationship between stopping performance and RS-fMRI in the elderly population. The relationship may have practical clinical applications. Based on the overall results, the current study demonstrated that the bilateral inferior frontal gyrus and parts of the default mode network activation were negatively correlated with SSRT, suggesting that they have crucial roles in inhibitory function. However, the pre-supplementary motor area (pre-SMA) and SMA played only a small role during the resting state in association with stopping performance.

#### PDF Y Endnote Y

#### **The association between hearing loss, postural control, and mobility in older adults: a systematic review**

Agmon M, Lavie L, Doumas M.

*J. Am. Acad. Audiol.* 2017; 28(6): 575-588.

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(Copyright © 2017, American Academy of Audiology)

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#### **Abstract**

**BACKGROUND:** Degraded hearing in older adults has been associated with reduced postural control and higher risk of falls. Both hearing loss (HL) and falls have dramatic effects on older persons' quality of life (QoL). A large body of research explored the comorbidity between the two domains. **PURPOSE:** The aim of the current review is to describe the comorbidity between HL and objective measures of postural control, to offer potential mechanisms underlying this relationship, and to discuss the clinical implications of this comorbidity.

**DATA COLLECTION AND ANALYSIS:** PubMed and Google Scholar were systematically searched for articles published in English up until October 15, 2015, using combinations of the following strings and search words: for hearing: Hearing loss, "Hearing loss," hearing, presbycusis; for postural control: postural control, gait, postural balance, fall, walking; and for age: elderly, older adults.

**RESULTS:** Of 211 screened articles, 7 were included in the systematic review. A significant, positive association between HL and several objective measures of postural control was found in all seven studies, even after controlling for major covariates. Severity of hearing impairment was connected to higher prevalence of difficulties in walking and falls. Physiological, cognitive, and behavioral processes that may influence auditory system and postural control were suggested as potential explanations for the association between HL and postural control.

**CONCLUSIONS:** There is evidence for the independent relationship between HL and objective measures of postural control in the elderly. However, a more comprehensive understanding of the mechanisms underlying this relationship is yet to be elucidated. Concurrent diagnosis, treatment, and rehabilitation of these two modalities may reduce falls and increase QoL in older adults.

#### PDF N Endnote Y

#### **The design and development of a complex multifactorial falls assessment intervention for falls prevention: the Prevention of Falls Injury Trial (PreFIT)**

Bruce J, Ralhan S, Sheridan R, Westacott K, Withers E, Finnegan S, Davison J, Martin FC, Lamb SE.

*BMC Geriatr.* 2017; 17(1): e116.

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### Abstract

**BACKGROUND:** This paper describes the design and development of a complex multifactorial falls prevention (MFFP) intervention for implementation and testing within the framework of a large UK-based falls prevention randomised controlled trial (RCT).

**METHODS:** A complex intervention was developed for inclusion within the Prevention of Falls Injury Trial (PreFIT), a multicentre pragmatic RCT. PreFIT aims to compare the clinical and cost-effectiveness of three alternative primary care falls prevention interventions (advice, exercise and MFFP), on outcomes of fractures and falls. Community-dwelling adults, aged 70 years and older, were recruited from primary care in the National Health Service (NHS), England.

**RESULTS:** Development of the PreFIT MFFP intervention was informed by the existing evidence base and clinical guidelines for the assessment and management of falls in older adults. After piloting and modification, the final MFFP intervention includes seven falls risk factors: a detailed falls history interview with consideration of 'red flags'; assessment of balance and gait; vision; medication screen; cardiac screen; feet and footwear screen and home environment assessment. This complex intervention has been fully manualised with clear, documented assessment and treatment pathways for each risk factor. Each risk factor is assessed in every trial participant referred for MFFP. Referral for assessment is based upon a screening survey to identify those with a history of falling or balance problems. Intervention delivery can be adapted to the local setting.

**CONCLUSION:** This complex falls prevention intervention is currently being tested within the framework of a large clinical trial. This paper adheres to TIDieR and CONSORT recommendations for the comprehensive and explicit reporting of trial interventions. Results from the PreFIT study will be published in due course. The effectiveness and cost-effectiveness of the PreFIT MFFP intervention, compared to advice and exercise, on the prevention of falls and fractures, will be reported at the conclusion of the trial.

### PDF Y Endnote Y

#### **The evaluation of a strength and balance exercise program for falls prevention in community primary care**

Hawley-Hague H, Roden A, Abbott J.

*Physiother. Theory Pract.* 2017; ePub(ePub): ePub.

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### Abstract

We aimed to evaluate a strength and balance program delivered in the community. There is little evidence of implementation of evidence-based exercise in practice. The program was a step-down model, designed to encourage long-term exercise in community classes. The program consisted of a fully funded referral only evidence-based 12-week strength and balance (Community Otago) class, followed by an evidence-based continuous open-access community strength and balance class (Active Always). The program was offered to patients: 1) after formal falls rehabilitation (falls and fracture service); 2) after falls rehabilitation in intermediate care; and 3) referred by a GP who were not eligible for rehabilitation (preventative measure). Outcome evaluation used descriptive statistics to report changes in function, confidence in balance, hospital attendance/admission for

falls/fractures and transition to community classes. Focus groups established participant experience/satisfaction. Seventy-nine participants were included, aged 56-96, and 53 (67%) were women. About 63.3% of patients transitioned to Active Always classes, demonstrating improvement in maintenance. Follow-up scores from baseline attendance at falls and fracture service to 12-weeks follow-up (24 weeks) in Community Otago showed the majority of patients improved their function (Timed up and Go), confidence (ConfBal) and lowered their falls risk (Tinetti). Follow-up of participants from Community Otago baseline to the end of 12-weeks showed improvement in function and confidence, but only a third of participants lowered their falls risk. Focus groups data suggest that continuity of delivery, the role of the instructor, health professional, and social and physical outcomes were essential for maintenance. A supportive environment can be created which encourages older adults' continued participation in group-based strength and balance, helping the delivery of evidence-based practice.

#### **PDF Y Endnote Y**

#### **Arousability and fall risk during forced awakenings from nocturnal sleep among healthy males following administration of zolpidem 10 mg and doxepin 6 mg: a randomized, placebo-controlled, four-way crossover trial**

Drake CL, Durrence H, Cheng P, Roth T, Pillai V, Peterson EL, Singh M, Tran KM.

*Sleep* 2017; ePub(ePub): ePub.

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(Copyright © 2017, American Academy of Sleep Medicine, Publisher Associated Professional Sleep Societies)

**DOI** 10.1093/sleep/zsx086 **PMID** 28575467

#### **Abstract**

**STUDY OBJECTIVES:** To examine and compare the arousability threshold and fall risk upon awakening of doxepin (6 mg) versus zolpidem (10 mg).

**METHODS:** A total of 52 healthy adult males were included in a double-blind, placebo-controlled, 4-way crossover study. The experimental procedure included four nights with polysomnography in the lab (zolpidem, doxepin, and their respective placebo conditions). Arousability was measured using an auditory awakening threshold delivered at the peak-plasma concentration for the active hypnotics and at matched times for the respective placebo conditions. Fall risk during the night was measured following awakening using the Berg Balance Scale and the Tandem Walk Task.

**RESULTS:** Both arousability and fall risk were lower in the doxepin condition compared to the zolpidem condition. Furthermore, arousability and fall risk for doxepin did not differ significantly from the placebo conditions. A significantly greater proportion of participants in the zolpidem condition (63.5%) did not wake until receiving the loudest tone (110dB) as compared to the doxepin (17.6%) and placebo conditions (17.3%, 5.8%).

**CONCLUSIONS:** Results suggest that zolpidem has greater risks for balance and awakening threshold compared with low-dose doxepin. Future prospective studies should extend results to clinical samples with population-level risk of injury and arousability.

#### **PDF Y Endnote Y**

### **Effects of unstable footwear on gait characteristic: a systematic review**

Farzadi M, Nemati Z, Jalali M, Doulagh RS, Kamali M.

*Foot (Edinb)* 2017; 31: 72-76.

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**DOI** 10.1016/j.foot.2017.04.005 **PMID** 28577440

#### **Abstract**

**BACKGROUND:** Over the last three decades, several designs of unstable footwear have been developed in the forms of shoes, sandals and boots. There are marketing claims related to the positive effects of these shoes on the training of lower limb muscles and improving gait. Many studies have been performed on the effects of unstable footwear on muscle activity, balance, posture, energy expenditure, lower extremity disorders, and biomechanical changes. The analysis of the kinetics and kinematics characteristics of gait would provide objective representation of body movement.

**OBJECTIVE:** To systematically review available evidence on the use of unstable footwear on kinetic and kinematic parameters to make specific recommendation for practice and future studies.

**METHOD:** A computer-based search was undertaken through PubMed, Cochrane Library, Embase, PEDro, Web of Science and Google Scholar from 2005 to 2015. The included studies were appraised using McMaster Critical Review Form for Quantitative Studies.

**RESULT:** Ten studies (quasi-experimental design) were included.

**CONCLUSION:** Considering kinetic and kinematic interaction of variables in the included studies revealed that confounding factors may have high impact on biomechanical findings of unstable footwear. Then, more homogeneous studies, considering these factors, should be implemented in future studies to inform the best clinical practice.

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#### **PDF Y Endnote Y**

### **Falls, functioning, and disability among women with persistent symptoms of chemotherapy-induced peripheral neuropathy**

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*J. Clin. Oncol.* 2017; ePub(ePub): ePub.

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**DOI** 10.1200/JCO.2016.71.3552 **PMID** 28586243

#### **Abstract**

**PURPOSE** Chemotherapy-induced peripheral neuropathy (CIPN) may persist after treatment ends and may lead to functional decline and falls. This study compared objective and self-report measures of physical function, gait patterns, and falls between women cancer survivors with and without symptoms of CIPN to identify targets for functional rehabilitation.

**METHODS** A secondary data analysis of 512 women cancer survivors (age,  $62 \pm 6$  years; time since diagnosis,  $5.8 \pm 4.1$  years) categorized and compared women self-reporting symptoms of CIPN (CIPN+) with asymptomatic women (CIPN-) on the following: maximal leg strength, timed chair



stand, physical function battery, gait characteristics (speed; step number, rate, and length; base of support), self-report physical function and disability, and falls in the past year.

**RESULTS** After an average of 6 years after treatment, 47% of women still reported symptoms of CIPN. CIPN+ had significantly worse self-report and objectively measured function than did CIPN-, with the exception of maximal leg strength and base of support during a usual walk. Gait was slower among CIPN+, with those women taking significantly more, but slower and shorter, steps than did CIPN- (all  $P < .05$ ). CIPN+ reported significantly more disability and 1.8 times the risk of falls compared with CIPN- ( $P < .0001$ ). Increasing symptom severity was linearly associated with worsening function, increasing disability, and higher fall risk (all  $P < .05$ ).

**CONCLUSION** This work makes a significant contribution toward understanding the functional impact of CIPN symptoms on cancer survivors. Remarkably, 47% of women in our sample had CIPN symptoms many years after treatment, together with worse function, greater disability, and more falls. CIPN must be assessed earlier in the clinical pathway, and strategies to limit symptom progression and to improve function must be included in clinical and survivorship care plans.

#### PDF Y Endnote Y

#### How humans use visual optic flow to regulate stepping during walking

Salinas MM, Wilken JM, Dingwell JB.

*Gait Posture* 2017; 57: 15-20.

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(Copyright © 2017, Elsevier Publishing)

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#### Abstract

Humans use visual optic flow to regulate average walking speed. Among many possible strategies available, healthy humans walking on motorized treadmills allow fluctuations in stride length ( $L_n$ ) and stride time ( $T_n$ ) to persist across multiple consecutive strides, but rapidly correct deviations in stride speed ( $S_n = L_n/T_n$ ) at each successive stride,  $n$ . Several experiments verified this stepping strategy when participants walked with no optic flow. This study determined how removing or systematically altering optic flow influenced peoples' stride-to-stride stepping control strategies. Participants walked on a treadmill with a virtual reality (VR) scene projected onto a 3m tall, 180° semi-cylindrical screen in front of the treadmill. Five conditions were tested: blank screen ("BLANK"), static scene ("STATIC"), or moving scene with optic flow speed slower than ("SLOW"), matched to ("MATCH"), or faster than ("FAST") walking speed. Participants took shorter and faster strides and demonstrated increased stepping variability during the BLANK condition compared to the other conditions. Thus, when visual information was removed, individuals appeared to walk more cautiously. Optic flow influenced both how quickly humans corrected stride speed deviations and how successful they were at enacting this strategy to try to maintain approximately constant speed at each stride. These results were consistent with Weber's law: healthy adults more-rapidly corrected stride speed deviations in a no optic flow condition (the lower intensity stimuli) compared to contexts with non-zero optic flow. These results demonstrate how the temporal characteristics of optic flow influence ability to correct speed fluctuations during walking.

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#### PDF Y Endnote Y

### **Implementation fidelity of a nurse-led falls prevention program in acute hospitals during the 6-PACK trial**

Morello RT, Barker AL, Ayton DR, Landgren F, Kamar J, Hill KD, Brand CA, Sherrington C, Wolfe R, Rifat S, Stoelwinder J.

*BMC Health Serv. Res.* 2017; 17(1): e383.

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**DOI** 10.1186/s12913-017-2315-z **PMID** 28577530

#### **Abstract**

**BACKGROUND:** When tested in a randomized controlled trial (RCT) of 31,411 patients, the nurse-led 6-PACK falls prevention program did not reduce falls. Poor implementation fidelity (i.e., program not implemented as intended) may explain this result. Despite repeated calls for the examination of implementation fidelity as an essential component of evaluating interventions designed to improve the delivery of care, it has been neglected in prior falls prevention studies. This study examined implementation fidelity of the 6-PACK program during a large multi-site RCT.

**METHODS:** Based on the 6-PACK implementation framework and intervention description, implementation fidelity was examined by quantifying adherence to program components and organizational support. Adherence indicators were: 1) falls-risk tool completion; and for patients classified as high-risk, provision of 2) a 'Falls alert' sign; and 3) at least one additional 6-PACK intervention. Organizational support indicators were: 1) provision of resources (executive sponsorship, site clinical leaders and equipment); 2) implementation activities (modification of patient care plans; training; implementation tailoring; audits, reminders and feedback; and provision of data); and 3) program acceptability. Data were collected from daily bedside observation, medical records, resource utilization diaries and nurse surveys.

**RESULTS:** All seven intervention components were delivered on the 12 intervention wards. Program adherence data were collected from 103,398 observations and medical record audits. The falls-risk tool was completed each day for 75% of patients. Of the 38% of patients classified as high-risk, 79% had a 'Falls alert' sign and 63% were provided with at least one additional 6-PACK intervention, as recommended. All hospitals provided the recommended resources and undertook the nine outlined program implementation activities. Most of the nurses surveyed considered program components important for falls prevention.

**CONCLUSIONS:** While implementation fidelity was variable across wards, overall it was found to be acceptable during the RCT. Implementation failure is unlikely to be a key factor for the observed lack of program effectiveness in the 6-PACK trial. **TRIAL REGISTRATION:** The 6-PACK cluster RCT is registered with the Australian New Zealand Clinical Trials Registry, number ACTRN12611000332921 (29 March 2011).

#### **PDF Y Endnote Y**

### **Interchangeability of the Wii balance board for bipedal balance assessment**

Bonnechere B, Jansen B, Omelina L, Rooze M, Van Sint Jan S.

*JMIR Rehabil. Assist. Technol.* 2015; 2(2): e8.

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(Copyright © 2015, JMIR Publications)

DOI 10.2196/rehab.3832 PMID 28582237

### Abstract

**BACKGROUND:** Since 2010, an increasing interest in more portable and flexible hardware for balance and posture assessment led to previously published studies determining whether or not the Wii Balance Board could be used to assess balance and posture, both scientifically and clinically. However, no previous studies aimed at comparing results from different Wii Balance Boards for clinical balance evaluation exist.

**OBJECTIVE:** The objective of this crossover study is to assess the interchangeability of the Wii Balance Board.

**METHODS:** A total of 6 subjects participated in the study and their balance was assessed using 4 different Wii Balance Boards. Trials were recorded simultaneously with Wii Balance Boards and with a laboratory force plate. Nine relevant clinical parameters were derived from center of pressure displacement data obtained from Wii Balance Board and force plate systems. Intraclass correlation coefficients (ICC), F tests, and Friedman tests were computed to assess the agreement between trials and to compare the Wii Balance Board and force plate results.

**RESULTS:** Excellent correlations were found between the Wii Balance Board and force plate (mean  $\rho = .83$ ). With the exception of 2 parameters, strong to excellent agreements were found for the 7 remaining parameters (ICC=.96). No significant differences were found between trials recorded with different Wii Balance Boards.

**CONCLUSIONS:** Our results indicate that for most of the parameters analyzed, balance and posture assessed with one Wii Balance Board were statistically similar to results obtained from another. Furthermore, the good correlation between the Wii Balance Board and force plate results shows that Wii Balance Boards can be reliably used for scientific assessment using most of the parameters analyzed in this study. These results also suggest that the Wii Balance Board could be used in multicenter studies and therefore, would allow for the creation of larger populations for clinical studies. **TRIAL REGISTRATION:** Ethical Committee of the Erasme Hospital (CCB B406201215142).

**PDF Y Endnote Y**

### Novel use of a smartphone to measure standing balance

Shah N, Aleong R, So I.

*JMIR Rehabil. Assist. Technol.* 2016; 3(1): e4.

**Affiliation:** Department of Electrical and Computer Engineering, University of Toronto, Toronto, ON, Canada.

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DOI 10.2196/rehab.4511 PMID 28582247

### Abstract

**BACKGROUND:** Balance assessment and training is utilized by clinicians and their patients to measure and improve balance. There is, however, little consistency in terms of how clinicians, researchers, and patients measure standing balance. Utilizing the inherent sensors in every smartphone, a mobile application was developed to provide a method of objectively measuring standing balance.

**OBJECTIVE:** We aimed to determine if a mobile phone application, which utilizes the phone's accelerometer, can quantify standing balance.

**METHODS:** Three smartphones were positioned simultaneously above the participants' malleolus and patella and at the level of the umbilicus. Once secured, the myAnkle application was initiated to

measure acceleration. Forty-eight participants completed 8 different balance exercises separately for the right and left legs. Accelerometer readings were obtained from each mobile phone and mean acceleration was calculated for each exercise at each ankle and knee and the torso.

**RESULTS:** Mean acceleration vector magnitude was reciprocally transformed to address skewness in the data distribution. Repeated measures ANOVAs were completed using the transformed data. A significant 2-way interaction was revealed between exercise condition and the body position of the phone ( $P < .001$ ). Post-hoc tests indicated higher acceleration vector magnitude for exercises of greater difficulty. ANOVAs at each body position were conducted to examine the effect of exercise. The results revealed the knee as the location most sensitive for the detection of differences in acceleration between exercises. The accelerometer ranking of exercise difficulty showed high agreement with expert clinical rater rankings (kappa statistic  $> 0.9$ ).

**CONCLUSIONS:** The myAnkle application revealed significantly greater acceleration magnitude for exercises of greater difficulty. Positioning of the mobile phone at the knee proved to be the most sensitive to changes in accelerometer values due to exercise difficulty. Application validity was shown through comparison with clinical raters. As such, the myAnkle app has utility as a measurement tool for standing balance.

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