

Safety Literature 5th December 2021

Burden of falls among people aged 60 years and older in mainland China, 1990-2019: findings from the Global Burden of Disease Study 2019

Ye P, Er Y, Wang H, Fang L, Li B, Ivers R, Keay L, Duan L, Tian M. *Lancet Public Health* 2021; 6(12): e907-e918.

(Copyright © 2021, Elsevier Publishing)

DOI 10.1016/S2468-2667(21)00231-0 **PMID** 34838197

Abstract

BACKGROUND: Falls in older people have become a major public health concern worldwide, but a comprehensive assessment of the burden of falls for older people in mainland China has not been done. We aimed to investigate the burden of falls among older people at the national and subnational level in mainland China, and explore the trends from 1990 to 2019, using data from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019.

METHOD: Using data from GBD 2019, we estimated the burden of falls among people aged 60 years and older by sex and age group in terms of incidence, mortality, and disability-adjusted life-year (DALY) rates and assessed these indicators at the subnational level in 31 geographical units (hereafter called provinces). We investigated the overall trend in the burden of falls across these 31 provinces from 1990 to 2019, and assessed the change in the burden of falls by sex, age group (60-64, 65-69, 70-74, 75-79, and ≥ 80 years), and province between 1990 and 2019.

FINDINGS: In 2019, in mainland China, the incidence rate of falls among people aged 60 years and older was 3799.4 (95% uncertainty interval [UI] 3062.4-4645.0) new falls per 100 000 population, and 39.2 deaths (21.8-48.8) per 100 000 population and 1238.9 DALYs (920.5-1553.2) per 100 000 population were due to falls. We found no significant difference in the burden of falls between males and females. The incidence, mortality, and DALY rates of falls for people aged 80 years and older were significantly higher than those in the other age groups, except for incidence rate, which was non-significantly different between the age 75-79 years group and the oldest age group. Large variations in the incidence and DALY rates of falls were observed across 31 provinces. Although between 1990 and 2019 we found no significant changes in overall mortality due to falls in all provinces and in DALY rates for 23 provinces (DALY rates significantly decreased in two provinces and increased in six provinces), we found large increases in the incidence rate of falls in both males (percentage change between 1990 and 2019: 82.9% [67.4-100]) and females (77.0% [63.3-91.8]). The percentage change in incidence rate of falls between 1990 and 2019 varied from 50.0% (42.2-59.5) for people aged 60-64 years to 123.8% (105.4-141.9) for people aged 80 years and older. All provinces had significant increases in the incidence rate of falls between 1990 and 2019, with Sichuan having the greatest increase (148.5% [125.5-171.4]) and Jilin the smallest increase (14.7% [3.6-26.1]).

INTERPRETATION: Between 1990 and 2019, the incidence rate of falls increased substantially in older adults across mainland China, whereas the rates of mortality and DALY of falls among older people remained relatively stable, suggesting improvements in outcomes of falls. Nevertheless, falls remain an ongoing health burden for older people in mainland China, and there is an urgent need to introduce system-wide, integrated, and cost-effective measures to protect and support older people to minimise their risks and combat an increasing absolute burden as the population continues ageing. **FUNDING:** Bill & Melinda Gates Foundation.

Language: en

Cholinesterase inhibitors for gait, balance, and fall in Parkinson disease: a meta-analysis

Chen JH, Huang TW, Hong CT. NPJ Parkinsons Dis. 2021; 7(1): e103.

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DOI 10.1038/s41531-021-00251-1 **PMID** 34824258

Abstract

Gait disturbance and imbalance are the major symptoms of Parkinson disease (PD), with fall being the most undesirable consequence. However, few effective evidence-based treatments are available for alleviating these symptoms and preventing falls. Cholinesterase inhibitors (ChEIs) are a well-established treatment for PD dementia with possible impacts on gait, balance, and fall reduction. The present study involved a meta-analysis of randomized controlled trials (RCTs) to investigate the effects of ChEIs on gait, balance, and fall in patients with PD. We searched for studies using the PubMed, Embase, and Web of Science databases. The major outcomes were effects on gait parameters, balance, and fall. This study was registered with PROSPERO (CRD42021254733). Five RCTs were included in the present meta-analysis. ChEIs did not significantly increase gait speed in PD patients (mean difference [MD]: 0.03 m/s, 95% confidence interval [CI]: -0.02 to 0.07, $p = 0.29$). However, ChEI treatment significantly decreased step or stride variability during the single task (standard MD: -0.43, 95% CI = -0.79 to -0.06, $p = 0.02$). Regarding fall and balance, trending but nonsignificant beneficial effects were observed with ChEI treatment. In conclusion, although ChEI treatment did not significantly improve gait speed and reduce fall, it can significantly reduce step or stride variability. Considering that gait disorder is a challenging issue in patients with PD and that ChEIs are generally tolerable, the present meta-analysis may provide more evidence for the benefit of ChEIs on PD gait disturbance as an alternative treatment consideration.

Language: en

Comparison between the effects of exergame intervention and traditional physical training on improving balance and fall prevention in healthy older adults: a systematic review and meta-analysis

Chen Y, Zhang Y, Guo Z, Bao D, Zhou J. J. Neuroengineering Rehabil. 2021; 18(1): e164.

(Copyright © 2021, Holtzbrinck Springer Nature Publishing Group - BMC)

DOI 10.1186/s12984-021-00917-0 **PMID** 34819097

Abstract

OBJECTIVE: Physical training (PT, e.g., Tai Chi and strength training) has been demonstrated to improve balance control and prevent falls. Recently, exergame intervention (EI) has emerged to prevent falls by enhancing both physical and cognitive functions in older adults. Therefore, we aim to quantitatively assess and compare the effects of PT and EI on the performance of balance control and fall prevention in healthy older adults via meta-analysis.

METHODS: A search strategy based on the PICOS principle was used to find the publication in the databases of PubMed, EMBASE, Web of Science, Cochrane Library, and MEDLINE. The quality and risk of bias in the studies were independently assessed by two researchers.

RESULTS: Twenty studies consisting of 845 participants were included.

RESULTS suggested that as compared to PT, EI induced greater improvement in postural control (sway path length, SMD = - 0.66, 95% CI - 0.91 to - 0.41, $P < 0.001$, $I(2) = 0\%$; sway speed, SMD = - 0.49, 95% CI - 0.71 to - 0.27, $P < 0.001$, $I(2) = 42\%$) and dynamic balance (SMD = - 0.19, 95% CI - 0.35 to - 0.03, $P = 0.02$, $I(2) = 0\%$) in healthy older adults. The EI with 90-119 min/week for more than 8-week significantly reduced falls. Subgroup analyses revealed that exergames, which were designed by the two principles of repeatedly performing diversified tasks and gradually increase the difficulty of the task, induced significant effects in improving balance control and falls prevention respectively ($P = 0.03$, $P = 0.009$). In addition, intervention that combines EI and PT induced significant improvement in postural control ($P = 0.003$).

CONCLUSION: The exergame intervention, especially the combination of EI and PT, is a promising strategy to improve balance control and reduce falls in healthy older adults. Future studies with rigorous design, larger sample size, and follow-up assessments are needed to further assess the effectiveness of diverse exergame interventions in fall prevention and to quantify the "dose-effect" relationship, as well as the carry-over effect of such intervention, which will ultimately help optimize the rehabilitative strategies to improve balance control and prevent falls.

Language: en

Keywords

Systematic review; Meta-analysis; Balance; Older adults; Exergame; Fall prevention

Effect of 6-week balance exercise by real-time postural feedback system on walking ability for patients with chronic stroke: a pilot single-blind randomized controlled trial

Komiya M, Maeda N, Narahara T, Suzuki Y, Fukui K, Tsutsumi S, Yoshimi M, Ishibashi N, Shirakawa T, Urabe Y. Brain Sci. 2021; 11(11): e1493.

(Copyright © 2021, Switzerland Molecular Diversity Preservation International (MDPI) AG)

DOI 10.3390/brainsci11111493 **PMID** 34827492

Abstract

Stroke causes balance dysfunction, leading to decreased physical activity and increased falls. Thus, effective balance exercises are needed to improve balance dysfunction. This single-blind, single-center randomized controlled trial evaluated the long-term and continuous effects of balance exercise using a real-time postural feedback system to improve balancing ability safely. Thirty participants were randomized into intervention ($n = 15$) and control ($n = 15$) groups; 11 in each group completed the final evaluation. The effect of the intervention was evaluated by muscle strength of knee extension, physical performance (short physical performance battery, the center of pressure trajectory length per second, and Timed Up and Go test [TUG]), and self-reported questionnaires (modified Gait Efficacy Scale [mGES] and the Fall Efficacy Scale) at pre (0 week), post (6-week), and at follow-up (10-week) visits. The TUG and mGES showed a significant interactive (group * time) effect ($p = 0.007$ and $p = 0.038$, respectively). The intervention group showed significant decreasing time to perform TUG from pre- to post-intervention ($p = 0.015$) and pre-intervention to follow-up ($p = 0.016$); mGES showed a significant change from pre-intervention to follow-up ($p = 0.036$). Thus, balance exercise using a real-time postural feedback system can confer a positive effect on the walking ability in patients with chronic stroke and increase their self-confidence in gait performance.

Language: en

Keywords

randomized controlled trial; balance exercise; chronic stroke

Effects of intensive multiplanar trunk training coupled with dual-task exercises on balance, mobility, and fall risk in patients with stroke: a randomized controlled trial

Ahmed U, Karimi H, Amir S, Ahmed A. J. Int. Med. Res. 2021; 49(11): e3000605211059413.

(Copyright © 2021, Field House Publishing)

DOI 10.1177/03000605211059413 **PMID** 34812070

Abstract

OBJECTIVE: We determined whether an exercise regime comprising high-intensity training, multiplanar trunk movements, and dual-task practice could improve trunk control, balance, functional mobility, and reduce fall risk in patients with hemiplegic stroke.

METHODS: In this randomized controlled trial, 74 patients (mean age 61.71 years) were randomly assigned to the experimental and comparison groups. Primary outcome was trunk impairment scale (TIS) scores. Secondary outcomes were scores on the Berg balance scale, 10-meter walk test, Timed-up-and-go test, timed-Up-Go-cognitive, and Stroke Impact Scale-16 to measure between-group changes from baseline. We used linear mixed modeling to identify changes over time within and between groups on each scale and whether changes persisted at 6- and 12-month follow-ups.

RESULTS: We observed significantly increased mean TIS scores from baseline to 3 months post-treatment (7.74); the increased scores were maintained at 6- and 12-month follow-ups (8.60 and 8.43, respectively). In the experimental group, all secondary outcomes showed significant and clinically meaningful results. Fall risk between groups was significantly reduced at 6 and 12 months.

CONCLUSIONS: Intensive multiplanar trunk movements coupled with dual-task practice promoted trunk control, balance, and functional recovery in patients with stroke, reduced fall risk, and improved independent mobility. Trial registration: #IRCT20200127046275N1.

Language: en

Keywords

balance; fall risk; function; mobility; stroke; Trunk control

Falls prevention in China: time for action [editorial]

Yao Y, Yin P, Liu X. Lancet Public Health 2021; 6(12): e875-e876.

(Copyright © 2021, Elsevier Publishing)

DOI 10.1016/S2468-2667(21)00251-6 **PMID** 34838193

Abstract

Globally, falls are a major public health concern for older people (aged ≥ 65 years). Approximately a third of older adults and half of those aged 80 years and older have at least one fall a year. Falls are not only the leading cause of injury-related mortality but also lead in the causes of traumatic bone fracture and injury-related outpatient visits in older people in China.

In this issue of The Lancet Public Health, Pengpeng Ye and colleagues report the burden of falls in terms of incidence, mortality, and disability-adjusted life-year (DALY) in people aged 60 years and above in China from 1990 to 2019. Using data from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019, this Article fills an important gap in the literature because the spatiotemporal trends of fall burden at the national level in China has not previously been reported....

Language: en

Investigating home modification areas and falls in post-discharge home assessments

Narukawa R, Suzumura S, Ito K, Ueda T, Kondo I. *Geriatr. Gerontol. Int.* 2021; ePub(ePub): ePub.

(Copyright © 2021, Japan Geriatrics Society, Publisher John Wiley and Sons)

DOI 10.1111/ggi.14317 **PMID** 34825449

Abstract

[The publisher has not provided an abstract for this article.]

Language: en

Non-immersive virtual reality to improve balance and reduce risk of falls in people diagnosed with Parkinson's disease: a systematic review

García-López H, Obrero-Gaitán E, Castro-Sánchez AM, Lara-Palomo IC, Nieto-Escamez FA, Cortés-Pérez I. Brain Sci. 2021; 11(11): e1435.

(Copyright © 2021, Switzerland Molecular Diversity Preservation International (MDPI) AG)

DOI 10.3390/brainsci11111435 **PMID** 34827433

Abstract

(1) Objective: To evaluate the effectiveness of non-immersive virtual reality in reducing falls and improving balance in patients diagnosed with Parkinson's disease. (2) Methods: The following databases were searched: PUBMED, PEDro, Scielo, CINAHL, Web of Science, Dialnet, Scopus and MEDLINE. These databases were searched for randomized controlled trials published using relevant keywords in various combinations. The methodological quality of the articles was evaluated using the PEDro scale. (3) Results: A total of 10 studies with a total of 537 subjects, 58.7% of which (n = 315) were men, have been included in the review. The age of the participants in these studies ranged between 55 and 80 years. Each session lasted between 30 and 75 min, and the interventions lasted between 5 and 12 weeks. These studies showed that non-immersive virtual reality is effective in reducing the number of falls and improving both static and dynamic balance in patients diagnosed with Parkinson's disease.

RESULTS after non-immersive virtual reality intervention showed an improvement in balance and a decrease in the number and the risk of falls. However, no significant differences were found between the intervention groups and the control groups for all the included studies regarding balance. (4) Conclusions: There is evidence that non-immersive virtual reality can improve balance and reduce the risk and number of falls, being therefore beneficial for people diagnosed with Parkinson's disease.

Language: en

Keywords

balance; non-immersive; Parkinson's disease; rehabilitation; risk of falls; virtual reality; VR

Predictors of fall-related injuries due to common consumer products among elderly adult emergency department visits in the United States during 2007-2017

Aldailami D, Banta JE, McCleary KJ, Mataya R, Ramadan MM, Chinnock R, Suprono MS. Int. J. Inj. Control Safe. Promot. 2021; ePub(ePub): ePub.

(Copyright © 2021, Informa - Taylor and Francis Group)

DOI 10.1080/17457300.2021.1975769 **PMID** 34823446

Abstract

Falls are the leading cause of injuries and death among the elderly in the United States (U.S.). This study examined unintentional fall related-injuries and potential associations between various consumer products. Data was analyzed from the National Electronic Injury Surveillance System (NEISS) of hospital emergency department (ED) visits for unintentional injuries among the elderly between 2007 and 2017. Multiple logistic regression was used to examine the association between consumer products and fall-related injury ED visits. A total of 537,703 injury-related ED visits were analyzed. Two-thirds of visits were fall-related. Of those, 33% were among those 85 years and older, 62.5% occurred at home, 37.6% had head trauma, and 28.7% resulted in hospitalization. Flooring materials accounted for 29.1% of injuries. Ladders were significantly associated with fall-related injuries (adjusted odds ratio [AOR] 5.48, 95% confidence interval [CI] 4.72-6.36), followed by flooring materials (AOR 3.09, 95% CI 2.60-3.67), and porches and balconies (AOR 2.61, 95% CI 2.30-2.96). Several common consumer products are associated with fall-related injuries among the elderly. Increased awareness and education are critical.

Language: en

Keywords

emergency department; accidental falls; consumer products; Elderly; emergency service; hospital visits

Tai chi effects on balance in older adults: the role of sustained attention and myokines

Solianik R, Brazaitis M, Čekanauskaitė-Krušnauskienė A. J. Sports Med. Phys. Fitness 2021; ePub(ePub): ePub.

(Copyright © 2021, Edizioni Minerva Medica)

DOI 10.23736/S0022-4707.21.12990-1 PMID 34821494

Abstract

BACKGROUND: Though previous research has shown that tai chi improves balance and reduces falls risk in older adults, the mechanisms responsible for this improvement remains not fully investigated. Thus, the aim of this study was to determine the efficacy of tai chi practice in improving weight loss, cognitive processes and molecular mechanisms underlying balance control in older adults.

METHODS: Subjects aged 60-79 years were randomized to either a control group (n = 15) or a tai chi group (n = 15) for a 10-week period during COVID-19 pandemic. Changes in anthropometric characteristics, sustained attention, balance, myokines levels were assessed.

RESULTS: Weight increased in control group ($p < 0.05$), whereas it remained unchanged in tai chi group. Tai chi improved ($p < 0.05$) accuracy during go/no-go task, center of pressure velocity in the Romberg stance position with eyes closed under single and dual-task conditions, and increased ($p < 0.05$) levels of brain-derived neurotrophic factor and irisin, while in control group center of pressure velocity with eyes open tended to decrease. Changes in balance within 10 weeks were moderately correlated ($p < 0.05$) with changes in anthropometric characteristics, sustained attention and levels of myokines.

CONCLUSIONS: Thus, 10 weeks of tai chi practice induced improvements in balance, which was related with improved sustained attention, and increased myokines levels, whereas decrements in balance under pandemic conditions were related with weight gain in older adults.

Language: en

The complex associations between late life depression, fear of falling and risk of falls. a systematic review and meta-analysis

Gambaro E, Gramaglia C, Azzolina D, Campani D, Molin AD, Zeppego P. Ageing Res. Rev. 2021; ePub(ePub): ePub.

(Copyright © 2021, Elsevier Publishing)

DOI 10.1016/j.arr.2021.101532 **PMID** 34844015

Abstract

INTRODUCTION: Depression rates in older people worldwide vary from 10 to 15% of community-dwelling older persons. There are two others problems related to depression in old age, namely the high incidence of falls and the so-called fear of falling (FOF), with a prevalence ranging from 20% to 85%; it was initially considered a post-fall syndrome, which later as a fall-independent event. **AIMS:** Study aims to conduct a systematic review and meta-analysis to bridge the existing gap in literature about the association between depressive symptomatology, FOF, use of antidepressant therapy and falls, also identifying a possible effect of the study quality on the outcome.

METHODS: The selection of studies was carried out between May 20, 2020, and July 27, 2020 and only observational clinical trials, written in English, with participants aged more or equal to 60 years affected by diagnosis of depression or treatment for depression mentioned both as a clinical diagnosis in older patient, and as a predictor/consequence of falls were included. The systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines for reporting systematic reviews and meta-analysis, and the protocol was recorded in the International Prospective Register of Systematic Reviews (PROSPERO).

RESULTS AND DISCUSSION: The screening process ultimately led to the inclusion of 18 articles. Many of the included studies showed that depressive symptoms caused the subsequent increase in the number of falls.

RESULTS from the meta-analysis had no highlighted association between depression and falls, in contrast to other review and metaanalysis works: our work includes a substantial number of studies, with a relatively recent publication date, including patients diagnosed with depression, clearly evaluating the association between depression and falls.

RESULTS all seem to confirm the hypothesis of an interdependent association between the presence of FOF and the risk of fall, despite the high percentage of cross-sectional studies prevents inferring on the direction of the association. Therapeutic interventions aimed at decrease rate of falls reducing depressive symptoms and FOF.

Language: en

Keywords

elderly; Depression; systematic review; falls; , Meta-analysis; Fear of Falling

The effects of high-intensity interval training (HIIT) on fall risk factors in healthy older adults: a systematic review

Elboim-Gabyzon M, Buxbaum R, Klein R. *Int. J. Environ. Res. Public Health* 2021; 18(22): e11809.

(Copyright © 2021, MDPI: Multidisciplinary Digital Publishing Institute)

DOI 10.3390/ijerph182211809 **PMID** 34831565

Abstract

High-intensity interval training (HIIT) improves functional capacity, muscle power and physical performance in older adults with and without comorbidities. The aim of this study was to explore the effectiveness of HIIT as a method for reducing major fall risk factors (balance, muscle strength and physical activity) in older adults. A systematic literature search was conducted following the PRISMA guidelines. A computerized search was conducted using electronic databases (PubMed, CINAHL, Cochrane Library, APA PsycInfo, Web of Science, Scopus, PEDro, and AgeLine) published up to July 2021. Eleven papers (9 studies) of moderate quality (mean of 5.5 in Pedro scale) involving 328 healthy older adults met the inclusion criteria. Studies were characterized by high heterogeneity in terms of methodology, HIIT modality and protocol, subject characteristics, and outcome measures.

RESULTS indicate that HIIT cannot be recommended as a single modality for fall prevention in older adults due to insufficient data and no consensus among the studies. HIIT appears to be a safe and well-tolerated supplement to proven fall prevention programs, due to its effects on lower limb strength reflected in functional performance tests, and on dynamic balance and subjective balance perception. However, caution is warranted following HIIT, especially after the first session, due to possible temporary instability.

Language: en

Keywords

older adults; balance; HIIT; falls risk; high-intensity interval training approach

The relationship between Modified Short Physical Performance Battery and falls: a cross-sectional study of older outpatients

Fukui K, Maeda N, Komiya M, Sasadai J, Tashiro T, Yoshimi M, Tsutsumi S, Arima S, Kaneda K, Onoue S, Shima T, Niitani M, Urabe Y. *Geriatrics (Basel)* 2021; 6(4): e106.

(Copyright © 2021, MDPI: Multidisciplinary Digital Publishing Institute)

DOI 10.3390/geriatrics6040106 **PMID** 34842725

Abstract

The Short Physical Performance Battery (SPPB) is a physical fall-risk screening tool and predictor of adverse health effects for the older. Its limited use in Japan is due to the relative ease for high-functioning older adults to achieve perfect scores. Japanese researchers thus created a community-based SPPB (SPPB-com). This study investigated whether the SPPB-com score can distinguish between older patients classified as "fallers" and "non-fallers." Participants comprised 185 older outpatients aged 65 and above who self-reported their history of accidental falls and relevant physical activity. Fall risk was assessed using SPPB and SPPB-com. Handgrip strength, maximum isometric knee extensor strength, and maximum walking speed were measured as physical functions. Multivariate logistic regression and receiver-operating characteristic analyses determined criteria indicating faller status. Fallers were older and had lower physical function, physical activity, SPPB, and SPPB-com scores than non-fallers. Multivariate logistic regression analysis showed SPPB (OR 0.76, 95% CI 0.59-0.99, $p = 0.045$) and SPPB-com (OR 0.63, 95% CI 0.45-0.87, $p = 0.005$) scores were both independently associated with prior falls. The SPPB-com score may function as a fall-risk assessment tool for older outpatients, and its combined use with SPPB can increase the accuracy and precision of distinction between fallers and non-fallers.

Language: en

Keywords

aged; accidental falls; logistic models; physical function performance; short physical performance battery

A study on the impact of the users' characteristics on the performance of wearable fall detection systems

Santoyo-Ramón JA, Casilari-Pérez E, Cano-García JM. Sci. Rep. 2021; 11(1): e23011.

(Copyright © 2021, Nature Publishing Group)

DOI 10.1038/s41598-021-02537-z **PMID** 34836975

Abstract

Wearable Fall Detection Systems (FDSs) have gained much research interest during last decade. In this regard, Machine Learning (ML) classifiers have shown great efficiency in discriminating falls and conventional movements or Activities of Daily Living (ADLs) based on the analysis of the signals captured by transportable inertial sensors. Due to the intrinsic difficulties of training and testing this type of detectors in realistic scenarios and with their target audience (older adults), FDSs are normally benchmarked against a predefined set of ADLs and emulated falls executed by volunteers in a controlled environment. In most studies, however, samples from the same experimental subjects are used to both train and evaluate the FDSs. In this work, we investigate the performance of ML-based FDS systems when the test subjects have physical characteristics (weight, height, body mass index, age, gender) different from those of the users considered for the test phase. The results seem to point out that certain divergences (weight, height) of the users of both subsets (training and test) may hamper the effectiveness of the classifiers (a reduction of up to 20% in sensitivity and of up to 5% in specificity is reported). However, it is shown that the typology of the activities included in these subgroups has much greater relevance for the discrimination capability of the classifiers (with specificity losses of up to 95% if the activity types for training and testing strongly diverge).

Language: en

Balance recoverability and control of bipedal walkers with foot slip

Mihalec M, Trkov M, Yi J. J. Biomech. Eng. 2021; ePub(ePub): ePub.

(Copyright © 2021, American Society of Mechanical Engineers)

DOI 10.1115/1.4053098 **PMID** 34817050

Abstract

Low-friction foot/ground contacts present a particular challenge for stable bipedal walkers. The slippage of the stance foot introduces complexity in robot dynamics and the general locomotion stability results cannot be applied directly. We relax the commonly used assumption of non-slip contact between the walker foot and the ground and examine bipedal dynamics under foot slip. Using a two-mass linear inverted pendulum model, we introduce the concept of balance recoverability and use it to quantify the balanced or fall-prone walking gaits. Balance recoverability also serves as the basis for the design of the balance recovery controller. We design the within- or multi-step recovery controller to assist the walker to avoid fall. The controller performance is validated through simulation results and robustness is demonstrated in the presence of measurement noises as well as variations of foot/ground friction conditions. In addition, the proposed methods and models are used to analyze the data from human walking experiments. The multiple subject experiments validate and illustrate the balance recoverability concept and analyses.

Language: en

Effect of 6-week balance exercise by real-time postural feedback system on walking ability for patients with chronic stroke: a pilot single-blind randomized controlled trial

Komiya M, Maeda N, Narahara T, Suzuki Y, Fukui K, Tsutsumi S, Yoshimi M, Ishibashi N, Shirakawa T, Urabe Y. Brain Sci. 2021; 11(11): e1493.

(Copyright © 2021, Switzerland Molecular Diversity Preservation International (MDPI) AG)

DOI 10.3390/brainsci11111493 **PMID** 34827492

Abstract

Stroke causes balance dysfunction, leading to decreased physical activity and increased falls. Thus, effective balance exercises are needed to improve balance dysfunction. This single-blind, single-center randomized controlled trial evaluated the long-term and continuous effects of balance exercise using a real-time postural feedback system to improve balancing ability safely. Thirty participants were randomized into intervention ($n = 15$) and control ($n = 15$) groups; 11 in each group completed the final evaluation. The effect of the intervention was evaluated by muscle strength of knee extension, physical performance (short physical performance battery, the center of pressure trajectory length per second, and Timed Up and Go test [TUG]), and self-reported questionnaires (modified Gait Efficacy Scale [mGES] and the Fall Efficacy Scale) at pre (0 week), post (6-week), and at follow-up (10-week) visits. The TUG and mGES showed a significant interactive (group * time) effect ($p = 0.007$ and $p = 0.038$, respectively). The intervention group showed significant decreasing time to perform TUG from pre- to post-intervention ($p = 0.015$) and pre-intervention to follow-up ($p = 0.016$); mGES showed a significant change from pre-intervention to follow-up ($p = 0.036$). Thus, balance exercise using a real-time postural feedback system can confer a positive effect on the walking ability in patients with chronic stroke and increase their self-confidence in gait performance.

Language: en

Keywords

randomized controlled trial; balance exercise; chronic stroke

Falls in post-polio patients: prevalence and risk factors

Ofran Y, Schwartz I, Shabat S, Seyres M, Karniel N, Portnoy S. *Biology (Basel)* 2021; 10(11): e11110.

(Copyright © 2021, MDPI: Multidisciplinary Digital Publications Institute)

DOI 10.3390/biology10111110 **PMID** 34827103

Abstract

Individuals with post-polio syndrome (PPS) suffer from falls and secondary damage.

AIM: To (i) analyze the correlation between spatio-temporal gait data and fall measures (fear and frequency of falls) and to (ii) test whether the gait parameters are predictors of fall measures in PPS patients.

METHODS: Spatio-temporal gait data of 50 individuals with PPS (25 males; age 65.9 ± 8.0) were acquired during gait and while performing the Timed Up-and-Go test. Subjects filled the Activities-specific Balance Confidence Scale (ABC Scale) and reported number of falls during the past year.

RESULTS: ABC scores and number of falls correlated with the Timed Up-and-Go, and gait cadence and velocity. The number of falls also correlated with the swing duration symmetry index and the step length variability. Four gait variability parameters explained 33.2% of the variance of the report of falls ($p = 0.006$). The gait velocity was the best predictor of the ABC score and explained 24.8% of its variance ($p = 0.001$).

CONCLUSION: Gait variability, easily measured by wearables or pressure-sensing mats, is an important predictor of falls in PPS population. Therefore, gait variability might be an efficient tool before devising a patient-specific fall prevention program for the PPS patient.

Language: en

Keywords

coefficient of variability; gait analysis; gait symmetry; timed up and go

Frailty and falls in people living with multiple sclerosis

Zanotto T, Galperin I, Mirelman A, Yehezkiyahu S, Estes J, Chen L, Regev K, Karni A, Schmitz-Hübsch T, Paul F, Lynch SG, Akinwuntan AE, Devos H, Hausdorff JM, Sosnoff JJ. Arch. Phys. Med. Rehabil. 2021; ePub(ePub): ePub.

(Copyright © 2021, Elsevier Publishing)

DOI 10.1016/j.apmr.2021.10.025 PMID 34838587

Abstract

OBJECTIVE: To explore the association between frailty and history of falls in people living with multiple sclerosis (MS).

DESIGN: Secondary analysis. **SETTING:** University research laboratories in the United States and Israel. **PARTICIPANTS:** 118 people with relapsing-remitting MS [age=48.9 years (SD=10.0); 74.6% female; expanded disability status scale (EDSS) range=1.0-6.0] were studied in this cross-sectional analysis. **INTERVENTION:** Not applicable. **MAIN OUTCOMES:** A frailty index was calculated from 40 health deficits by following standard validated procedures. The number of falls (12-month history) was recorded.

RESULTS: Overall, 33.9%, 29.7%, and 36.4% of participants were classified as non-frail, moderately frail, and severely frail, respectively. The frailty index was significantly correlated ($\rho=0.37$, $p<0.001$) with higher scores on the EDSS. In univariable negative binomial regression analysis, the frailty index was associated with a higher number of falls (IRR=3.33, 95%CI[1.85-5.99], $p<0.001$). After adjustment for age, gender and EDSS, frailty remained strongly associated with history of falls (IRR=2.78, 95%CI[1.51-5.10], $p=0.001$).

CONCLUSION: The current study identifies a significant relationship between frailty and history of falls in MS, independent of age, gender, and disease severity. These findings support the notion that frailty is a syndrome related to, but independent of, disability in MS.

Language: en

Keywords

disability; aging; frailty; Multiple sclerosis; accidental falls

Sensor-based fall risk assessment: a survey

Zhao G, Chen L, Ning H. Healthcare (Basel) 2021; 9(11): e1448.

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Abstract

Fall is a major problem leading to serious injuries in geriatric populations. Sensor-based fall risk assessment is one of the emerging technologies to identify people with high fall risk by sensors, so as to implement fall prevention measures. Research on this domain has recently made great progress, attracting the growing attention of researchers from medicine and engineering. However, there is a lack of studies on this topic which elaborate the state of the art. This paper presents a comprehensive survey to discuss the development and current status of various aspects of sensor-based fall risk assessment. Firstly, we present the principles of fall risk assessment. Secondly, we show knowledge of fall risk monitoring techniques, including wearable sensor based and non-wearable sensor based. After that we discuss features which are extracted from sensors in fall risk assessment. Then we review the major methods of fall risk modeling and assessment. We also discuss some challenges and promising directions in this field at last.

Language: en

Keywords

fall risk assessment; fall prediction; gait monitoring; sensor

Testing of reliability and validity of the Peninsula Health Falls Risk Assessment Tool (PHFRAT) in acute care: a cross-sectional study

Heikkilä A, Lehtonen L, Haukka J, Havulinna S, Junttila K. Risk Manag. Healthc. Policy 2021; 14: 4685-4696.

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Abstract

PURPOSE: The purpose of this study was to evaluate the validity and reliability of the Peninsula Health Fall Risk Assessment Tool (PHFRAT) in acute care in various medical specialties. The assessment has not been previously studied in acute care.

METHODS: The cross-sectional study was conducted in a large acute care hospital system. The retrospective medical data were used to explore the validity of the PHFRAT. The data consisted of all adult inpatients (≥ 18 age) evaluated by the PHFRAT during 2014-2016 ($n = 22,700$). The Poisson regression, logistic regression, sensitivity, specificity, and the area under the ROC curve were evaluated. The data for the reliability study were collected in 2016 in twelve units by evaluating the patients ($n = 359$) twice using the PHFRAT. The prospective data were analyzed using Fleiss' Kappa, and the content validity index was also counted.

RESULTS: In the somatic data, the change in the risk level from low risk to high risk increases the probability of falls by a factor of 2.8 ($p < 0.01$). When the cut-off point was 9, sensitivity and specificity were 72% and 59%, respectively, and the area under the ROC curve was 0.67 ($p < 0.01$). Validity varied by medical specialties. In the validity analysis, it was not possible to calculate the statistical significance from the psychiatry data. The inter-rater reliability was 0.68 ($p < 0.01$).

CONCLUSION: This study shows that the PHFRAT proved to be moderately suitable for detecting the risk of falling for adult patients admitted to somatic units in acute care. The reliability of the PHFRAT was moderate. The results indicate the need to study the PHFRAT more broadly in psychiatric care as well as some specialties in somatic care.

Language: en

Keywords

falls; acute care; fall risk assessment; PHFRAT

The Falls Efficacy Scale International is a valid measure to assess the concern about falling and its changes induced by treatments

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Abstract

OBJECTIVE: To test with the Rasch analysis the psychometric properties of the Falls Efficacy Scale International, a questionnaire for measuring concern about falling.

DESIGN: Longitudinal observational study, before-after rehabilitation. **SETTING:** Inpatient rehabilitation. **SUBJECTS:** A total of 251 neurological patients with balance impairment. **INTERVENTIONS:** Physiotherapy and occupational therapy aimed at reducing the risk of falling. **MAIN MEASURES:** Participants (median age, first-third quartile: 74.0, 65.5-80.5 years; stroke and polyneuropathy: 43% and 21% of the sample, respectively) received a balance assessment (Falls Efficacy Scale International included) pre- and post-rehabilitation. Rasch analysis was used to evaluate the Falls Efficacy Scale International. Differential item functioning, which assesses the measures' stability in different conditions (e.g. before vs. after treatment) and in different groups of individuals, was tested for several variables.

RESULTS: Patients suffered a moderate balance impairment (Mini-BESTest median score; first-third quartile: 15; 11-19), mild-moderate concern about falling (Falls Efficacy Scale International: 28; 21-37) and motor disability (Functional Independence Measure, motor domain: 70.0; 57.0-76.5). Falls Efficacy Scale International items fitted the Rasch model (range of infit and outfit mean square statistics: 0.8-1.32 and 0.71-1.45, respectively) and the questionnaire's reliability was satisfactory (0.87). No differential item functioning was found for treatment, gender, age and balance impairment. Differential item functioning was found for diagnosis and disability severity, but it is shown that it is not such as to bias measures.

CONCLUSIONS: Falls Efficacy Scale International ordinal scores can be turned into interval measures, i.e. measures of the type of temperature. Being differential item functioning-free for treatment, these measures can be safely used to compare concern about falling before and after rehabilitation, such as when interested in assessing the rehabilitation effectiveness.

Language: en

Keywords

Falls; accidental; Patient Health Questionnaire; postural balance; reliability of results; validation study