Effects of Unstable Surface Lower Extremity Resistance Training on Balance in Older Adults: A Systematic Review

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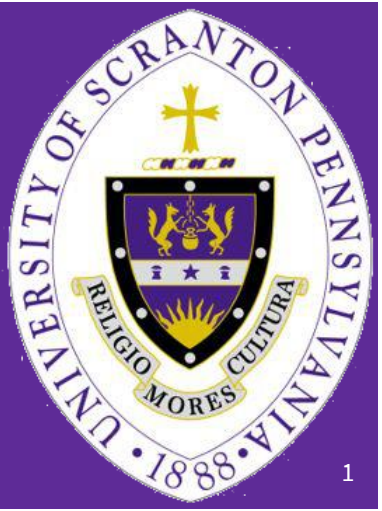

Presentation Overview

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Objectives

By the end of this presentation, attendees will:

1. Understand the potential benefits of incorporating unstable surfaces into resistance training programs to optimize older adult balance outcomes.
2. Understand how to appropriately and safely utilize unstable surfaces when prescribing a resistance training program.

Background

- Aging causes decreased function of body systems that maintain balance, potentially leading to falls which are the leading cause of injury in older adults.[1]
- Past research has supported lower extremity (LE) resistance training on stable surfaces for improving balance in older adults.[2-3]
- Utilizing unstable surfaces for LE resistance training to improve balance has not been thoroughly discussed.[4]

Background

Theorized additive benefits of unstable surface LE resistance training:

- Normalization of postural reflexes[5]
- Enhanced trunk activation[4]
- Improved proprioception in the LEs[5]
- Increased sensitivity of cutaneous receptors in the soles of the feet[5]

Purpose

- The purpose of this systematic review was to determine the effects of unstable surface LE resistance training on balance in older adults.

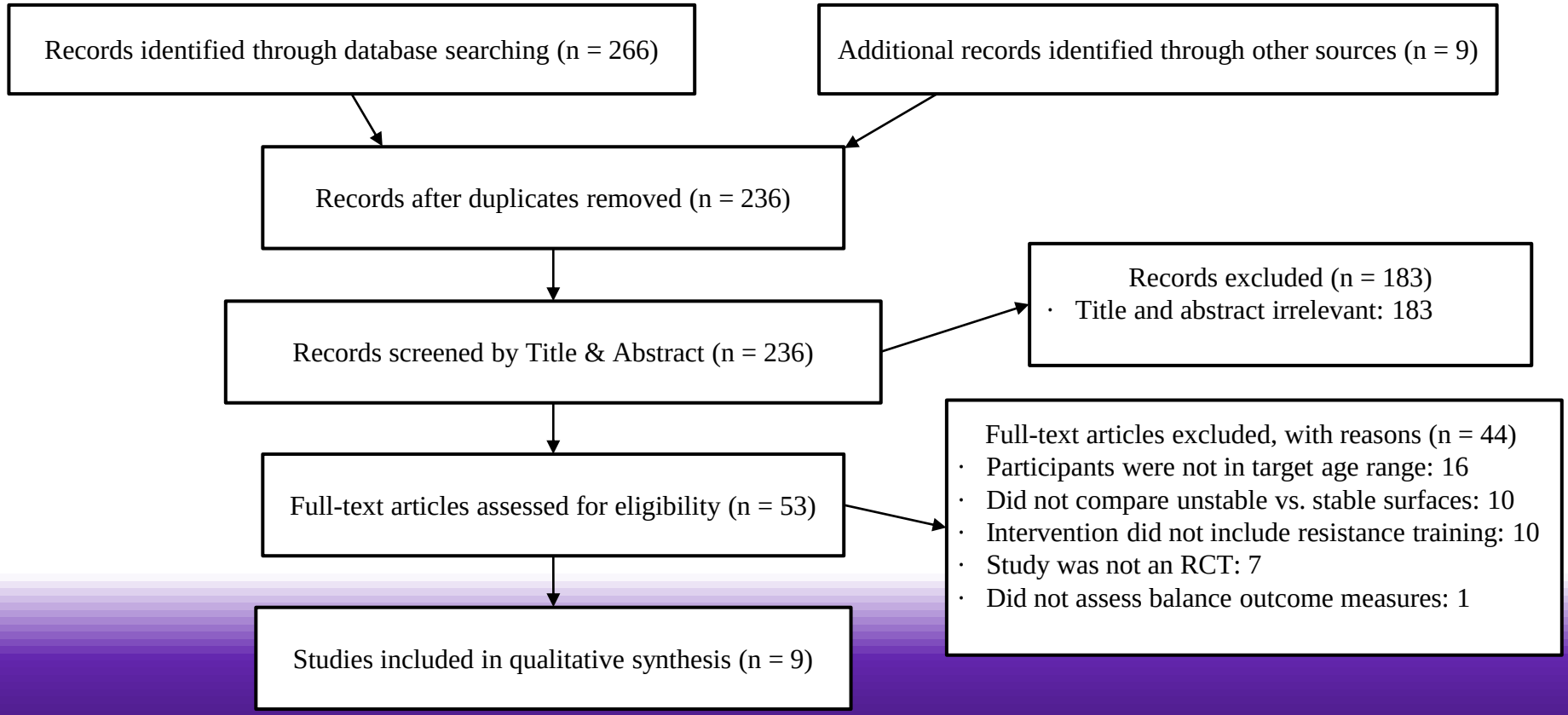
Methods

- **Search Engines:**
  - PubMed, ProQuest, CINAHL, and Google Scholar
- **Limits:**
  - Human Subjects, Peer-Reviewed, Randomized Control Trials (RCTs)
- **Search Terms:**
  - (“unstable surfaces” **OR** “instability”) **AND** (“stable surfaces” **OR** “steady surfaces”) **AND** (“lower extremity” **OR** “LE”) **AND** (“resistance training” **OR** "strength training") **AND** (“balance”) **AND** (“older adults” **OR** “geriatrics” **OR** “seniors”)

Selection Criteria

- Selection criteria included:
  - RCT design
  - Participants: 65+ years of age with no history of neurologic diagnoses affecting the LE's or recent LE fractures/surgeries
  - Interventions: LE strength training protocols on unstable surfaces
  - Comparator: LE strength training protocols on stable surfaces
  - Outcomes: Standardized balance measures

PRISMA


Records identified through database searching (n = 266)
Additional records identified through other sources (n = 9)
Records after duplicates removed (n = 236)
Records screened by Title & Abstract (n = 236)
Records excluded (n = 183)
· Title and abstract irrelevant: 183
Full-text articles assessed for eligibility (n = 53)
Full-text articles excluded, with reasons (n = 44)
· Participants were not in target age range: 16
· Did not compare unstable vs. stable surfaces: 10
· Intervention did not include resistance training: 10
· Study was not an RCT: 7
· Did not assess balance outcome measures: 1
Studies included in qualitative synthesis (n = 9)

PEDro Scores

Studies	Eligibility Criteria	Random Allocation	Concealed Allocation	Baseline Comparison	Blind Subjects	Blind Therapists	Blind Assessors	Adequate Follow-up	Intention to Treat	Between Group Comparison	Point Estimate Variability	Pedro Score
Piraua et al.[3]	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	**7/10**
Eckardt[4]	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	**7/10**
Hirase[5]	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	**7/10**
Zhou, Yuan, Ma[6]	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	**5/10**
Hamed et al.[7]	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	**7/10**
Eckardt and Rosenblatt[8]	Y	Y	Y	Y	N	N	Y	N	Y	Y	Y	**7/10**
Kim, Choi, Kim[9]	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	**6/10**
Cavalcante[10]	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	**6/10**
Eckardt, Braun, Kibele[11]	Y	Y	Y	Y	Y	N	Y	N	Y	Y	Y	**8/10**

Results

- A total of 266 articles were screened
  - 9 RCTs met the selection criteria
- Samples ranged from 14-86 subjects (511 total)
  - Average age of 72.73 years

Results

Intervention parameters:

- Study durations ranged from 3 weeks-6 months (1-5 sessions/week) and session durations ranged from 30-60 minutes
- Unstable surface groups (USG) differed by exercise selection and the instability devices used
- Stable surface groups (SSG) performed various LE resistance training protocols on firm, even ground

Results

The USG demonstrated statistically significant improvements in balance outcomes compared to the SSG in five[5-9] studies:

- The USG held tandem stance 12.9 s longer and single leg stance (SLS) 6.0 s longer than the SSG after 2 months ($p<0.02$).[5]
- The USG walked 11.2% faster in the 10mWT after 3 weeks of training while the SSG improved by 6.6% ($p=0.049$).[6]

Results

- The USG showed a significantly larger effect size than the SSG for center of pressure to the limits of stability, d=1.61 and d=0.23, respectively.[7]
- The USG increased their side reaching in the multidirectional reach test by 14% (p=0.036) while the SSG improved by 4% (p=0.398).[8]
- The USG improved their SLS on foam from 9.42 to 15.30 s (p=0.03) after 8 weeks while the SSG improved from 7.07 to 11.27 s (p=0.20).[9]

Conclusion

- There is **mixed evidence** in support of unstable surface LE resistance training programs for improving balance in older adults.
- Further high-level research should be conducted to determine optimal LE exercises and dosage in order to provide maximal balance gains in older adults.

Limitations

- Small sample sizes
- Large age range which led to high variability in performance
- Subject variability may have also led to different motor strategies utilized
- Study protocols varied by frequency and duration
- Results cannot be generalized to less healthy or frail older adults

Future Research

- Future studies should focus on:
  - Optimal training dosage, intensity, frequency, and duration parameters to maximize prevention of future falls
  - Studying the underlying mechanisms to explain why unstable surfaces may promote additional balance improvements to prevent falls

Clinical Relevance

- Implementing unstable surface resistance training **may** reduce risk of future falls as evident by TUG fall risk cutoff scores for community dwelling older adults.[5,12]
- It **may** also decrease risk of injurious falls as evident by SLS time predictors.[13]
- LE resistance training on unstable surfaces did not lead to increased adverse events and **may** be considered by clinicians when balance training with older adults, in addition to training on stable surfaces.

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Appendix

Outdoor multi-surface terrain environment

BOSU ball

Foam pad

Appendix Cont.

TOGU Aero-step Balance Trainer pad

Posturomed device

Study	Unstable Surface Group (USG) Parameters	Key findings
Piraua et al. (2019)[3]	**Frequency:** 24 weeks, 3x/week **Duration/Volume:** 30-60 mins, 2-5 sets and 7-12 reps **Exercises:** 45º ROM leg press, bridges **Equipment:** BOSU ball, balance disc, Swiss ball	There were no statistically significant differences between the USG and the stable surface group (SSG) in TUG, BBS, and FES-I scores.
Eckardt (2016)[4]	**Frequency:** 10 weeks, 2x/week **Duration/Volume:** 60 mins **Exercises:** Squats, stair walker, front lunges, bridges, farmer carries **Equipment:** BOSU ball, wobble board, inflatable disc	Both groups improved in the FRT, however free weight USG (F-USG) revealed the largest effect size.There were no statistically significant differences between groups in TUG and FRT scores.
Zhou, Yuan, Ma (2020)[5]	**Frequency:** 5x/week for 3 weeks **Duration:** 30 min sessions **Exercises:** Bodyweight squats, single-leg squats, heel raises **Equipment:** Outdoor environment consisting of grass, sand, gravel, pebbles and plastic	The USG showed statistically significant improvements when compared to the SSG for the 10 mWT. No statistically significant differences were seen in TUG times, SLSTEO, or SLSTEC.
Hamed et al. (2018)[6]	**Frequency:** 2x/week for 14 weeks **Duration:** 1.5 hour sessions **Exercises:** Lunges, jumping, squatting **Equipment:** Wedged soft mat, soft pad, BOSU ball, balance beam, semicircular block, Posturomed device	The USG showed a significantly higher effect size than the SSG for improvements in their center of pressure towards the anterior limit of stability.

Hirase (2015)[7]	**Frequency:** 1x/week for 4 months **Duration:** 60 min sessions **Exercises:** Heel raises, toe raises, free-leg swinging **Equipment:** Foam rubber pad	The USG held SLS and tandem stance significantly longer than the SSG after 2 months. The USG had significantly greater improvements in their TUG and FES scores when compared to the SSG.
Eckardt and Rosenblatt (2019)[8]	**Frequency:** 2x/week for 10 weeks **Duration/Volume:** 60 min sessions **Exercises:** Squats, stair walker, front lunges, bridges, farmer carries **Equipment:** BOSU ball, wobble board, inflatable disc	Free weight USG group increased its side reaching in the MDRT outcome measure by 14%, compared to the SSG group which only improved by 4%.
Kim, Choi, Kim (2016)[9]	**Frequency:** 2x/week for 8 weeks **Duration:** 40 min sessions **Exercises:** Isometric squats, weight shifts in squat stance **Equipment:** TOGU Aero-step Balance Trainer pad	The USG held SLS on a soft surface for a significantly longer time than the SSG. While not statistically significant, the USG improved in their TUG time to a greater degree than the SSG.
Cavalcante (2020)[10]	**Frequency:** 3x/week for 12 weeks **Duration/Volume:** 3 sets of 10-15 reps for each exercise **Exercises:** Wall ball squat, horizontal leg press, bridges, standing calf raises **Equipment:** BOSU ball, balance disc, Swiss ball	The USG showed non-statistically significant improvements in TUG and SPPB scores compared to the SSG.
Eckardt, Braun, Kibele (2020)[11]	**Frequency:** 2x/week for 10 weeks **Duration:** 60 min sessions **Exercises:** Squats, forward lunges **Equipment:** BOSU ball, foam pad, soft pad	There were no significant differences for improvements in FES-I scores between the USG and the SSG after the intervention period.

Questions?


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