Functional Power Training for Mature Adults

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Vice President, Functional Aging Institute
Co-Owner, Miracles Fitness
Cody Sipe, PhD
Co-founder

20+ years industry experience
Over 100 presentations internationally
Over 30 published articles
2005 IDEA Program Director of the Year
Advisory Boards for National Posture Institute, International Council on Active Aging, Act!vate Brain and Body, ACSM, CFES, WCAA
Editorial Boards: IDEA, Faith and Fitness Magazine, Boomerbloomer.com
Dan Ritchie, PhD, CSCS
Co-founder

16 years experience
Certified Strength and Conditioning Specialist
FallProof Balance and Mobility Enhancement Specialist
Enhance Fitness Master Trainer
2014 PFP Personal Trainer of the Year
Owner, Miracles Fitness
President, Functional Aging Institute
Creator, Never Grow Old Fitness Program
Global Aging Explosion
Huge Growth means Huge Potential...

Total number of persons age 65 or older, by age group, 1900 to 2050, in millions

Note: Data for the years 2000 to 2050 are middle-series projections of the population. Reference population: These data refer to the resident population. Source: U.S. Census Bureau, Decennial Census Data and Population Projections.
Percentage of persons age 70 or older who are unable to perform certain physical functions, by sex, 1984 and 1995

<table>
<thead>
<tr>
<th></th>
<th>MEN</th>
<th>WOMEN</th>
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<tbody>
<tr>
<td>WALK</td>
<td>13%</td>
<td>21%</td>
</tr>
<tr>
<td>CLIMB STAIRS</td>
<td>9%</td>
<td>16%</td>
</tr>
<tr>
<td>STOOP</td>
<td>12%</td>
<td>16%</td>
</tr>
<tr>
<td>REACH UP</td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td>ANY 1 OF 9</td>
<td>23%</td>
<td>34%</td>
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Note: The nine physical functioning activities are: walking a quarter mile; walking up ten steps without resting; standing or being on your feet for about two hours; sitting for about two hours; stooping, crouching or kneeling; reaching up over your head; reaching out as if to shake someone's hand; using your fingers to grasp or handle; lifting or carrying something as heavy as ten pounds. A person is considered disabled if he or she is unable to perform an activity alone and without aids. Rates for 1984 are age-adjusted to the 1995 population.
Reference population: These data refer to the civilian noninstitutional population.
Source: Supplement on Aging and Second Supplement on Aging.
Percentage of persons age 70 or older who reported having selected chronic conditions, by sex, 1984 and 1995

Men
- Arthritis: 45% (1984), 50% (1995)
- Diabetes: 10% (1984), 13% (1995)
- Stroke: 8% (1984), 10% (1995)
- Hypertension: 37% (1984), 41% (1995)
- Heart Disease: 19% (1984), 25% (1995)

Women
- Arthritis: 61% (1984), 64% (1995)
- Diabetes: 10% (1984), 12% (1995)
- Cancer: 12% (1984), 17% (1995)
- Stroke: 7% (1984), 8% (1995)
- Hypertension: 51% (1984), 48% (1995)
- Heart Disease: 15% (1984), 19% (1995)

Note: 1984 percentages are age-adjusted to the 1995 population.
Reference population: These data refer to the civilian noninstitutional population.
Source: Supplement on Aging and Second Supplement on Aging.
The Research Says...

Have we oversold the benefits of late-life exercise? (2001)

Critical review of 31 studies
- Impairment – Strength, ROM, Aerobic capacity, body comp
- Function – Walking, chair rise, balance
- Disability – Physical, social, emotional, overall

Results
- Impairment: Very Strong
- Function: Strong but inconsistent
- Disability: Weak and inconclusive


Pooled data from 62 trials
- Randomized controlled trials
- PRT with subjects aged 60+

Results
- Large positive effect on muscular strength
- Small to moderate effect on functional ability
  - Strength gains do not equate to similar functional gains
- No evidence of an effect was found for physical disability
Exercise: necessary but not sufficient for improving function and preventing disability? (2011)

Key Points:

• There is consistent and convincing evidence that older adults and adults with knee OA who engage in strength training or aerobic exercise are able to decrease pain and increase strength and physical function.

• The effects on strength, pain and function, though, are modest, at best.

• It is not clear that exercise interventions alone will minimize or prevent disability.

• Exercise may be necessary but not sufficient in minimizing or preventing disability. Effective interventions for minimizing disability are scarce and novel approaches are needed.
How do we maximize function and prevent disability in aging adults if basic cardio and strength training aren’t enough?

Take a comprehensive approach to training the components of function (i.e. impairment level factors).
What leads to functional loss and disability?

The Nagi Model
Revised, Rikli and Jones, 1997
What Impairment Level Factors are Vital for Function?

- Muscular Strength
  - Concentric
  - Eccentric
  - Isometric
- Contractile Velocity
  - Acceleration
  - Deceleration
- Muscular Power
- Muscular Endurance
- Aerobic Power
- Flexibility
- Joint Range of Motion
- Coordination
- Reaction Time

- Motor Control
- Proprioception
- Somatosensation
- Vestibular control
- Vision
- Mobility
- Agility
- Balance**
- Stability
- Gait
- Postural Control
- Core Stability
What is the trajectory of aging? How do we delay or prevent the slide towards disability? Is the aging process inevitable?
Functional Aging Training™ Model
Functional Aging Training™ Model

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The FAT™ takes functional training philosophies, strategies and techniques and applies them specifically to meet the needs and wants of mature adults.

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5 hours of reading
90 question test

ALL Online
Muscle Power and Aging
What is Power?

• Power (W) = Force (N) x Velocity (m/s)
• Rate at which work is performed

<table>
<thead>
<tr>
<th></th>
<th>Force</th>
<th>Power</th>
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<tr>
<td>Shot (7.25 Kg 18.19 m)</td>
<td>513 N</td>
<td>5075 W</td>
</tr>
<tr>
<td>Snatch (150 Kg)</td>
<td>2000 N</td>
<td>3163 W</td>
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Sarcopenia = age related decline in muscle mass and strength

Muscle strength declines 30% (on average) from age 50-70, more dramatic losses after age 80
Large degree of variability between individuals

www.sarcopenia.com

Starling et al. *Am J Clin Nutr* 1999
Power and Advancing Age

- Leg Strength
- Leg Muscle Area
- Leg Power

Muscle, Strength & Power (%)
Power and Advancing Age

At Age 30

Strength = 10
Velocity = 10
Power = 100

At Age 70

Strength = 7
Velocity = 7
Power = 49

↓ 30%
↓ 51%
Dynapenia = age-related loss of muscle strength and power


- Great deal of focus on strategies to maintain muscle mass with aging because the rationale is that loss of strength is a direct result of loss of mass
- Recent evidence questions this relationship
- Sarcopenia’s role in age-associated strength loss (termed dynapenia) is exaggerated
- Alternative mechanisms underlie dynapenia and these need more attention


- Age-related loss of muscle strength is greater than the loss of mass
  - Health ABC Study found that change in quad CSA = 6-8% variance in knee extensor strength
- Low strength is much more strongly associated with low physical performance or disability than low mass
Relationship of Strength, Power and Function
Seminal Works


– Linked leg power to functional performance (timed chair rises, stair climbing and 6m walk)
Bean (2002), *The relationship between leg power and physical performance in community dwelling mobility limited older people*
Reid and Fielding (2012), *Skeletal muscle power: A critical determinant of physical functioning in older adults* (Eur J Appl Physiol)

Reid et al. (2011)
- Middle aged (47yrs), health OA (74yrs), mobility-limited OA (78yrs)
  - About 95% and 65% reduction in power, respectively
  - Only about 25% and 13% reduction in mass, respectively
  - Muscle Quality (strength/CSA; power/CSA)
    - No change in specific strength
    - Deficits in specific power

- Other studies report deficits in neuromuscular activity during power testing suggesting that impairments in the neuromuscular system may be a major physiologic mechanism contributing to muscle power deficits and mobility limitations with advancing age
Conclusions:

1. Muscle power is a more discriminant predictor of functional performance in older adults than muscle strength
2. Power training has been well-tolerated, safe and effective, even among frail older adults
3. Power training improves muscle power more than traditional strength training
4. Power training MAY improve physical functioning in older adults to a greater extent than traditional slow velocity strength training
Pojednic et al. (2012), *The specific contributions of force and velocity to muscle power in older adults.*  
(Exp Ger 47:608-613)

Purpose: explain inter-individual differences in power production capability and functional task performance

79 subjects: MH (40-55yrs), OH (70-85yrs), OML (70-85yrs)

Power of unilateral leg extension at 180°/sec, isometric max torque and max velocity at 40%1RM

Functional tasks: SPPB, multiple chair rise, stair climb

MH: Torque but not velocity associated with power
OH: Both torque and velocity
OML: Velocity but not torque

Max velocity associated with multiple chair rise time ($R^2 = 0.59$) and stair climb time($R^2 = 0.29$) in OML but not MH or OH
Strength vs Power Training

- 12 studies that investigated PT on ADL functional ability as well as strength and/or power
- Good scientific rigor:
  - Most were RCT
  - 7/12 used a non-active control group
  - 9/12 had ST and PT groups
- 9/12 used traditional RT exercises performed explosively; 3/12 used functional exercises

- Wide variety of ADL tests were used, e.g. gait, stair climbing, sit to stand
- 10/12 PT groups showed significant improvements
- 4/9 ST groups showed significant improvements
- Within-study comparisons revealed that functional improvements for PT were either significantly greater (4) or similar (5) to ST
Tschopp (2011), *Is power training or conventional resistance training better for function in elderly person? A meta-analysis*

- Power training was compared with conventional strength training in 11 randomised or quasi-randomised trials with 377 non-frail patients.
- Weak evidence (i.e. mostly small studies leading to wide confidence intervals).
- Most studies in this review used an exercise load of about 70% of the 1 RM in the power training group. With the data obtained from this review, we cannot answer the question about optimal exercise load.
Tschopp (2011), *Is power training or conventional resistance training better for function in elderly person? A meta-analysis*

- Self-reported function (n=2)
  - Small, non-significant effect for PT
- Balance (n=4)
  - Moderate to large, significant effect for PT
- Walking (n=4)
  - Conflicting evidence
- Strength (n=9)
  - Small, non-significant effect for PT
- Power (n=9)
  - Small, significant effect for PT
de Vos et al. (2008) *Effect of power-training intensity on the contribution of force and velocity to peak power in older adults* (Journal of Aging and Physical Activity 16, 393-407)
de Vos et al. (2008) *Effect of power-training intensity on the contribution of force and velocity to peak power in older adults* (Journal of Aging and Physical Activity 16, 393-407)
Orr et al. (2006) *Power training improves balance in healthy older adults* (Journals of Gerontology; Jan; 1A, 1; p. 78)
Sayers and Gibson (2011) *Effects of high-speed power training on muscle performance and braking speed in older adults* (Journal of Aging Research)

72 older adults (22m, 50f; age = 70.6 ± 7.3 yrs) were randomized to HSPT at 40% 1RM (3 sets of 12–14 repetitions), slow-speed strength training at 80%1RM (3 sets of 8–10 repetitions), or control (stretching) 3 times/week for 12 weeks.

Keiser leg press and knee extension

Leg press and knee extension peak power, peak power velocity, peak power force/torque, and braking speed were obtained at baseline and 12 weeks.
Sayers and Gibson (2011) *Effects of high-speed power training on muscle performance and braking speed in older adults* (Journal of Aging Research)

**Figure 2**: Driving simulator (a) and closeup of accelerator and brake pedal (b) used in the high-speed functional task.
Sayers and Gibson (2011) *Effects of high-speed power training on muscle performance and braking speed in older adults* (Journal of Aging Research)

**Figure 3:** Baseline to posttraining changes in leg press peak power relative to baseline one-repetition maximum (1RM) across a range of external resistances. HSPT = high-speed power training; SSST = slow-speed strength training; CON = control. *HSPT > CON; †SSST > CON.*
Sayers and Gibson (2011) *Effects of high-speed power training on muscle performance and braking speed in older adults* (Journal of Aging Research)

**Figure 4:** Baseline to posttraining changes in leg press peak power velocity relative to baseline one-repetition maximum (1RM) across a range of external resistances. HSPT = high-speed power training; SSST = slow-speed strength training; CON = control. *HSPT > CON; †SSST > CON.*
Sayers and Gibson (2011) *Effects of high-speed power training on muscle performance and braking speed in older adults* (Journal of Aging Research)

HSPT increased peak power and peak power velocity across a range of external resistances (40%–90% 1RM; \( P < 0.05 \)) and improved braking speed (\( P < 0.05 \)).

Work was similar between groups, but perceived exertion was lower in HSPT (\( P < 0.05 \)). Thus, the less strenuous HSPT exerted a broader training effect and improved braking speed compared to SSST.

**Practical Application:**
Quicker braking time from HSPT could stop a car traveling 60mph 4 feet sooner
Granacher et al. (2011) *Comparison of traditional and recent approaches in the promotion of balance and strength in older adults* (Sports Med 41(5): 377-400)

“...it seems that PT compared with RT is more beneficial in improving measures of physical function.”

“...it appears that the specificity of the contraction mode (moderate vs high velocity) may represent an important determinant for producing substantial gains in muscle power and functional capacity.”

“This result complies with the principle of training specificity and suggests that ballistic contractions should be incorporated in RT for older adults.”

- Narrative review
Hazell et al. (2007), *Functional benefit of power training for older adults* (Journal of Aging and Physical Activity, 15; 349-359)

**Figure 1** — Differences for activities of daily living and strength reported from a variety of studies on older adults subsequent to 8–16 weeks of resistance or power training. Values are calculated differences and the subsequent averages for resistance-training studies (Brandon, Boyette, Gaasch, & Lloyd, 2000; Fialarone et al., 1994; Jette et al., 1999; Judge et al., 1994; Schlicht, Camaione, & Owen, 2001; Singh et al., 1997; Skelton & McLaughlin, 1994; Skelton et al., 1995; Westhoff, Stemmerik, & Boshuizen, 2000) and high-velocity-training studies (Bean et al., 2004; Earles et al., 2001; Fielding et al., 2002; Henwood & Taffe, 2005; Hruda et al., 2003; Kongsgaard et al., 2004; Sayers et al., 2003).
Bean et al. (2010), *Are changes in leg power responsible for clinically meaningful improvements in mobility among older adults?* (J Am Geriatr Soc, 58; 2363-2368)

**Followup analyses of INVEST training study**

**Objectives**—Mobility as measured by the SPPB or habitual Gait Speed (GS) is predictive of mortality and disability among older adults. Clinically meaningful changes of these measures have been identified. Among physiologic attributes we sought to identify those attributes in which changes led to CMDs in the mobility outcomes.

**Results**—Participants were 68% female, mean age 75.2 years, with a mean of 5.5 chronic conditions and a baseline mean SPPB score of 8.7. After controlling for age, site, group assignment, and baseline outcome values, leg power was the only attribute in which changes were significantly associated with a large CMD in SPPB and GS.

**Conclusion**—Improvements in leg power, independent of strength, appear to make an important contribution towards clinically meaningful improvements in both SPPB and GS.
Bean et al. (2008), *Which impairments are most associated with high mobility performance in older adults? Implications for a rehabilitation prescription* (Arch Phys Med Rehabil, 89; 2278-84)

It is interesting that only the lowest tertile of strength and balance were significantly associated with mobility status, suggesting a possible threshold effect.

More specifically, this implies that impairment changes among those who are most impaired may have a very direct impact on physical function improvements, although changes in impairment among those less impaired, (eg, among healthier individuals) have little effect on physical function.

Similar findings were observed in a previous investigation of the InCHIANTI population and support the reported effect that these impairments may have curvilinear association with mobility status.

Interestingly, both tertiles of leg velocity had a significant influence on functional performance, suggesting that improvements in leg velocity may have functional consequences for a broader range of individuals.
Well what about…?
Corti M et al. (2012), *Differential effects of power training versus functional task practice on compensation and restoration of arm function after stroke* (Neurorehabil Neural Repair; Sep; 26(7): 842-854)

Subjects: 14 hemiparetics

Methods: Randomized crossover design
- 10 wks POWER, 10 wks FTP
- 10 wks FTP, 10 wks POWER

Results:
- Shoulder flexion and elbow extension decreased with FTP and were associated with increased trunk displacement (compensatory movement patterns)
- Shoulder flexion and elbow extension increased with POWER and were associated with decreased trunk displacement (normal movement patterns)
- Greatest improvements in POWER then FTP group

**Purpose:** To explore the feasibility and efficacy of using a power training exercise programme for elderly women with knee OA

**Method:** A one-group quasi-experimental design with 17 older adult women with knee OA pain. A bilateral QF exercise programme (3x/wk, 8 weeks) 3x10 of flexion-extension as fast as possible at 40% 1RM.

**Results:** Significant improvements (p < 0.05) on the five categories of the KOOS. Significant decrease (p < 0.01) in pain intensity on VAS. QFP and QFW increased significantly on both sides (p < 0.05). Exercise compliance was 99.5% for 16 participants.

**Conclusions:** A short power-training exercise programme is feasible for patients with knee OA, and significant functional improvements can be achieved.
Segal and Wallace (2012), *Tolerance of an aquatic power training program by older adults with symptomatic knee osteoarthritis.* (Arthritis)

**Objective:** To determine the tolerance and feasibility of aquatic-based power training in adults with symptomatic knee OA.

**Participants:** Twenty-nine adults age 50 + with symptomatic knee OA and mobility limitation completed 45-minute aquatic power training sessions twice weekly for 6 weeks

**Results:** Modifications needed for 9/29 participants. Muscle power, ADL, QOL, and pain improved immediately and 6 weeks after. No change in 400-m walk times or lower limb function.

**Conclusions:** A 6-week aquatic rehabilitation program appears to be well tolerated by adults with symptomatic knee OA with mobility limitations and may result in improved lower limb muscle power, symptoms, ADL, and QOL. However, this intervention may have insufficient specificity or intensity for improving physical function.
Fukomoto et al. (2013), *Effects of high-velocity resistance training on muscle function, muscle properties, and physical performance in individuals with hip osteoarthritis: a randomized controlled trial.* (Clinical Rehabilitation, Vol 28(1):48-58)

**Objective:** To investigate the effects of high-velocity resistance training in patients with hip osteoarthritis

**Subjects:** 46 women with hip OA were randomly assigned to the high-velocity or low-velocity training group.

**Interventions:** 8-week daily *home-based* resistance training programme using an elastic band (hip abduction, extension, and flexion and knee extension).

**Results:** Decreases in the time for performing the Timed Up and Go test and echo intensity of the gluteus maximus were significantly greater in the high-velocity group.

**Conclusion:** This study revealed that high-velocity training for patients with hip OA has partially a greater effect on muscle properties and physical performance than low-velocity training.
Considerations for Power Training
Safety

Therefore, although injuries do occur in power-training research studies using resistance training machines, it appears that the risk is likely substantially higher for a fast walk and (or) jog program. In fact, the risks associated with power-training research primarily occur during testing, so power-training programs with little or no testing likely have a low risk for injury. (Porter 2006)
Equipment: Power and Inertia
Exercise Programming

Equipment:  Pneumatic, elastic, bodyweight
Speed:  Concentric “as fast as possible”, Eccentric “slow and controlled”
Load:  20-40% 1RM, variable
           RPE can be used instead of 1RM
Sets & Reps:  2-3 x 8-12
Frequency:  2x wk
Movements:  Lower body focus
           Machine and free moving/floor
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