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- Email customerservice@PhysicalTherapy.com

Balance Training with Smart Phone Apps and Household Items

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Certified Exercise Expert for Aging Adults

Disclosures

Financial disclosures:

- Meg Lowry – Owner of Next Step Allied Health Pty Ltd which published and profits from the Clock Yourself app, Sit Stand Think app, Balance Yourself book
- Kenneth L Miller – None to report

Non-Financial disclosures:

- ML – None
- KM - None

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Learning Outcomes

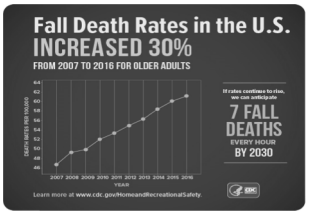
As a result of this course, participants will be able to:

- Describe how to use the Centers for Disease Control (CDC) Stopping Elderly Accidents, Deaths & Falls (STEADI) program as an assessment tool
- List 3 household items used for balance training
- Design a balance training program incorporating app technology and household items
- Describe how to incorporate balance confidence into a comprehensive treatment program

3

Falls- National(Global) Problem

- Falls are the leading cause of fatal and non-fatal injury and disability for adults aged 65 years and older. (1 out of 3 older adults fall each year).
- Over 800,000 patients a year are hospitalized for a fall injury
- In 2015, $50 billion in direct medical costs related to falls
- The risk of falling increases with age
  - Older adult population is expected to increase by over 50% in the next fifteen years.
    - Projection: 49 million falls and 12 million fall injuries in 2030



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Fall Program

STEADI Stopping Elderly Accidents, Deaths & Injuries

- Stopping Elderly Accidents, Deaths & Injuries (STEADI) – Centers for Disease Control and Prevention (CDC) program – implementation of American and British Geriatric Societies' Clinical Practice Guideline for fall prevention
  - **Screen** patients for fall risk,
  - **Assess** modifiable risk factors, and
  - **Intervene** to reduce risk by using effective clinical and community strategies

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CONTINUED

Screen

STEADI Stopping Elderly Accidents, Deaths & Injuries

- Stay Independent Brochure
  - Checklist for risk of falling
    - Answering 4 or more may indicate increased risk for falling and warrants further assessment.
    - Stay Independent

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CONTINUED

Assess

STEADI Stopping Elderly Accidents, Deaths & Injuries

- Evaluate gait, strength and balance
  - Timed Up and Go
  - 30 second chair stand test
  - 4-stage balance test
- Multifactorial Risk Assessment
  - Falls History
  - Physical Exam
    - Postural hypotension
    - Medication Review
    - Cognitive Screen
    - Feet and Footwear check
    - Use of mobility aids
    - Visual Acuity check

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CONTINUED

ASSESSMENT

Timed Up & Go (TUG)

Purpose: To assess mobility
Equipment: A stopwatch
Directions: Patients wear their regular footwear and can use a walking aid, if needed. Begin by having the patient sit back in a standard arm chair and identify a line 3 meters, or 10 feet away, on the floor.

NOTE: Always stay by the patient for safety.

① **Instruct the patient:**

When I say "Go," I want you to:
1. Stand up from the chair.
2. Walk to the line on the floor at your normal pace.
3. Turn.
4. Walk back to the chair at your normal pace.
5. Sit down again.

② **On the word "Go," begin timing.**
③ **Stop timing after patient sits back down.**
④ **Record time.**

8

30 Second Chair Stand Test – Assessment

Purpose: To test leg strength and endurance
Equipment: A chair with a straight back without arm rests (seat 17" high), and a stopwatch.

① **Instruct the patient:**

1. Sit in the middle of the chair.
2. Place your hands on the opposite shoulder crossed, at the wrists.
3. Keep your feet flat on the floor.
4. Keep your back straight, and keep your arms against your chest.
5. On **"Go,"** rise to a full standing position, then sit back down again.
6. Repeat this for 30 seconds.

NOTE: Stand next to the patient for safety.

SCORING

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4 Stage Balance Test – Assessment

① Stand with your feet side-by-side.	Time: _____seconds
② Place the instep of one foot so it is touching the big toe of the other foot.	Time: _____seconds
③ Tandem stand: Place one foot in front of the other, heel touching toe.	Time: _____seconds
④ Stand on one foot.	Time: _____seconds

Increased fall risk if unable to complete positions 1,2, or 3 for 10 sec.

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Fall Prevention - Assessment

- Home Safety Assessment
  - Environmental Hazards - Lighting, trip hazards
  - Durable Medical Equipment - Walkers, wheelchairs, beds
- Medication Review
  - Meds linked to falls; Polypharmacy
- Vision
- Strength/Balance Screen
  - 4 stage balance test
  - 30 second chair stand test
- Behavior
  - Short Falls Efficacy Scale
    - Over/Under Confidence
      - Sedentary lifestyle
      - Impulsive
      - Adherence with POC

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Fall Risk Factors

Most falls are caused by a combination of risk factors.

The more risk factors a person has, the greater their chances of falling.
Many risk factors are modifiable.

Risk factors:

- Lower body weakness
- Vitamin D deficiency (that is, not enough vitamin D in your system)
- Difficulties with walking and balance
- Use of medicines, such as tranquilizers, sedatives, or antidepressants. Even some over-the-counter medicines can affect balance and how steady you are on your feet.
- Vision problems
- Foot pain or poor footwear
- Home hazards or dangers such as
  - broken or uneven steps, and
  - throw rugs or clutter that can be tripped over.

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CONTINUED

Intervene

STEADI Stopping Elderly Accidents, Deaths & Injuries

- Educate patient
- Vitamin D +/- calcium
- Refer to PT to enhance functional mobility & improve strength and balance
- Manage & monitor hypotension
- Manage medications
- Address foot problems
- Optimize vision
- Optimize home safety

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CONTINUED

Fall Prevention – Intervention

- Setting the home up for safety
  - Remove throw rugs, extension cords, add night lights, secure rugs, rails and DME instruction
  - Proper foot wear
  - Address sensory deficits – vision loss, numbness, etc.
- Med reconciliation
  - Collaborate with MD for de-prescription of high risk meds, as appropriate.
  - Educate pt on risk of med
- Therapy interventions
  - Address physical and mental functions
  - Counseling to address behaviors; supervision; long term planning

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CONTINUED

Clinical Guidance Statement AGPT

- Assessment of body functions and structures:
  - Strength (LE)
  - Balance
  - Cognitive and neurologic function - lower extremity peripheral nerve function, proprioception, reflexes, and cortical, extrapyramidal, and cerebellar function
  - Cardiovascular function
  - Vision
  - Urinary function and incontinence
- Activity and Participation
  - Gait, ADL's, Physical Activity

Avin KG, Hanke TA, Kirk-Sanchez N, et al. Management of Falls in Community- Dwelling Older Adults : Clinical. *Phys Ther*. 2015;95(6):815-834.

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CONTINUED

Clinical Guidance Statement AGPT

- Intervention
  - Strength training
  - Balance training
  - Gait training
  - Correction of environmental hazards
  - Correction of footwear or structural impairments of the feet
- Program recommendations (from CDC STEADI)
  - Tai Chi
  - Stepping On
  - Otago

Avin KG, Hanke TA, Kirk-Sanchez N, et al. Management of Falls in Community- Dwelling Older Adults : Clinical. *Phys Ther*. 2015;95(6):815-834.

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Balance assessment (sensory systems, processing, motor output)

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Detailed Balance Assessment

- Sensory systems
  - Modified Clinical Test of Sensory Interaction on Balance (m CTSIB)
    - Eyes open/closed
    - Firm/Foam surfaces
  - Vision, Somatosensory, Vestibular
    - Visual Acuity
    - Sensation/Proprioception
    - Oculomotor testing
      - VOR
    - Vestibular provocation testing

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Central Processing and Motor Output

- Shumway-Cook, Woollacott (Motor Control, 2001)
  - Balance Control
    - Sensory strategies, individual sensory systems, neuromuscular synergies, musculoskeletal components, internal representations, adaptive mechanisms, anticipatory mechanisms
- Horak (2006 & 2009)
  - 6 Balance control systems
    - Biomechanical constraints
    - Stability limits/verticality
    - Anticipatory Postural Adjustments
    - Postural responses
    - Sensory Orientation
    - Stability in Gait

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Functional Vitals app (Apple)

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CONTINUED

App assessment tools

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CONTINUED

SPPB Calculator (Apple)

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SPPB (Android)

Stepping On

- Group based program
- Developed in Australia
- 31% reduction in falls and improved self-confidence
- For those without needing a walker for indoor ambulation. – (recommend individualized treatment)
- Must be trained and licensed.

CONTINUED

OTAGO Program Overview

- Muscle strengthening and balance retraining program delivered at home
  - By a physical therapist with Otago training
- Otago is a fall prevention program that improves strength and balance and reduces falls and fall related injuries among older adults
- Overall, the fall rate was reduced by 35 percent among program participants compared with those who did not take part.

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CONTINUED

OTAGO Program

- Assessment
  - Chair Stand Test (Five times sit to stand test)
  - 4 stage balance test
- Intervention – specific protocol
  - Walking program
  - Strengthening program (quads, hams, hip abductors, calves and dorsiflexors)
  - Balance program – knee bends, backwards walk, walk and turn, sideways walk, heel toe stand, heel toe walk, one leg stand, heel walk, toe walk, heel toe walk backwards, sit to stand, stair walking

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CONTINUED

OTAGO Program

- The exercises include:
  - Strengthening exercises for lower leg muscle groups using ankle cuff weights
  - Balance and stability exercises such as standing with one foot in front of the other and walking on the toes
  - Active range of motion exercises such as neck rotation and hip and knee extensions
  - Walking program

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CONTINUED

UK recommendation: FaME

- In the UK, FaME is a group balance and strength exercise group class led by a postural stability exercise instructor, combined with twice weekly home exercises based on Otago program.
- 9 month intervention with community dwelling frequent fallers: reduced falls by 31% overall, 54% in follow up period.
- Significantly lower mortality and morbidity at 3 year follow up.

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UK recommendation: FaME

- Specific examples of exercises include single side steps, double sidesteps, flamingo swings, sit to stand and squats.
- FaME includes the retraining and practice of getting up from the floor and to avoid a 'long lie' after a noninjurious fall

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ProAct 65+ (FaME vs Otago vs usual care)

- Large three arm cluster RCT n=1256 **low risk older people** (1 fall or less in past yr) recruited through GPs
- Results: FaME reduced falls by 26% and increased Moderate to Vigorous Physical Activity (MVPA) by 15 mins per day
- Otago group trended towards fewer falls (insignificant).
- However, only 37% of Otago group completed 75% of the HEP prescribed, and rarely progressed beyond 2kgs of resistance. Otago group did not increase their self-reported MVPA.

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CONTINUED

Why not just prescribe walking?

- A 10 year follow-up of regular walkers (post-menopausal women) showed the the health and mobility of the women who regularly walked was better than that of sedentary individuals, but there was no significant reduction in the number of falls compared to the group who stopped regular walking .

Pereira MA, Kriska AM, Day RD, Cauley JA, LaPorte RE, Kuller LH. A randomized walking trial in postmenopausal women: effects on physical activity and health 10 years later. Arch Intern Med 1998;158(15):1695-701.

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CONTINUED

Easy Steps RCT 2015

- 378 Community dwelling older adults aged 65+
- Intervention: a self-paced, 48-week walking program that involved three mailed printed manuals and telephone coaching.
- Mobility, leg strength and choice stepping reaction time were measured in a sub-sample (*n* = 178) of participants.

Voukelatos, A., Merom, D., Sherrington, C., Rissel, C., Cumming, R. G., & Lord, S. R. (2015). The impact of a home-based walking programme on falls in older people: the Easy Steps randomised controlled trial. *Age and ageing*, *44*(3), 377-383.

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CONTINUED

Easy Steps RCT 2015

- Results: No difference in fall rates between groups
- By the end of the study, intervention group participants spent significantly more time exercising in general, and specifically walking for exercise (median 1.69 versus 0.75 h/week, $P < 0.001$).
- No differences for CSRT or knee extension strength. Intervention group had significantly better SPPB scores (median 11 vs 12, $P = 0.04$) (Table 2).

Voukelatos, A., Merom, D., Sherrington, C., Rissel, C., Cumming, R. G., & Lord, S. R. (2015). walking programme on falls in older people: the Easy Steps randomised controlled trial. *Age and ageing*, *44*(3), 377-383.

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CONTINUED

A reminder about brisk walking

- "Walking training may be included in addition to balance training but high-risk individuals should not be prescribed brisk walking programmes" – Sherrington et al., 2017,

Sherrington, C., Michaleff, Z. A., Fairhall, N., Paul, S. S., Tiedemann, A., Whitney, J., ... & Lord, S. R. (2017). Exercise to prevent falls in older adults: an updated systematic review and meta-analysis. *Br J Sports Med*, *51*(24), 1750-1758.

Ebrahim S, Thompson PW, Baskaran V, Evans K. Randomized placebo-controlled trial of brisk walking in the prevention of postmenopausal osteoporosis. Age Ageing 1997;26(4):253-60

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Exercise Prescription (dual tasking, app use, household items)

35

Program Adherence

1. Patient must have own equipment. (If the patient only uses ankle weights with PT 2x per week, odds are patient will not continue program at dc)
2. Caregiver/Partner to encourage patient and assist patient with program increases compliance/adherence.
3. Balance Confidence is a factor as is depression.
4. Explain, explain, explain…if the patient understands the benefits of the program and buys in, adherence is greater.

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Balance Treatment with Household Items

- Commonly used items available in the home or community will be explored as treatment equipment

- Why?
  - Improved adherence/compliance
  - Cost of equipment
  - Infection control

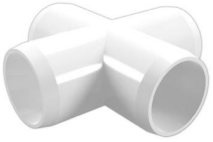
37

What to buy?

- Step Stool
- PVC pipes/connectors
- Foam/pillows
- Post it Notes
- Painter's Tape
- Safety Goggles
- Plastic Wrap
- Pool inflatables
- Flash cards
- Balls/Bean bags
- Safety glasses/goggles
- Carpet stay



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Places To Shop

- Home Improvement Store
  - Home Depot/Lowes
- Toy Stores
- Discount Stores
  - The Christmas Tree Shop
  - Family Dollar/Five Below

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Exercise Prescription

- Must incorporate basic training principles:
  - Specificity, i.e. being specific to the targeted function
  - Progressive overload, i.e. providing a challenging overload to the physiological system through a certain level of intensity and regularity
  - Varied practice, i.e. promoting variation between exercise conditions as balance training needs to target functions, or impairments of balance control

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Exercise Prescription

- Balance Training based on:
  - Sensory systems
    - Vestibular, Vision, Somatosensation
  - Motor Output
    - Ankle, Hip, Step Strategies
  - Central Processing
    - Equilibrium Reactions, Automatic Postural Reactions
- ROM and Strengthening

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Exercise Prescription

- Sensory System Training
  - Vestibular training – general vs. specific exercises
  - Equilibrium reactions, VOR training
    - Get input into the vestibular system in order for the vestibular system peripherally and centrally have information to process.
  - Goal is to remove/diminish one or two systems to increase work load on remaining system
  - Household items: Post it notes; Plastic Wrap; Painter's Tape; Rocking Chair; Soft Cushion.

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CONTINUED

Exercise Prescription

Painters Tape on safety goggles leaving "pin hole type" opening in center of visual field.

Plastic wrap on safety goggles to provide a distorted visual field.

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CONTINUED

Exercise Prescription

VOR x 1 exercise

https://www.youtube.com/watch?v=yL7TBP8fBtg

44

CONTINUED

Exercise Prescription

- Motor Output (Enhance Strategies and improve coordination)
  - Reduce BOS.
  - Single Limb stance.

  - Household Items: Plastic cups, paper towel roll, foam/cushion, carpet stay (to place under cushion or foam)

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Exercise Prescription

Basic weight shift using a sturdy casserole tray.

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Exercise Prescription



Single limb stance on LLE with foot eye coord on RLE.

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Exercise Prescription


Roll skateboard forward/backward

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Exercise Rx – Trunk Control/Reaching activities

- Household Items – bean bags, checkers,

Corner standing – reach across mid-line with trunk rotation

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Exercise Rx - Reaching

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Exercise Rx - Reaching

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Functional Reaching – Use kitchen items

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CONTINUED

Functional Reaching – Dominos

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CONTINUED

Functional Reaching – Cards

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CONTINUED

Functional Reaching – Drawing

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Sit to stand with balance challenge

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Exercise Rx – Mediball (or milk container)

Trunk and head rotation behind – pass object over L or R shoulder.

60

Other Objects – Plates and tape

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Carpet stay – (under pillow to prevent slippage)

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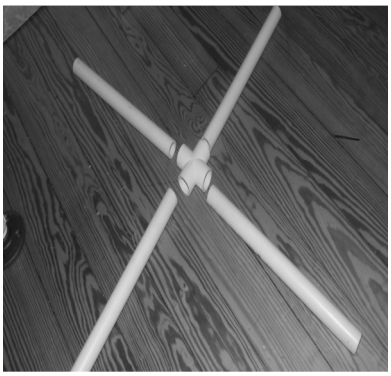
CONTINUED

Other Objects - PVC



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Other Objects - PVC

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Balance Confidence

- A persons perception of confidence in performing various ambulatory activities without falling
- Activities-Specific Balance Confidence Scale (ABC scale) is widely used
- 16-item self-report measure in which patients rate their balance confidence for performing activities.
- Items are rated on a rating scale that ranges from 0 – 100. Score of zero represents no confidence, a score of 100 represents complete confidence
- Overall score is calculated by adding item scores and then dividing by the total number of items

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CONTINUED

Strength and power

- Comparisons of fallers versus nonfallers have shown several muscle groups in the lower limb to be weaker, including quadriceps, hip and ankle strength.
- Fallers tend to have weaker lower limb power and more asymmetry in power between limbs.
- It's hypothesised that lower limb power is important in executing an effective stepping strategy.

Skelton DA, Kennedy J, Rutherford OM. Explosive power and asymmetry in leg muscle function in frequent fallers and non-fallers aged over 65. Age Ageing 2002;31(2):119-25

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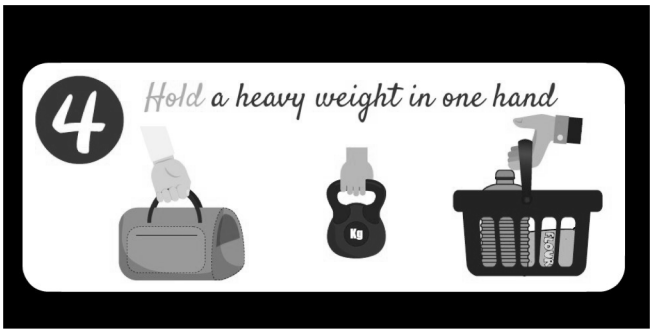
Adding resistance holds with gait activities



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Internal perturbations + LL power with Smash bags

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CONTINUED

Internal perturbations + LL power with Smash bags

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CONTINUED

Training the stepping strategy

- Ankle ⇨ Balance training
- Hip ⇨ Balance, reaching & strength
- Stepping ⇨ Volitional & reactive step training

21% - 39% reduction in falls

50% reduction in falls

Current options:

- Perturbation training in a harness
- Volitional step training with exergames (e.g. Nintendo Wii, X-box kinekt, Dance Dance Revolution)

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CONTINUED

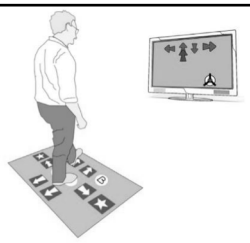
Step training improves reaction time, gait and balance and reduces falls in older people: a systematic review and meta-analysis

Yoshiro Okubo,[1,2] Daniel Schoene,[3] Stephen R Lord[1,4]

NeuRA
Discover. Conquer. Cure.

Reactive step training (average 34 days)

Volitional step training (average 105 days)



Okubo, Y., Schoene, D., & Lord, S. R. (2016). Step training improves reaction time, gait and balance and reduces falls in older people: a systematic review and meta-analysis. *Br J Sports Med*, bjsports-2015.

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CONTINUED

What are the findings

- This systematic review and meta-analysis has demonstrated that step training can prevent falls by approximately 50% in older adults in both community and institutional settings.
- Subgroup analyses stratified by reactive and volitional stepping interventions revealed a similar efficacy for rate of falls and proportion of fallers.
- This clinically significant reduction may be due to improvements in reaction time, gait, balance and balance recovery, but not in strength.

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CONTINUED

How might it impact on clinical practice in the future?

- Our findings suggest that step training should be a major component of exercise fall prevention interventions.
- This training could be either volitional or reactive but should be performed in an upright position and undertaken in response to environmental challenges which mimic common fall situations such as stepping onto a target, avoiding an obstacle or responding to a perturbation.
- Reactive step training which requires a perturbation module and full body harness is not readily available but volitional step training can be applied to various settings including community exercise classes or an individual's home.

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CONTINUED

An effective stepping reaction

Must be:

1. Large
2. Fast
3. Appropriate direction (**unanticipated**) [3]

This is a 'choice reaction' under cognitive control

Mille, M. L., Johnson-Hilliard, M., Martinez, K. M., Zhang, Y., Edwards, B. J., & Rogers, M. W. (2013). One step, two steps, three steps more… directional vulnerability to falls in community-dwelling older people. *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences*, *68*(12), 1540-1548.

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An effective stepping reaction

Must be:

1. Large
2. Fast
3. Appropriate direction (**unanticipated**)

This is a 'choice reaction' under cognitive control

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Conflict of interest

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CONTINUED

The Clock Yourself app

A purpose-built exergame

- **Low**-tech
- **Easy** to set up
  (no mats, wires, sensors)
- Adjustable stepping **speed**

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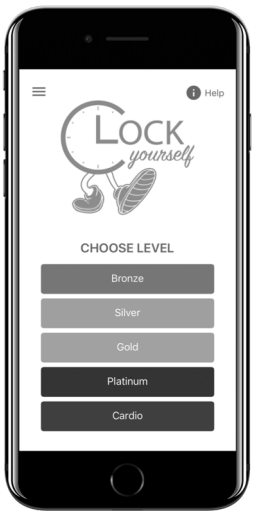
Help
Lock yourself
CHOOSE LEVEL
Bronze
Silver
Gold
Platinum
Cardio


vodafone AU
1:03 pm
35%
Back
Cardio Instructions
0:19 / 2:05

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Case Scenarios

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Case scenario 1

- Balance confidence – 80% on ABC
- Balance performance – 30/56 on BERG; OLST 0.5 seconds on LLE and 2.3 seconds on RLE
- It would be most concerning for a health care provider to have someone that had poor balance, but high balance confidence. The patient is at high risk for falls and doesn't believe their balance is an issue at all.
- POC – continuous assistance, medic alert, provide fall prevention education

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Case Scenario 2

- Balance confidence – 20% on ABC
- Balance performance – BERG – 48/56; OLST 12 sec on LLE and 10 seconds on RLE
- POC – encourage movement (involve caregiver), fall prevention education

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Summary, Q & A

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