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Applying Strength and Conditioning Principles to a Functional High-Intensity Resistance Training Program for Older Adults

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Objectives

1. Identify the need for high intensity, functional resistance training for our older adult patients
2. Understand the safety and efficacy of high intensity resistance training
3. Apply strength and conditioning principles to an exercise program
4. Understand various strategies to determine and monitor intensity
5. Increase confidence in exercise prescription and modification for a general exercise program
6. Foster an increase in physical activity for a chronically inactive population through effective patient education

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Problems

1. Most older adults don't meet CDC guidelines for physical activity
2. Our profession frequently underloads our older adult patients
3. Our profession often fails to apply strength and conditioning principles to our exercise programs
    1. Our profession inconsistently utilizes strategies to prescribe exercise, such as objective HR and intensity assessment

Why Resistance Training?

- Physiological Benefits (Fragala et al., 2019)
- Counteract age-related changes
- Functional Benefits
- Chronic Conditions?
- *Independence*

Program Strength & Conditioning Principles (Reiman and Lorenz, 2011)

- Individuality
- Progressive Overload
- Specificity
- Frequency
- Rest Period
- Periodization
- Volume and Intensity
- Types of Resistance

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Individuality

- The resistance program should be designed specifically for the patient in front of you
  - Medical history
  - Injury history
  - Training background
  - Goals
  - Motivation

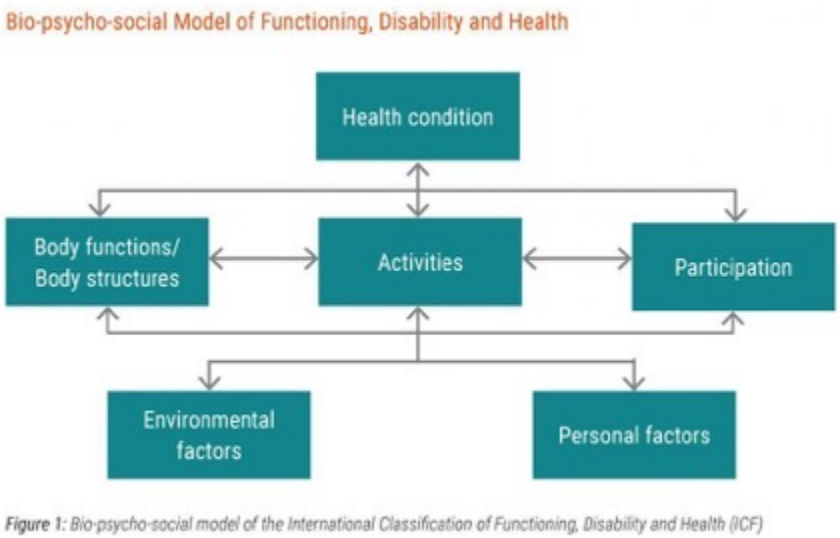


Figure 1: Bio-psycho-social model of the International Classification of Functioning, Disability and Health (ICF)

Progressive Overload

- Challenge the patient!
- Increase load as they increase force, power, endurance capability
  - » Frequent Reassessment (Avers et al., 2009)

Specificity

- “The way the athlete trains is how he or she will function”
- Include exercises that simulate activities of daily living for our older adult patients (Iversen et al., 2021)
- Functional training combines multiplanar, multiarticular movements to improve functional capacity (Kasukawa et al., 2010)
- https://www.instagram.com/tv/CXOsUjfFOcB/?utm_medium=copy_link

Frequency

- The number of training sessions per week (Reiman and Lorenz, 2011)
  - 2-3 times per week(Izquierdo et al., 2021)

Rest

- At least 1 day between sessions (Izquierdo et al., 2021)
- 60 seconds between sets (Borde, Hortobagyi, & Granacher, 2015)
- 4.0 seconds between repetitions (Borde, Hortobagyi, & Granacher, 2015)

Periodization

- The manipulation of training variables (loads, sets, repetitions)
  - » Used to prevent overtraining syndrome
- Linear model: high volume and low intensity initially
  - » Progression to low volume high intensity
  - » No need to wait months to reach high intensity! (Izquierdo et al., 2021)
    - 50%, 60%, 70%, 80% of 1RM over the first four training days
- Reverse Model: low volume and high intensity initially

Volume and Intensity

- Volume
  - » Total amount of weight lifted in a session
- Intensity (Load)
  - » The amount of weight assigned in a set
  - » High Intensity = >80%of maximal strength capacity (Avers et al., 2009)

Why High Intensity?

- High intensity progressive resistance training improves aerobic capacity to a similar extent as moderate intensity aerobic training (Izquierdo et al., 2021)
- High load is optimal for treating sarcopenia (Izquierdo et al., 2021)
- Greater strength and endurance gains (Steib et al., 2010)
- Greater functional improvement (Valenzuela et al., 2011)

But is it Safe?

- Osteoporosis
  - LIFTMOR (Watson et al., 2018)
  - LIFTMOR-M (Harding et al., 2020)
- Sarcopenia
  - FrOST (Kemmler et al., 2020)
- Frailty (Bray et al., 2020)
- Osteoarthritis
  - START (Messier et al., 2021)

Determining Intensity

- Should we use 1RM testing? (Izquierdo et al., 2021) (Barbalho et al., 2018)
- Brzycki 1-RM prediction equation (Abdul-Hameed et al., 2012) (Armante do Nascimento et al., 2007)

$$1RM = 100 * \frac{load}{102.78 - 2.78 * rep}$$

  - Where load = weight lifted in kg
  - Rep = number of repetitions
- Maintain Borg RPE (15-18) (Izquierdo et al., 2021) (Morishita et al., 2019)
  - RPE-AM (Gearhart et al., 2002)
- Speed of Lift, Form (Avers et al., 2009)

Rating of Perceived Exertion Borg RPE Scale

6 7 8 9 10 11	Very, very light Very light Fairly light	How you feel when lying in bed or sitting in a chair relaxed. Little or no effort.
12 13 14 15 16	Somewhat hard Hard	Target range: How you should feel with exercise or activity.
17 18 19 20	Very hard Very, very hard Maximum exertion	How you felt with the hardest work you have ever done. Don't work this hard!

1 - 10 Borg Rating of Perceived Exertion Scale	
0	Rest
1	Really Easy
2	Easy
3	Moderate
4	Sort of Hard
5	Hard
6	
7	Really Hard
8	
9	Really, Really, Hard
10	Maximal. Just like my hardest race

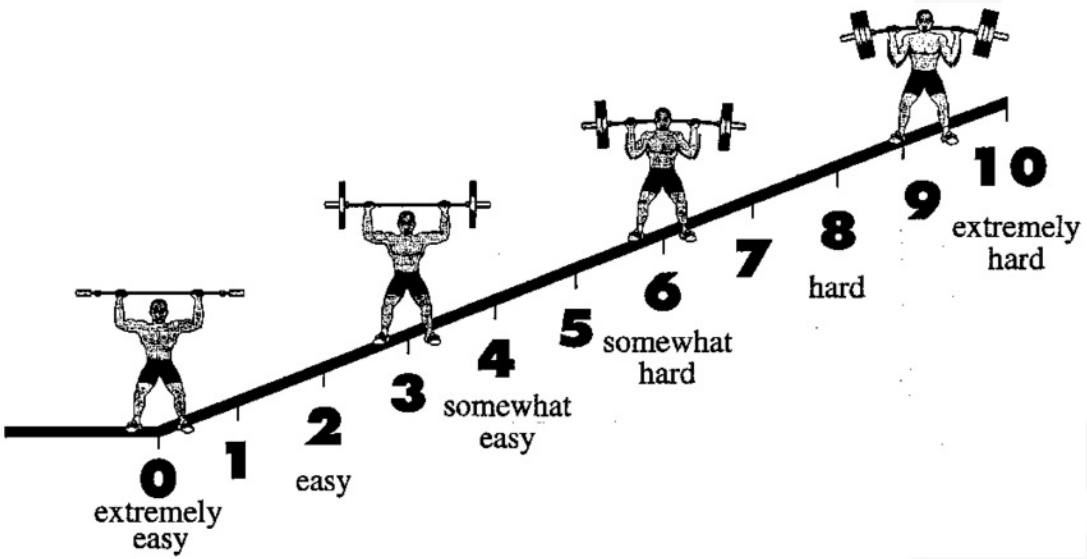


Table 1
Resistance training specific rating of perceived exertion (48)

Rating	Description of perceived exertion
10	Maximum effort
9	1 repetition remaining
8	2 repetitions remaining
7	3 repetitions remaining
5–6	4–6 repetitions remaining
3–4	Light effort
1–2	Little to no effort

Reprinted from Zourdos et al. 2015 with permission.

Table 2
Relationship with percentage 1RM, repetitions performed and RIR-based RPE

	Repetitions performed							
RPE	1	2	3	4	5	6	7	8
10	**100**[a]%	95.0%	91.0%	87.0%	85.0%	83.0%	81.0%	79.0%
9.5	97.0%	93.0%	89.0%	86.0%	84.0%	82.0%	80.0%	77.5%
9	95.0%	91.0%	87.0%	85.0%	83.0%	81.0%	79.0%	76.0%
8.5	93.0%	89.0%	86.0%	84.0%	82.0%	80.0%	77.5%	74.5%
8	**91**[a]%	87.0%	85.0%	83.0%	81.0%	79.0%	76.0%	73.0%
7.5	89.0%	86.0%	84.0%	82.0%	80.0%	77.5%	74.5%	71.5%
7	87.0%	85.0%	83.0%	81.0%	79.0%	76.0%	73.0%	**70**[a]%

[a]These bolded values are the mean percentage 1RM values from sets performed in Zourdos et al. (48).

1RM = one repetition maximum; RPE = rating of perceived exertion; RIR = repetitions in

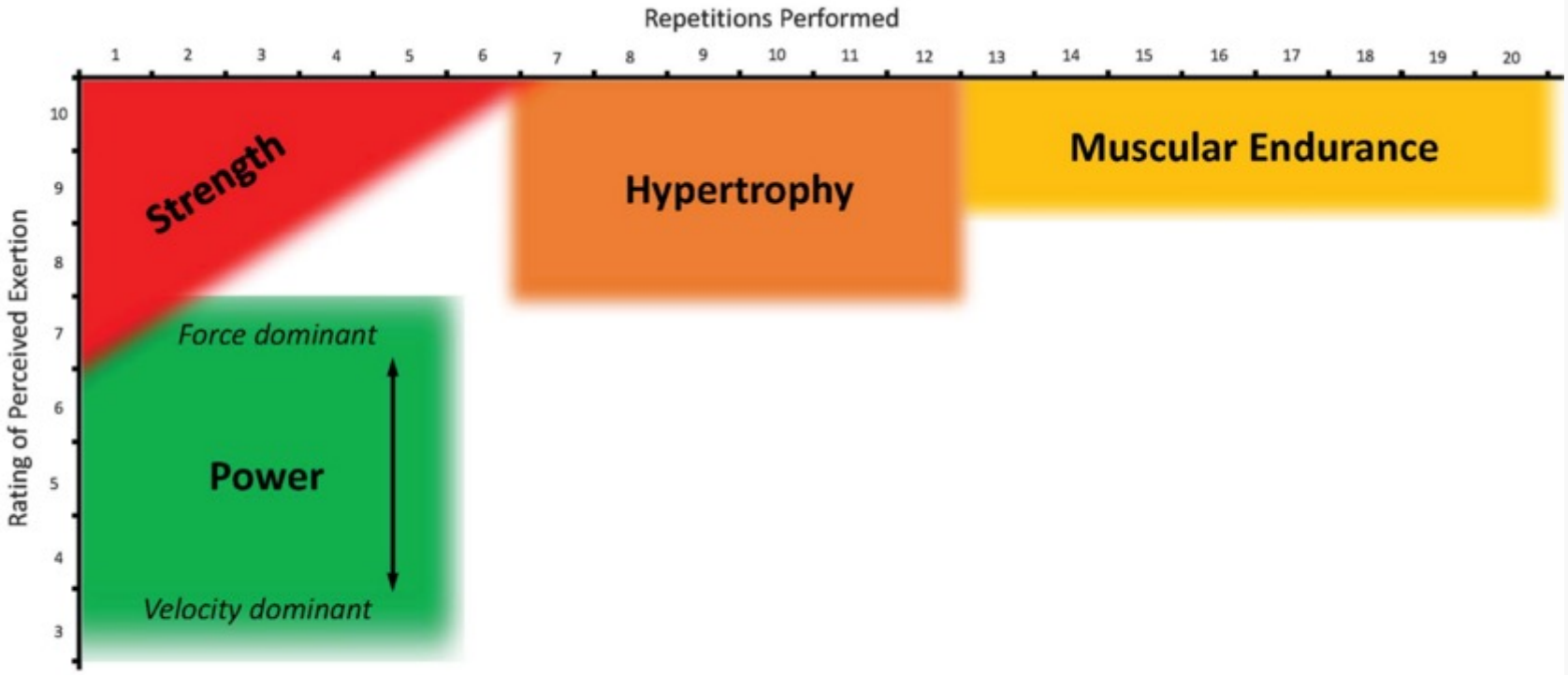


Figure. Relationship of repetitions in reserve–based rating of perceived exertion, repetitions, and training goals.

Additional Recommendations

- A program should consist of 6-10 exercises(Izquierdo et al., 2021)
  - 3-4 is possible too
    - At least one leg pressing exercise, one upper body pressing exercise, one upper body pulling exercise (Iversen et al., 2021)
  - Target major muscle groups

Sample Exercise Program

1. Deadlift
2. Squat
3. Step-Up
4. Lunge
5. Overhead Press
6. Row
7. Weighted Carry
8. Chop and Lift
9. Impact Loading

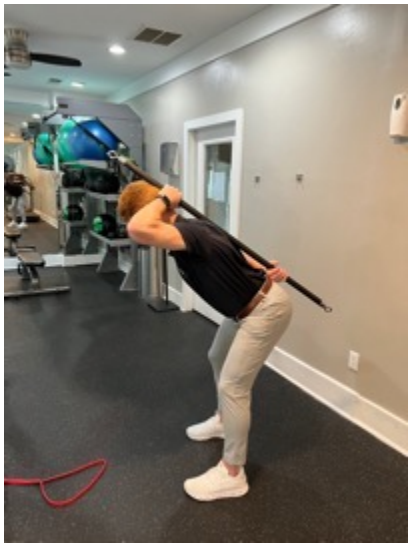
Deadlift

- Function
  - Picking up groceries, boxes, luggage from the floor
- Common Deficits
  - Excessive Lumbar Flexion (Boocock et al., 2015)(Sparto et al., 1997)
- Age-Related Considerations
  - Osteoporosis (Watson et al., 2018)
  - Low Back Pain (Berglund et al., 2015) (Wong et al., 2022)
- Learn the Hip Hinge!
  - Kneeling, Dowell, At Wall, Band Pull Through

Deadlift

- Modify ROM
  - Rack Pull, Block Pull
- Modify COM of Weight
  - KB Pull
  - Trap (Hexagonal) Bar
    - Lower erector spinae activation (Martin-Fuentes et al., 2020)
    - Lower peak moments at lumbar spine, hip, ankle (Swinton et al., 2011)
- Romanian Dead Lift
  - Greater biceps femoris, semitendinosus activation than erector spinae activation(Martin-Fuentes et al., 2020)
- Sumo Deadlift
  - Greater quadriceps and TA activation that conventional (Martin-Fuentes et al., 2020)

KB Deadlift

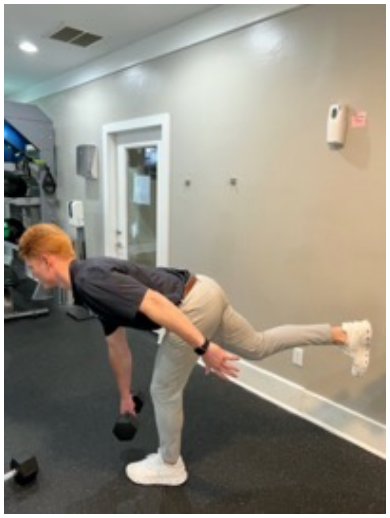


Dowel Hip Hinge

Box Pull Deadlift

Theraband Deadlift

RDL



SL RDL

Squat

- Function
  - Translates to numerous everyday tasks (Myer et al., 2014)
  - Preserve Physical Independence (Flanagan et al., 2003)

Squat

- Common Deficits (Myer et al., 2014)
  - ”Chest down”
  - Excessive trunk kyphosis
  - Frontal plane knee alignment
  - Tibial Translation
  - Lack of Depth
  - Asynchronous Ascent
- Anatomical variations are normal!
- Age-Related considerations
  - Thoracic Kyphosis
  - OA
  - Osteoporosis
  - Low Back Pain

Squat

- Modify ROM
  - Box Squat
- Modify COM of Weight
  - Goblet Squat, Front Squat
    - Decreased compressive forces, knee extensor forces (Gullett et al., 2009)
  - Back Squat
    - Greater trunk lean (Yavuz et al., 2015)
- Spanish Squat
  - Decreased anterior knee forces (Lee et al., 2022)

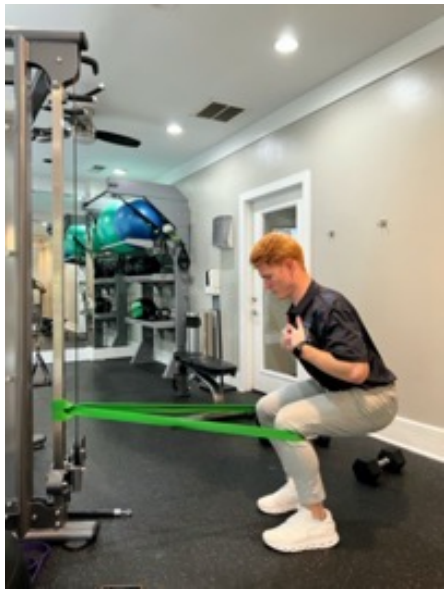
Squat

- Modify Stability
  - Smith Machine
  - Stability Ball Wall Squat
- Modify Bar Position (Glassbrook et al., 2019)
  - High Bar
    - Quad Emphasis
  - Low Bar
    - Hip Emphasis

Chair Squat

Stability Ball
Wall Squat

Goblet Squat



Spanish
Squat

Step-Up

- Function
  - Stair negotiation was among the top 5 tasks that community dwelling older adults rated as being most difficult due to “old age” (Verghese et al., 2008)
- The step-up exercise and its variations present the highest level of EMG glute max activation (Neto et al., 2020)
- Common Deficits
  - Trendelenburg
- Age-Related Considerations
  - Visual acuity
  - Falls risk

Step-Up

- Modify ROM
  - Step height
- Modify Support
  - Upper extremity
- Variations (Neto et al., 2020)
  - Crossover Step-Up
    - Higher glute med activation (Simenz, 2012)
  - Lateral Step-Up
    - Higher glute med activation (Mercer et al., 2009)
    - Higher knee extensor demand(Wang et al., 2003)
  - Step Down
    - Higher patellofemoral forces (Chinkulprasert et al., 2011)

Step Up

Lateral Step Up

Step Down

Lunge

- Function
  - » Tying shoe, getting to/standing up from floor, fall recovery
- Common Deficits
  - » Knee Alignment
    - Knees behind toes? (Kernozek et al., 2018)
- Age-Related Considerations
  - » Falls Risk

Lunge

- Modify ROM (Marchetti et al., 2018)
  - Elevated lunges
  - Upper extremity support
- Modify Base of Support
  - Mediolateral stability
    - In-line lunge
  - Bilateral vs Unilateral
    - Bulgarian Split Squat
- Modify Direction
  - Greater hip, ankle, knee moments for forward lunge vs reverse lunge (Comfort et al., 2015)
- Progression
  - Walking lunge, jumping lunge

Elevated
Lunge

Bulgarian
Split Squat

Overhead Press

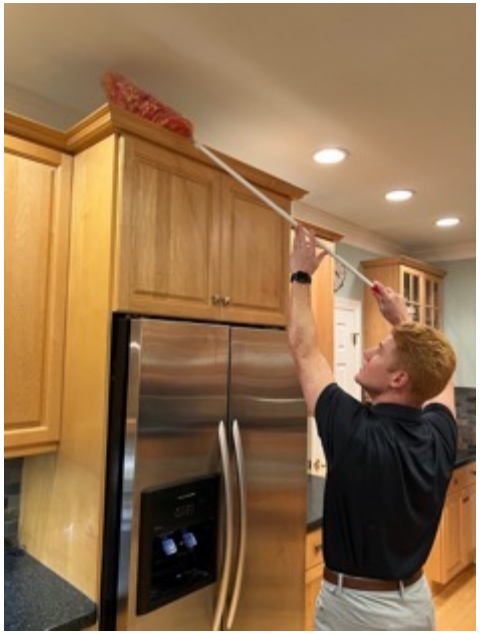
- Function
  - Pushing is a foundational functional movement pattern (Da Silva-Grigoletto et al., 2019)
  - Storing overhead objects, cleaning, etc.
  - Standing OH Press requires the UE to generate the pressing force while the LE generates the stabilizing force (Waller et al., 2009)

Overhead Press

- Common Deficits (Waller et al., 2009)
  - Limited lumbar, thoracic mobility
  - Limited horizontal shoulder abduction
  - Limited shoulder flexion
  - Limited elbow extension
  - Limited wrist flexion, extension
- Age-Related Considerations
  - Thoracic Kyphosis
  - Falls Risk

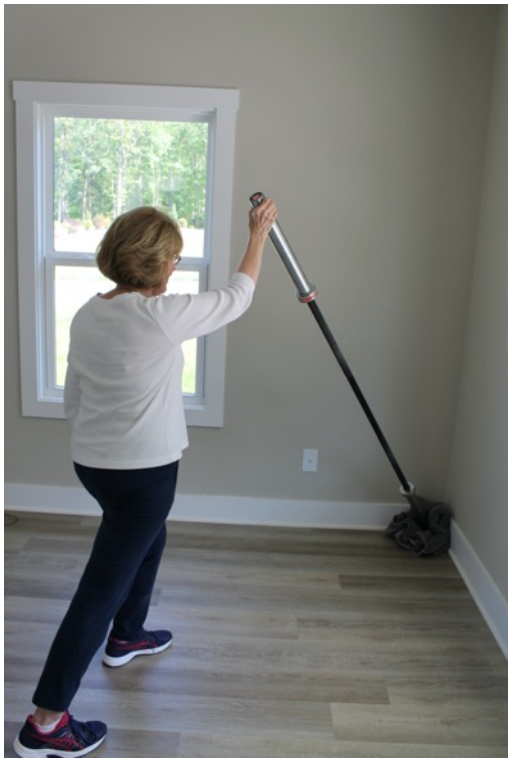
Overhead Press

- Modify Stability
  - Seated Press (Soriano et al., 2019)
- Modify ROM
  - Incline
  - Barbell vs Dumbbell




U-HAUL

Seated OH Press



Landmine Press

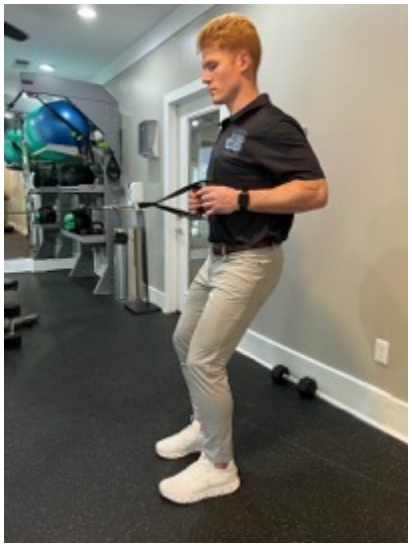
Arnold Press

Row

- Function
  - Pulling is a foundational functional movement pattern(Da Silva-Grigoletto et al., 2019)
  - Opening doors, fridge, etc.
- Common Deficits
  - Biceps brachii dominance
- Age-Related Considerations
  - Thoracic Kyphosis
  - Low Back Pain

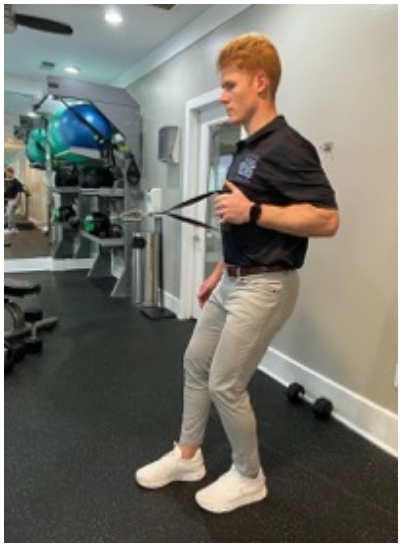
Row

- Numerous Rowing Strategies (Fenwick et al., 2009)
  - Inverted Row
    - Highest latissimus dorsi, upper back, hip extensor demand
    - Lowest lumbar spinal load
  - Standing Bent-Over Row
    - Highest lumbar spinal load
  - Standing 1-arm Cable Row
    - Highest rotational demand



Double Arm Cable Row

Bent Over Row



Single Arm Cable Row

Inverted Row

Weighted Carry

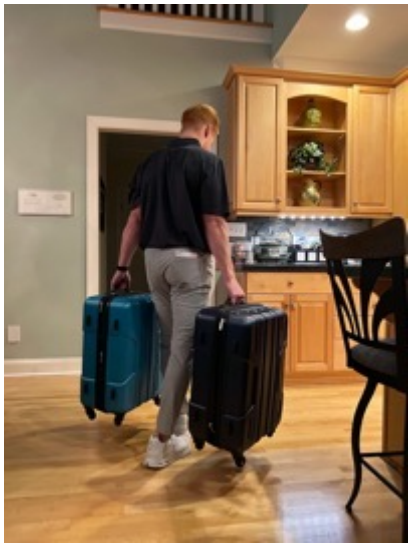
- Function
  - Carrying, “transporting” is a foundational, functional movement pattern (Da Silva-Grigoletto et al., 2019)
  - Carrying groceries, luggage
- Common Deficits
  - Lateral flexion of spine
- Age-Related Considerations
  - Gait variation

Weighted Carry

- Modify Weight Position
  - Rack Position
  - Waiter's Position
- Bilateral (McGill et al., 2009)
  - Farmer's Carry
- Unilateral (McGill et al., 2009)
  - Suitcase Carry
  - Contralateral vs ipsilateral?

Suitcase Carry

Farmers Carry



Rack
Position

Overhead
Position

Chop and Lift

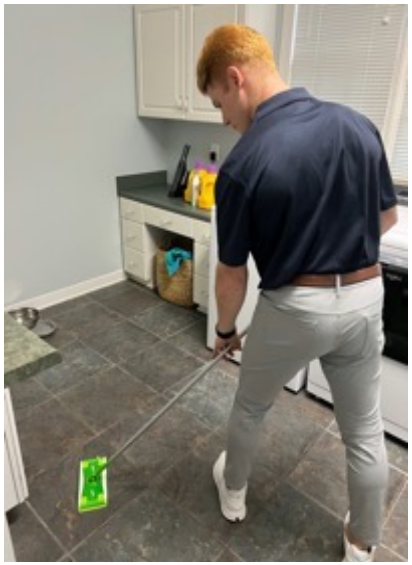
- Function
  - Transverse Plane
    - Loading dishwasher, starting lawnmower
  - Bilateral UE PNF pattern that mimics functional patterns/ADLs (Voight et al., 2008)
  - A 26-48% loss in trunk musculature was observed in participants >75 years of age (Cuellar et al., 2017)
  - Direct relationship between trunk musculature and functional outcomes (Shahtahmassebi et al., 2017)
  - ”Core Training”

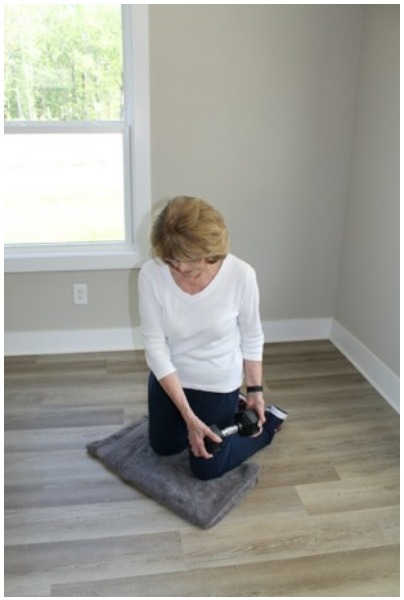
Chop and Lift

- Common Deficits (Voight et al., 2008)
  - Instability
  - Asymmetry
- Age-Related Considerations
  - Thoracic Kyphosis
  - Decreased Tissue Extensibility

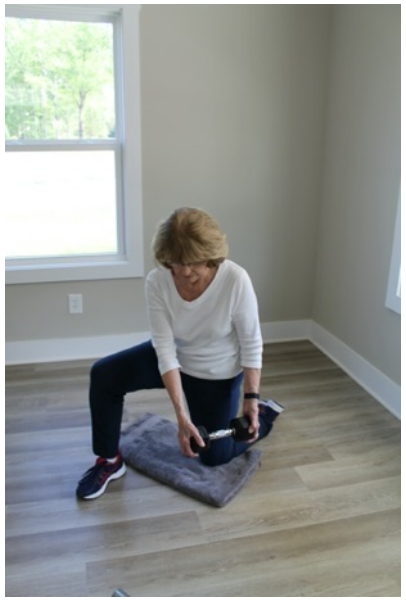
Chop and Lift

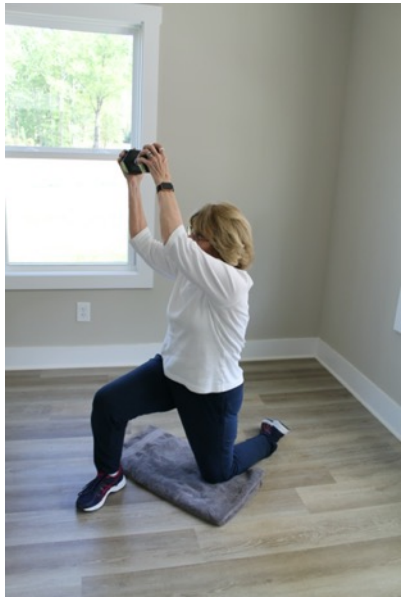
- Modify stability
  - » Half-kneeling, Tall-kneeling, Standing (Voight et al., 2008)
  - » Stability ball
- Introduce Power
  - » Medicine Ball Throws (Silva-Grigoletto et al., 2019)





Tall Kneeling Position





Half Kneeling Position

Impact Loading

- Function
  - Agility
  - Balance Recovery
  - Reaction to external events
- Common Deficits
  - Poor landing mechanics (Lopes et al., 2018)
- Age-Related Considerations
  - Psychosocial Influences (Baert et al., 2015)
  - Falls Risk

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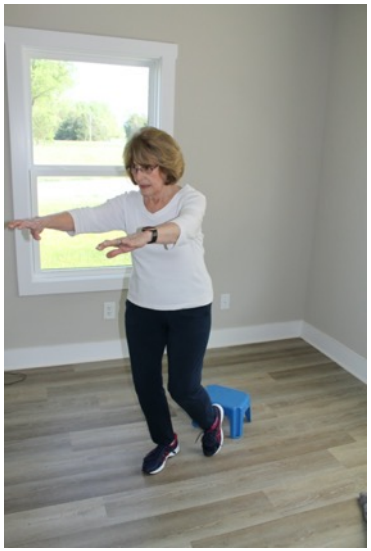
Impact Loading

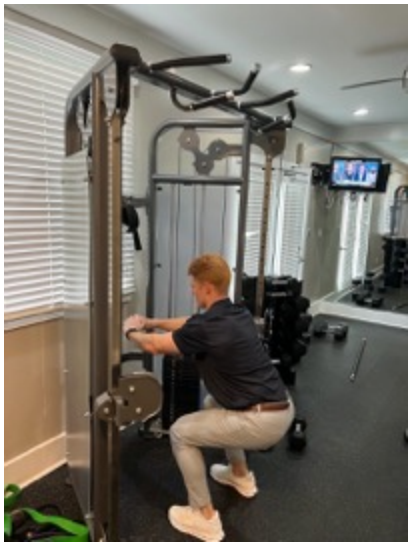
- Jumping Chin-ups with Drop Landing (Watson et al., 2018)
  - Height of bar
  - Landing Strategies
- Plyometric Training (Izquierdo et al., 2021)
  - Run and Jump between cones (Silva-Grigoletto et al., 2019)
  - Agility Ladder (Silva-Grigoletto et al., 2019)

Drop Landing



Single Leg
Drop Landing

Chin Up to
Drop Landing



Additional Considerations

- Valsalva and Hypertension (Blazek et al., 2019)
  - » Squats and deadlifts produce high intraabdominal pressure

Additional Considerations

- Don’t create additional barriers to physical activity…
  - Only 10-15% of older adults perform resistance training (Mayer et al., 2011)
  - Technique and Injury Risk?
    - ”neutral spine” (Aasa et al., 2019)
- Patient Education (Baert et al., 2015)
  - HEP!
  - DOMS
  - Pain
- Intrapersonal Factors (Baert et al., 2015)
  - Kinesiophobia

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