Seattle University

Assessing Postural Stability

Presented by Brenna Dunston

Project Question

How do adults interested in returning to recreational athletics perform on balance assessments?

Objectives

01 Assess Static Balance in Adults

02 Assess scores based on criterion and normative standards

03 Establish test retest reliability

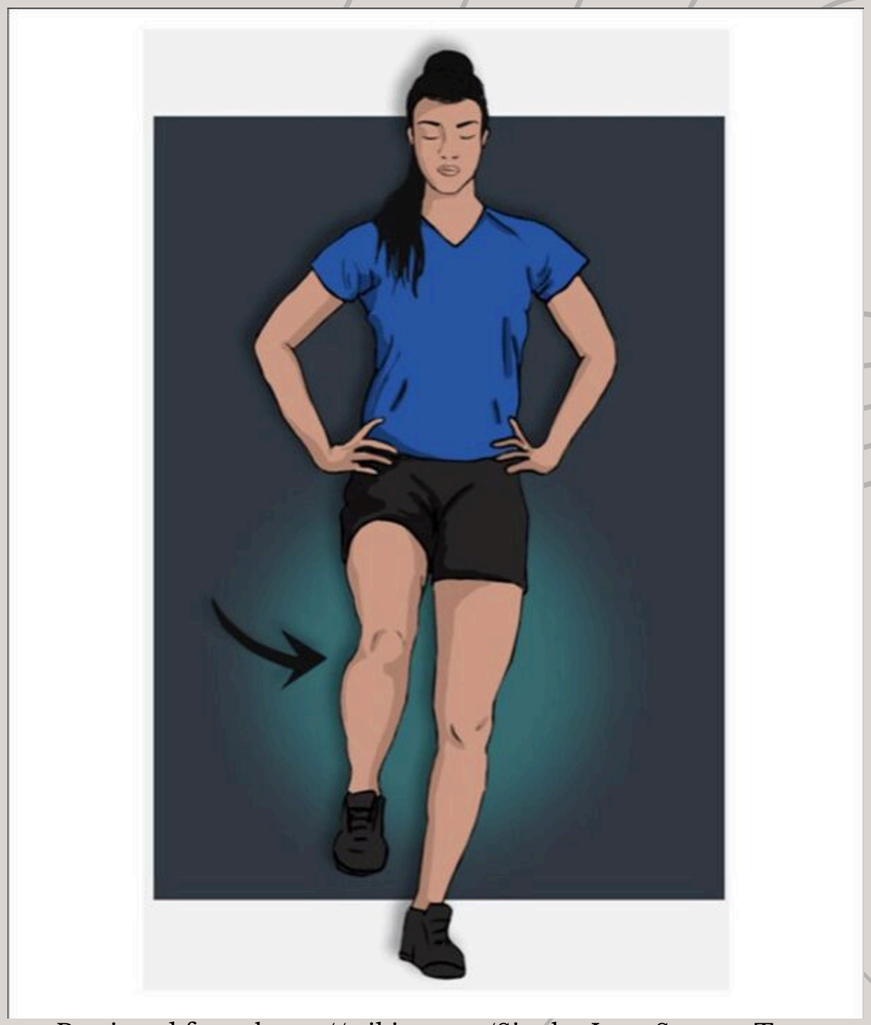
04 Calculate Change Scores to determine real differences

05 Investigate relationships between groups

06 Give those with insufficient scores recommendations to reduce change of injury

Background

- Growing popularity in recreational sport
- Ankle sprains one of most injuries in physically active (McCriskin et al., 2015)
- Postural Stability is a risk factor for injury (Herzog et al., 2019)
- Increased postural sway is associated with increased ankle sprain (McGuine et al., 2000)
- Assess postural/ankle stability to determine risk for ankle injury



Retrieved from https://wikism.org/Single_Leg_Stance_Test

Overview of Measurement

Single Leg Stance Test (SLST) and Time in Balance Test (TIBT)

- Why static and not dynamic?
  - in detecting ankle instability static and dynamic measures were found to have no significant differences (Arnold et al., 2009)
  - less equipment required
- SLST found to have predictive validity with lateral ankle sprains (Trojian & McKeag, 2006)
- TIBT found to be valid in detecting postural instability associated with chronic ankle instability (Linens et al., 2014)
- May be useful for detecting risk for non contact injury (Dingenen et al., 2016)

Methodology

Inclusion Criteria

- not currently participating in recreational sport
- interested in returning to recreational sport
- non currently injured

Participants

- 5 male
- 7 female participants
- Ages ranging from 21-61 years

Procedures

Procedures were adapted from Trojian & McKeag (2006) and Linens et al. (2014).

Test conducted with...

- on one foot without shoes on
- the contralateral knee bent and not touching the weight bearing leg
- the hips were level to the ground
- the eyes open and fixed on a spot marked on the wall and then the eyes were closed and timer was started

Test stopped if...

- the athlete's legs touched each other
- the feet moved on the floor
- the foot touches down
- or the arms moved from starting position
- participant reported sense of imbalance
- 60 seconds had passed

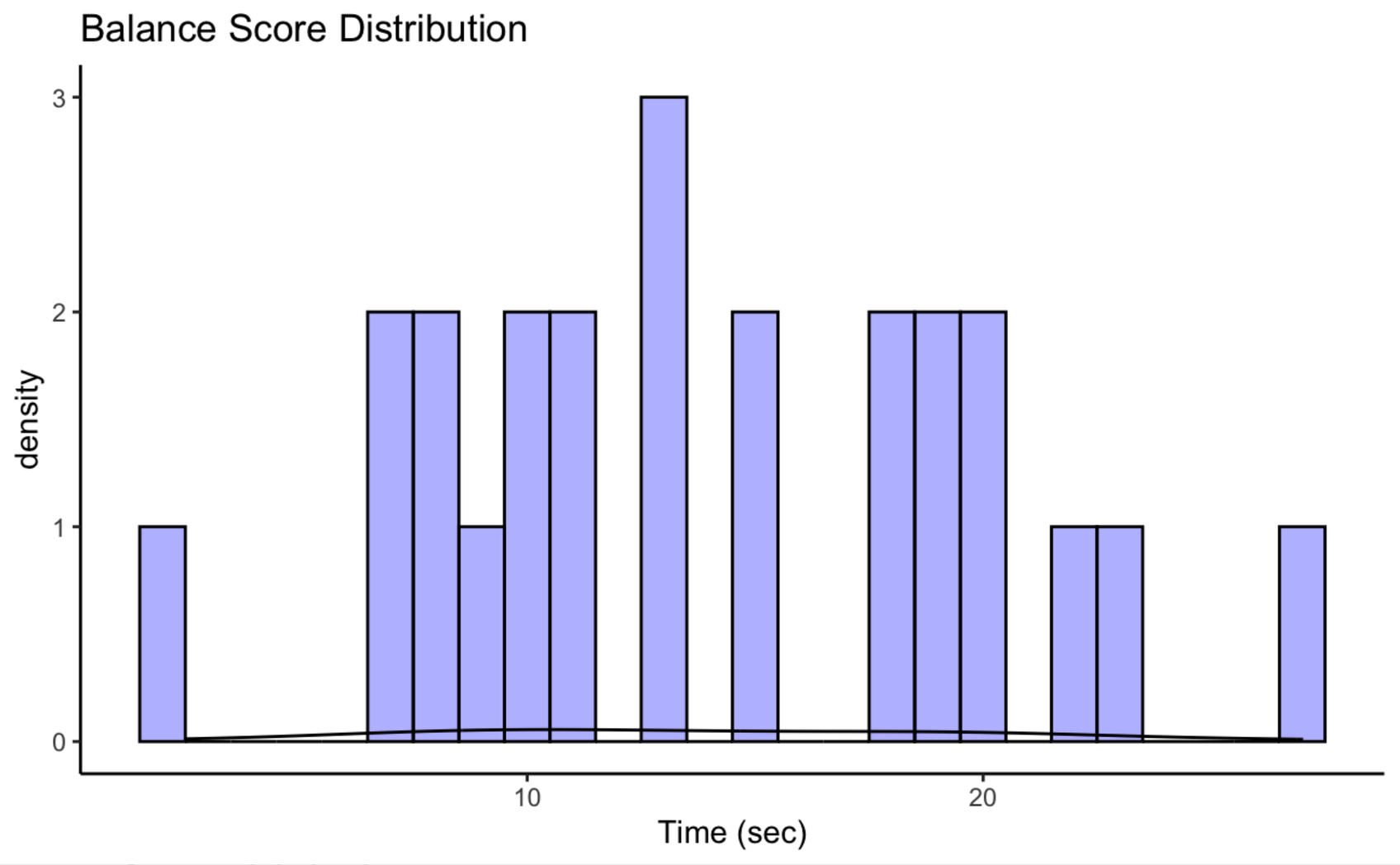
Time at stopping was recorded

Statistical Analysis

Types of Analysis...

- Assessment of Normality
  - Shapiro-Wilk, QQ Plot, etc
- Test-Retest Reliability
  - Pearsons coefficient and ICC
- Change Scores
  - calculated based on ICC
- Group Differences
  - t-test and cohen's d

Distribution of Data



- Visualizations
- Shapiro-Wilk Test
- QQ Plot

Normality Tests

Show 10 entries Search:

	trial	w_value	p_value
1	right_trial1	0.9433899760763712	0.5431948131601924
2	left_trial1	0.9099740346491174	0.213184277478903
3	right_trial2	0.9300259166904191	0.3803866897289499
4	left_trial2	0.9736636772914209	0.9451460694710041

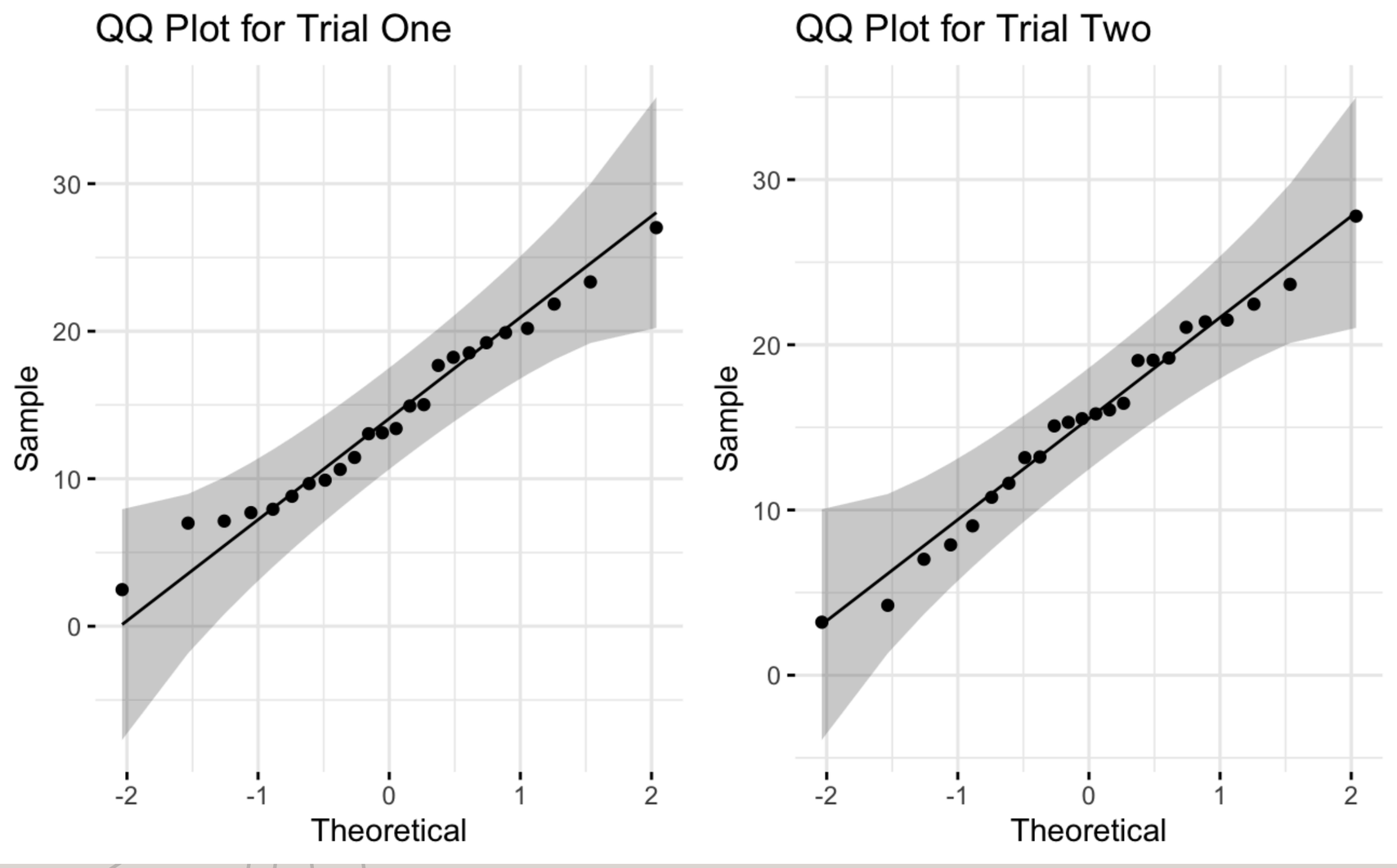
Showing 1 to 4 of 4 entries

Previous 1 Next

Shapiro-Wilk

- All data
  - W = 0.98372
  - p-value = 0.7378
  -
- PR data
  - W = 0.9359
  - p-value = 0.4469

Normality Tests



QQ Plot

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- PR data
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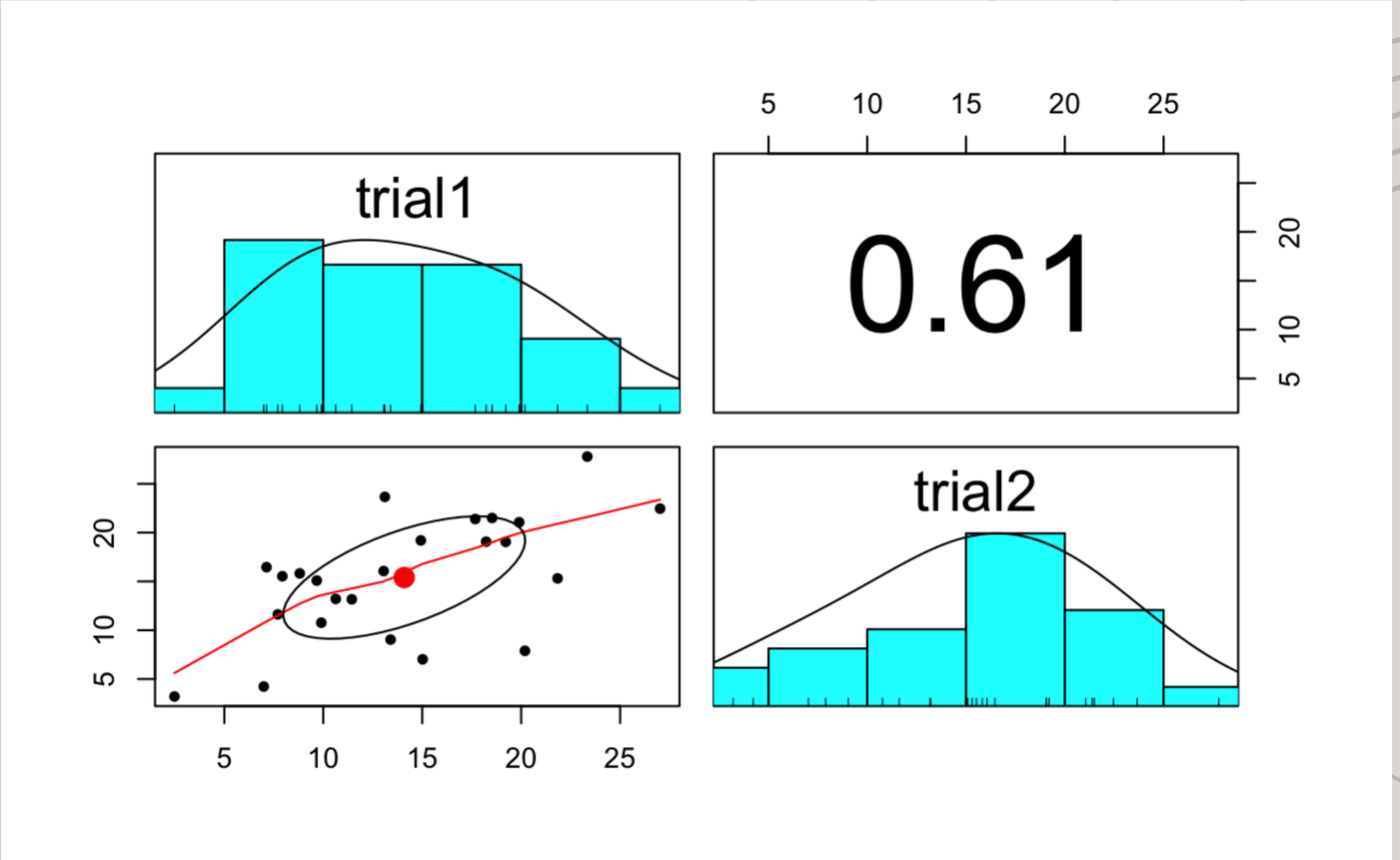
Test Retest Reliability

Both Legs

- Pearson's Coefficient
  - 0.61
  - moderate
- ICC
  - 0.60 (0.28-0.80)
  - moderate reliability



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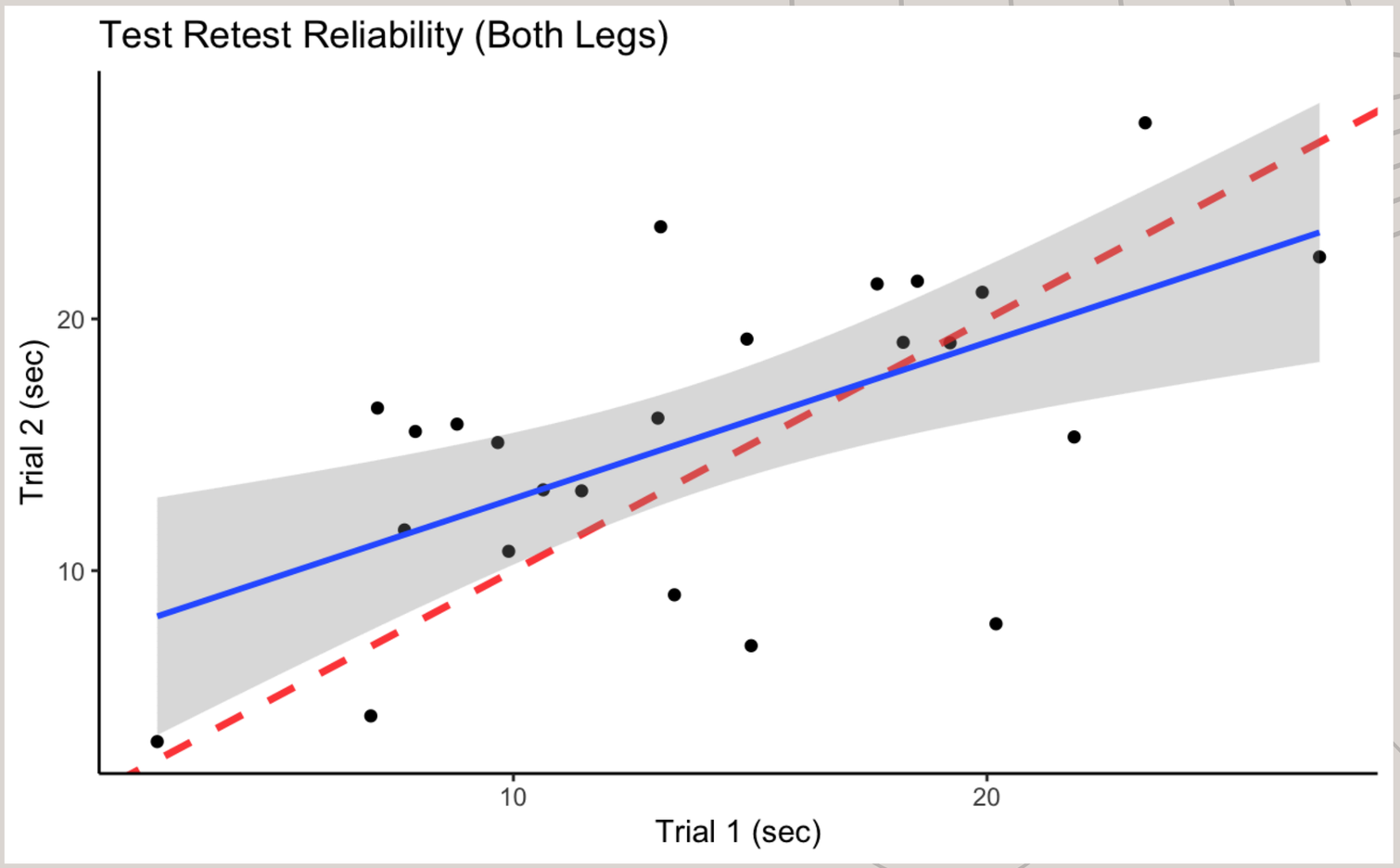
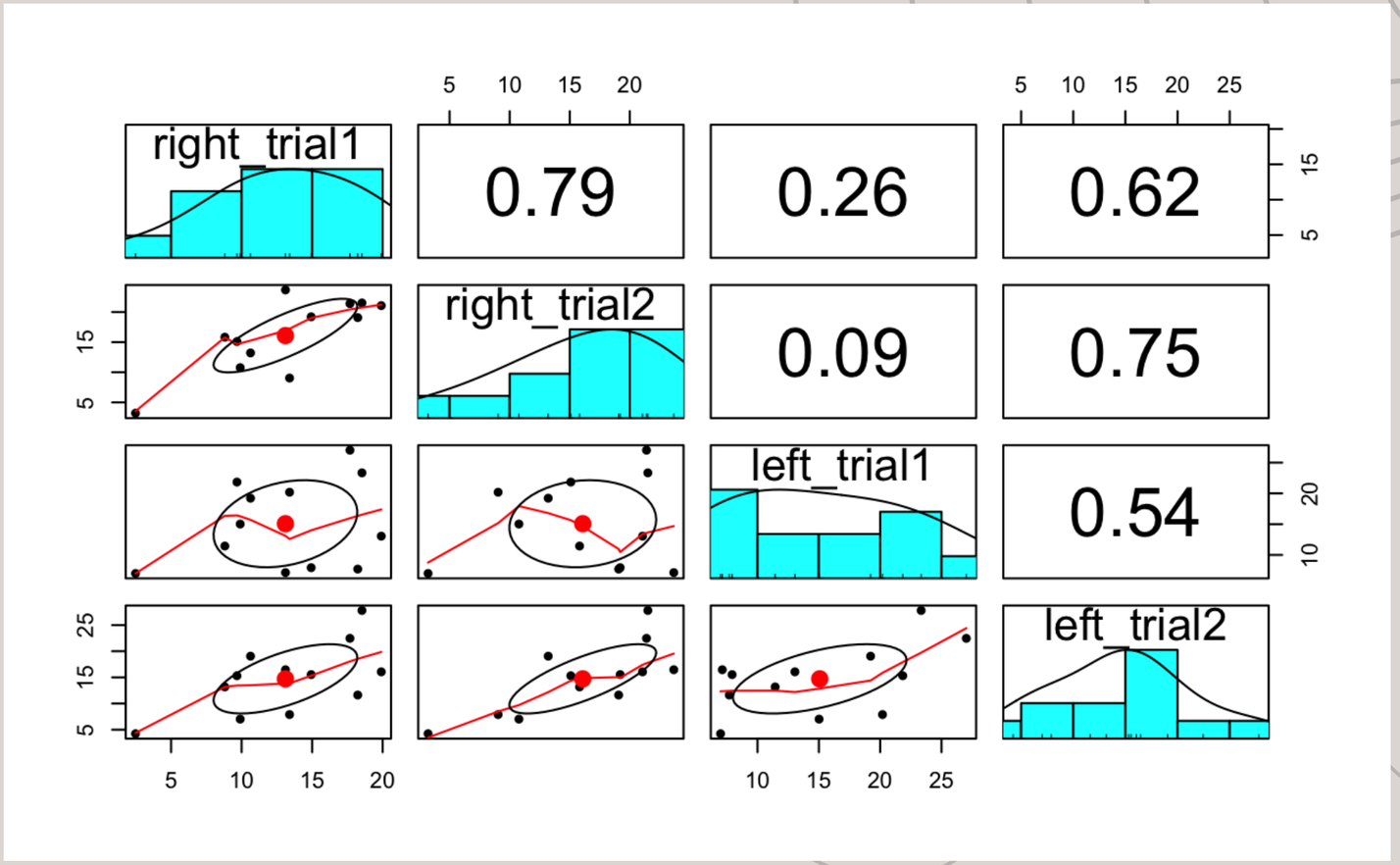


Reliability of Each Leg

- Right ICC
  - 0.70 (0.14-0.91)
- Left ICC
  - 0.57 (0.04-0.85)



Change Scores

- SEM
  - 3.89 seconds
- MDC
  - 10.78 (secs)
  - 2 seconds larger than the 8.7 seconds other studies have found (Goldberg et al., 2011)
- CoV
  - 42.02 %
  - agreeance with Goldberg and colleagues (2011)

Criterion for Assessment

Criteria from Trojian & McKeag (2006) and Linens et al. (2014).

Standards

- SLST test positive if unable to carry out the test on either or both legs for the criterion of 10 seconds (Trojian & McKeag, 2006)
  - Positive result = relative risk of 2.54 (95% CI, 1.02 to 6.03)
  - Athletes w/ no ankle taping and possible ankle sprain history = relative risk of 8.82 (95% CI, 1.07 to 72.70)
  - Athletes w/ no ankle taping and no ankle sprain history = relative risk of 7.18 (95% CI, 1.05 to 61.7)
- Criteria for CAI (Linens et al., 2014)
  - < 25.89 seconds

Ankle Sprain Risk Criteria

- Results
  - 5 Positive Tests
  - 7 Negative Tests

participant_id	age	gender	history	balance_training	positive_test
1	21	f	0	2.00	No
2	54	f	1	2.00	No
3	61	m	0	0.25	Yes
4	21	f	0	1.00	No
5	27	f	0	1.00	Yes
6	31	m	2	0.50	Yes
7	24	f	0	0.00	No
8	24	f	0	0.00	Yes
9	25	m	0	0.00	Yes
10	25	m	0	0.00	Yes
11	25	m	0	0.00	No
12	22	f	0	0.00	Yes

Ankle Instability Criteria

- Results
  - 10 Positive Tests
  - 2 Negative Tests

participant_id	age	gender	balance_training	pr	positive_test
1	21	f	2.00	27.79	No
2	54	f	2.00	27.02	No
3	61	m	0.25	6.99	Yes
4	21	f	1.00	19.22	Yes
5	27	f	1.00	19.20	Yes
6	31	m	0.50	19.07	Yes
7	24	f	0.00	20.19	Yes
8	24	f	0.00	23.66	Yes
9	25	m	0.00	15.82	Yes
10	25	m	0.00	15.02	Yes
11	25	m	0.00	21.06	Yes
12	22	f	0.00	21.84	Yes

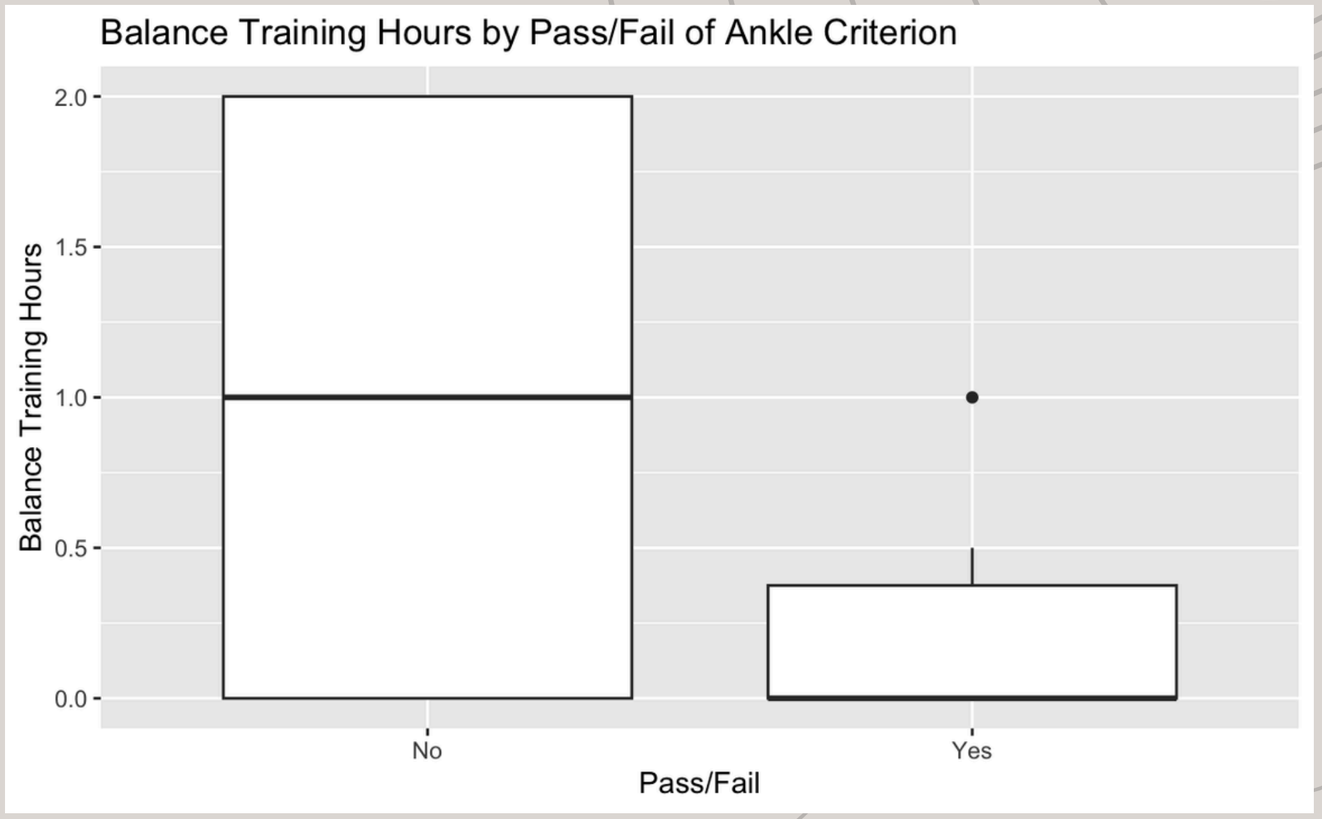
Normative Standards

- Normative Standards retrieved from Springer and colleagues (2007)
  - 18-39 = 15.2 seconds
  - 40-49 = 12.7 seconds
  - 50-59 = 8.3 seconds
  - 60-69 = 4.4 seconds

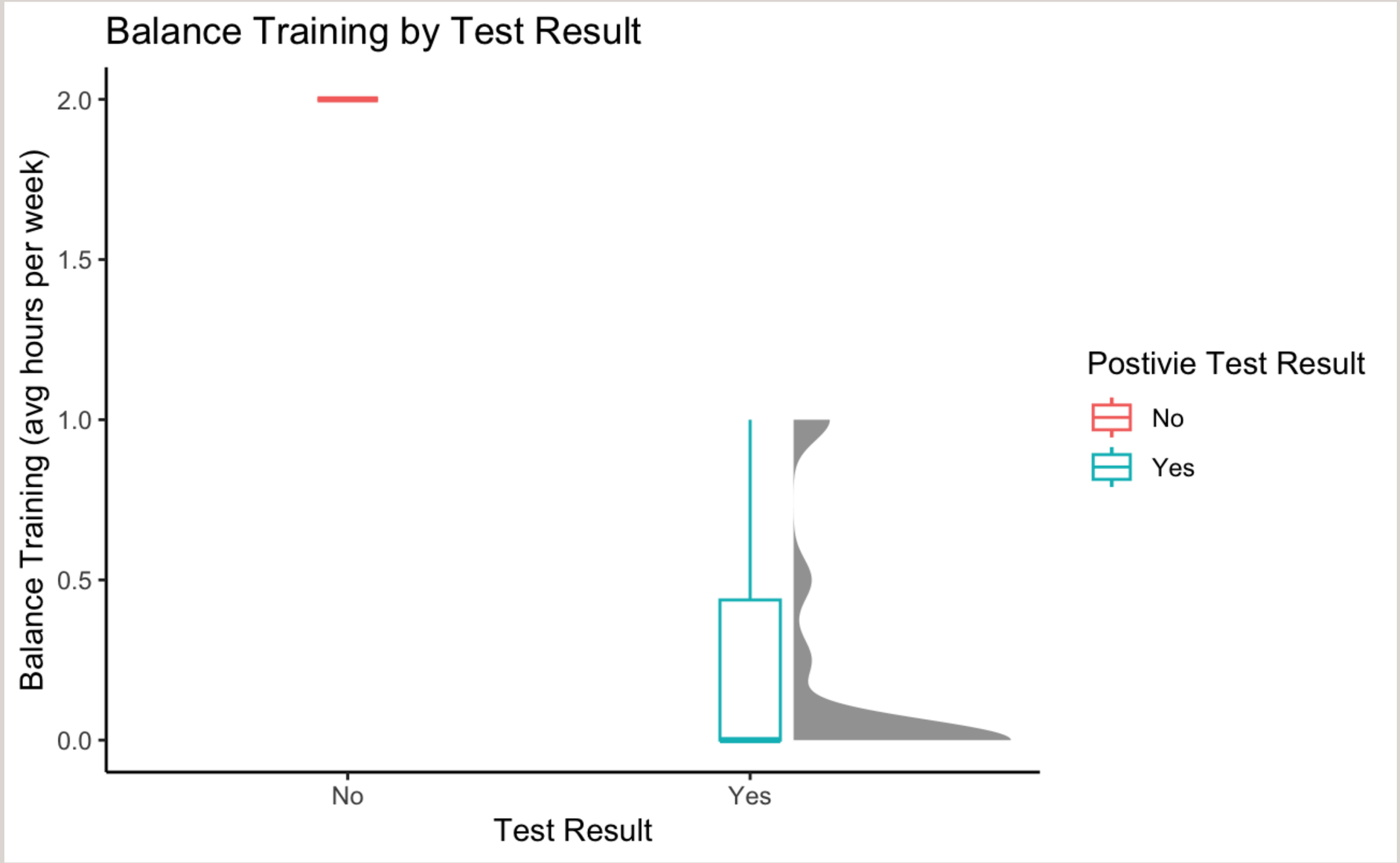
- Results
  - 8 were above standards on at least one leg
  - 4 were below standards on both legs

Effect of Balance Training?

- Was the outcome of each criteria test associated with the amount of balance training per week an individual had?
  - Ankle Risk Criteria?
    - No
    - t-test
      - p value of 0.1733
      - -0.47 1.97
  - Ankle Instability Criteria?
    - Yes
    - t-test
      - p value of 3.593e-07
      - 95% CI of 1.43-2.02

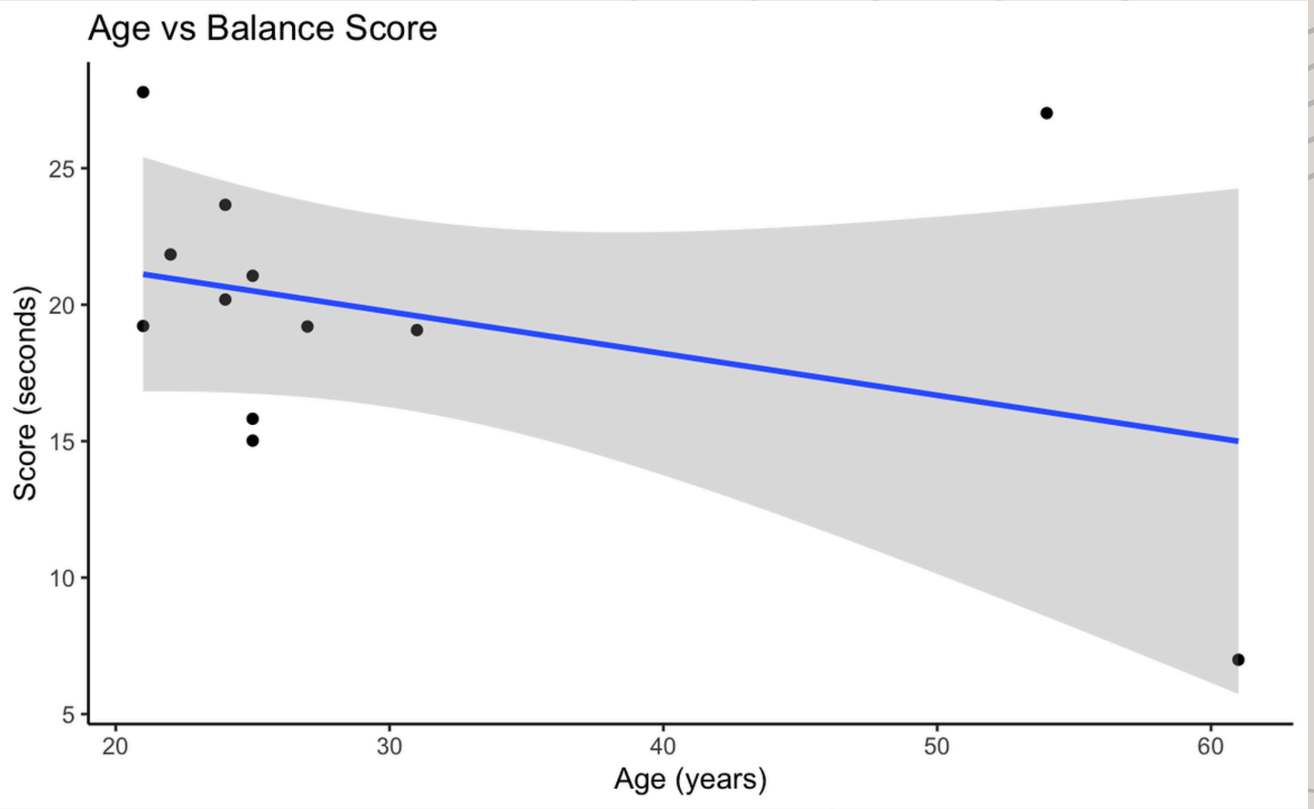


Effect of Balance Training?



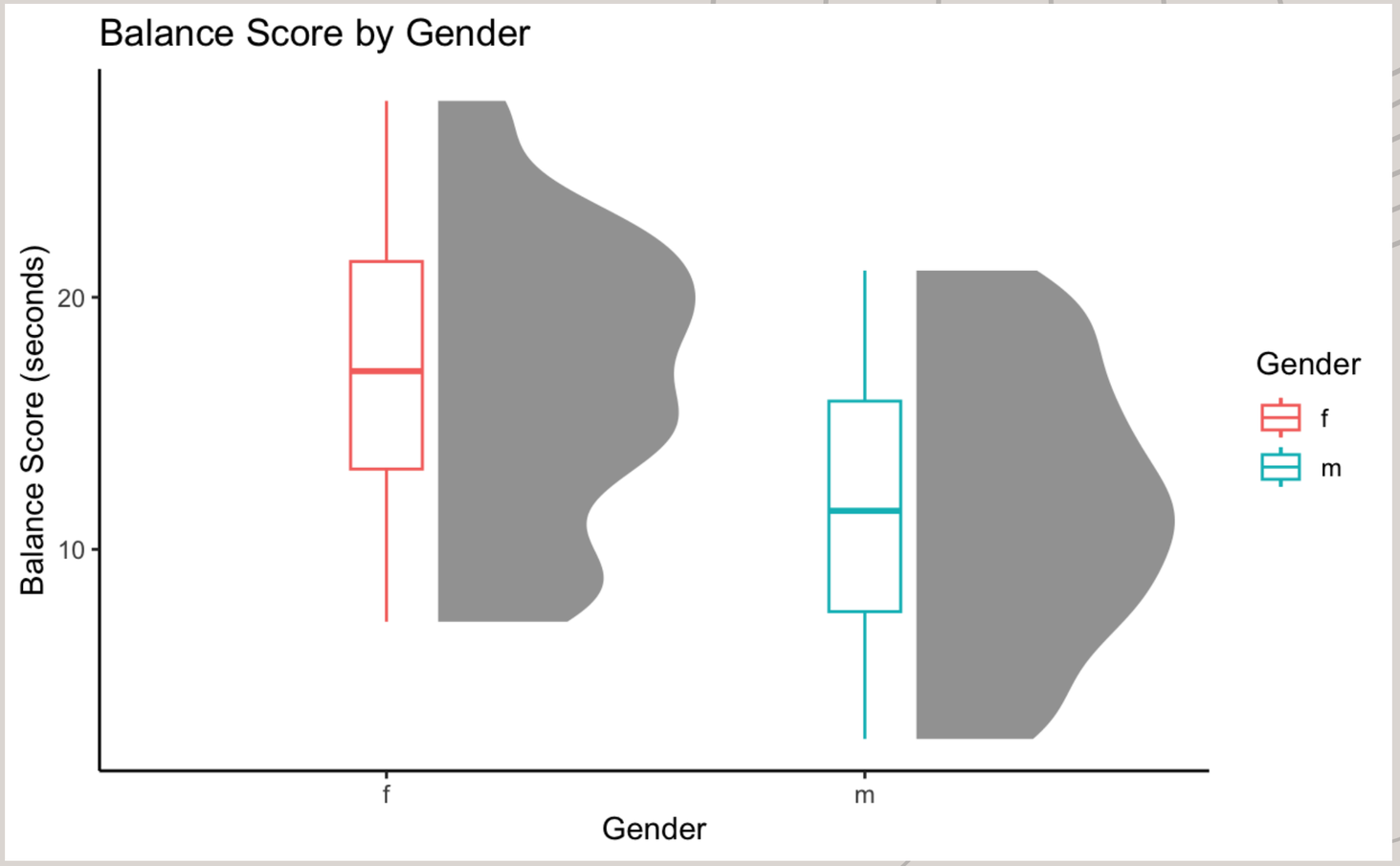
Effect of Age?

- Did not run further analysis because of the sample size of each age range and already known effects

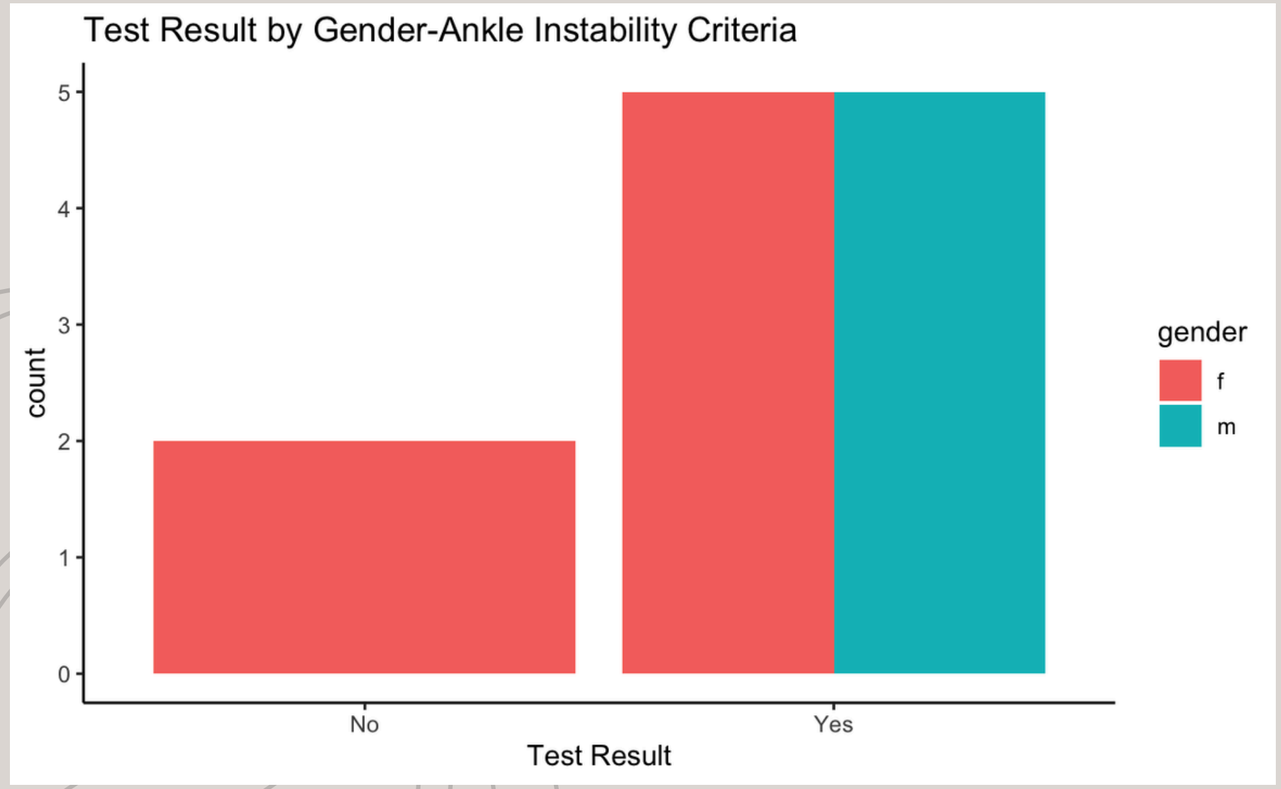


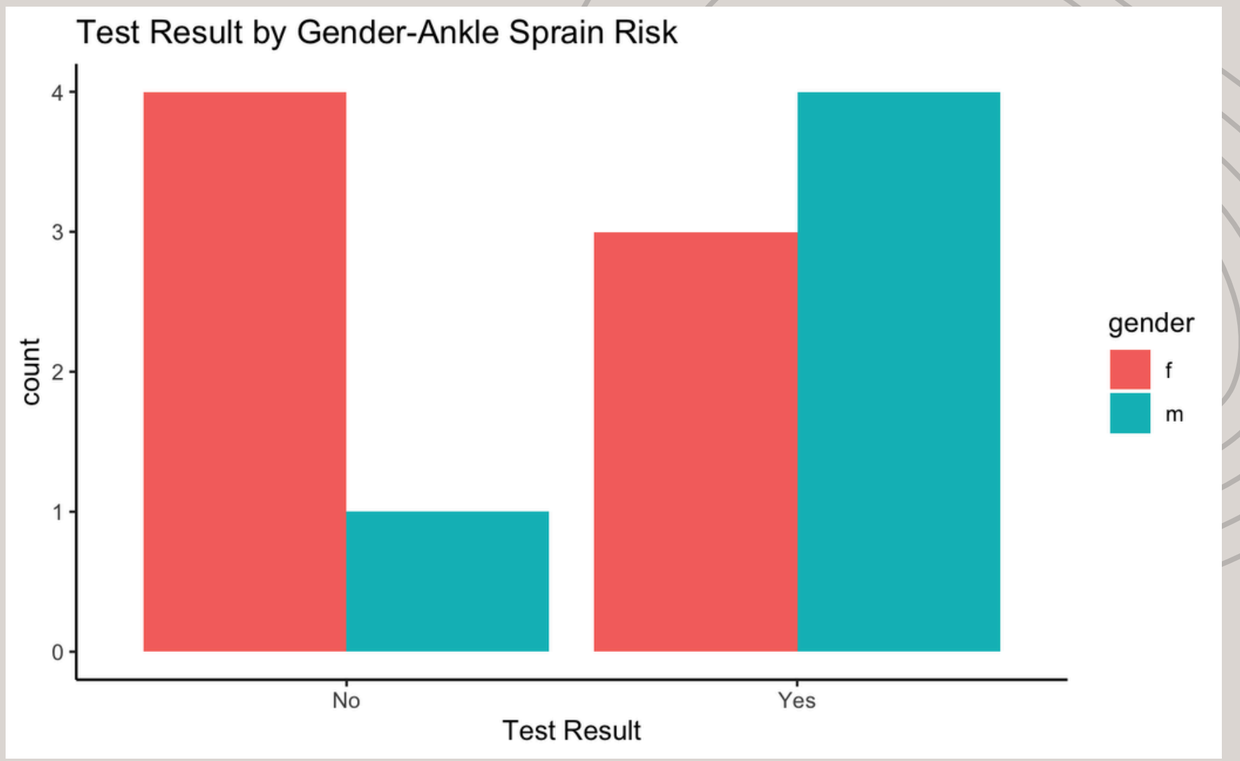
Effect of Gender?

- Significant differences between male and female when scores compared
  - t-test
    - p value
      - 0.003 (1.75-8.42)
    - F = 16.86429
    - M = 11.77750
  - Effect size
    - cohen's d
      - 0.91 (-1.51 - -0.31)
      - large effect size
- This disagrees without other research and could be due to sampling



Effect of Gender?





...by Criteria Result

Limitations/Conclusions

What to do differently...

- sample size of groups
- equipment
- 3 trials
- reliability
  - intrarater
- control for confounding variables better

Conclusions...

- were able to assess balance and give interventions

Practical Applications

Interventions

- Ankle Tapping or bracing (Trojian & McKeag, 2006)
- Neuromuscular Warm-ups (Labella et al., 2011)
- Neuromuscular training programs (McCriskin et al., 2015)
  - 45 min session twice a week (Brachman et al., 2017)

What is Chronic Ankle Instability?

Definition:
A condition involving recurrent ankle sprains, instability, and muscle weakness due to ligament injury. (Hou, Z., Huang.,2022)

- Affects 34% of individuals with lateral ankle sprains.
- Grade III ligament injuries are the most severe, requiring targeted rehabilitation.

Why Balance Training?

Purpose:

- Improve postural control, muscle strength, and functional stability.
- Reduce the risk of recurrent sprains and enhance quality of life.

Key Benefits:

- Strengthens muscles.
- Improves proprioception
- Builds dynamic stability for daily and sports activities..

Target Areas for Muscle Strengthening

- **Dorsiflexion**:

Lifting the front of the foot towards the shin.

Enhances balance during activities like stepping and climbing stairs.

- **Eversion:**

Moves the sole of the foot outward, away from the midline.
Reduces the likelihood of the ankle rolling inward, which is a common cause of sprains.

- **Inversion:**

Moves the sole of the foot inward, toward the midline.

Controls lateral body weight shifts during walking or standing on uneven surfaces.

1. Resistance Band Exercises

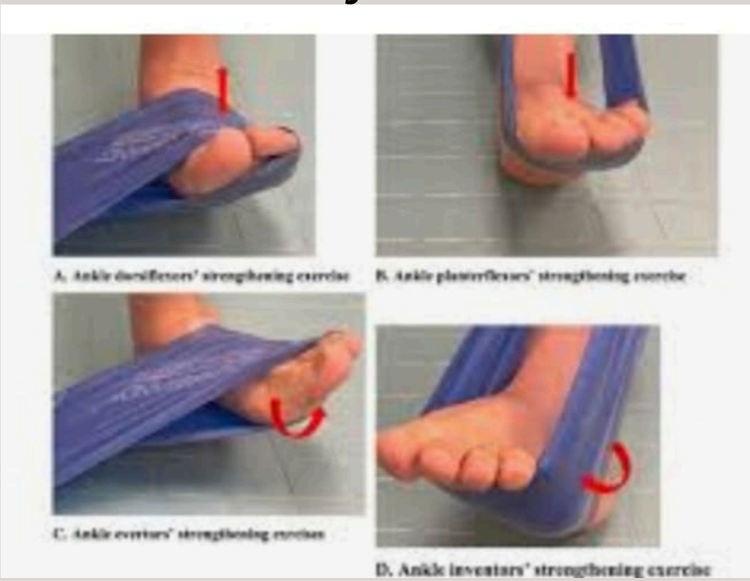
Objective:

Strengthen specific ankle muscles (dorsiflexors, evertors, and invertors) to improve control and stability.

Protocol: (Kaminski, T. W., et al 2003)

Secure a resistance band around the foot and anchor it to a stable object.
Perform controlled movements:

- Dorsiflexion: Pull toes upward against the resistance.
- Eversion: Move foot outward against resistance.
- Inversion: Move foot inward against resistance.
- Repeat 3 sets of 15 repetitions for each movement.



Progression:

- Use bands with higher resistance as strength improves.
- Introduce combined movements to mimic real-life ankle demands.

2. Wobble Board Training

Objective: Improve balance, proprioception, and ankle stabilizer strength.
Protocol ： (Hertel, J., et al 2007)

- Stand on a wobble board with feet shoulder-width apart.
- Perform slow, controlled movements:
- Tilt forward and backward (dorsiflexion/plantarflexion).
- Tilt side-to-side (inversion/eversion).
- Circular motions for multi-directional stability.
- Gradually progress to single-leg stance on the wobble board.

Progression:

- Add tasks like catching and tossing a ball while balancing.
- Reduce hand support or use unstable surfaces like foam pads.

3. Hop Training

Objective:

Enhance dynamic muscle strength and prepare for real-world movements

Types of Hops:

- Single-Leg Hop: Hop forward on one leg, maintaining balance on landing.
- Medial/Lateral Hop: Jump side-to-side to strengthen lateral stabilizers.
- Anterior/Posterior Hop: Hop forward and backward for dynamic control

Protocol: (Hale, S. A., et al., 2007)

- Perform 10-15 repetitions for each type of hop.
- Focus on soft, controlled landings to minimize ankle strain.

Progression:

1. Increase the distance or height of hops.
2. Add directional changes or obstacles (e.g., cones).

4. Single-Leg Balance Challenges

Objective: Build endurance and fine motor control in stabilizer muscles.

Protocol:

(Hertel, J., Olmsted-Kramer, L. C., 2006)

- Stand on one leg for 30-60 seconds.
- Introduce variations:
- Eyes closed.
- Standing on a soft surface like a foam pad.
- Holding or tossing a ball.
- Repeat 3-5 sets per leg.

Progression:

- Increase duration or add multi-tasking (e.g., moving arms or looking in different directions).

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