# SENIOR ATHLETE FITNESS EXAM

STRENGTH | BALANCE | CARDIOVASCULAR HEALTH | FLEXIBILITY

Presented by: Jennifer Vincenzo, PT, MPH, PhD
Assistant Professor, University of Arkansas for Medical Sciences
Department of Physical Therapy
Board Certified Clinical Specialist in Physical Therapy
Certified Health Education Specialist
Certified Dementia Specialist

UAMS
UNIVERSITY OF ARKANSAS FOR MEDICAL SCIENCES

# SENIOR ATHLETE FITNESS EXAM

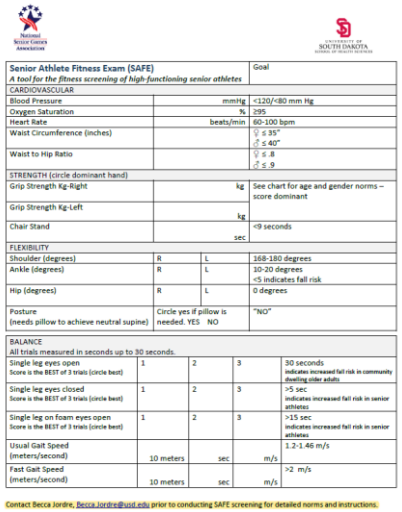
STRENGTH | BALANCE | CARDIOVASCULAR HEALTH | FLEXIBILITY

The Senior Athlete Fitness Exam, known as SAFE, is a battery of tests utilized to test fitness and identify potential risk factors in high functioning senior athletes.

The SAFE was developed by physical therapist and Associate Professor, Dr. Becca Jordre at the University of South Dakota and is regularly used at state and national Senior Games events.

**Thank you to Dr. Jordre for sharing her presentation!**

UNIVERSITY OF SOUTH DAKOTA SCHOOL OF HEALTH SCIENCES



| Senior Athlete Fitness Exam (SAFE)<br>*A tool for the fitness screening of high-functioning senior athletes* | | | | Goal |
|---|---|---|---|---|
| CARDIOVASCULAR | | | | |
| Blood Pressure | | | mmHg | <120/<80 mm Hg |
| Oxygen Saturation | | | % | ≥95 |
| Heart Rate | | | beats/min | 60-100 bpm |
| Waist Circumference (inches) | | | | ♀ ≤ 35"<br>♂ ≤ 40" |
| Waist to Hip Ratio | | | | ♀ ≤ .8<br>♂ ≤ .9 |
| STRENGTH (circle dominant hand) | | | | |
| Grip Strength Kg-Right | | | kg | See chart for age and gender norms – score dominant |
| Grip Strength Kg-Left | | | kg | |
| Chair Stand | | | sec | <9 seconds |
| FLEXIBILITY | | | | |
| Shoulder (degrees) | R | L | | 168-180 degrees |
| Ankle (degrees) | R | L | | 10-20 degrees<br><5 indicates fall risk |
| Hip (degrees) | R | L | | 0 degrees |
| Posture<br>(needs pillow to achieve neutral supine) | Circle yes if pillow is needed. YES NO | | | "NO" |

| BALANCE<br>All trials measured in seconds up to 30 seconds. | | | | |
|---|---|---|---|---|
| Single leg eyes open<br>Score is the BEST of 3 trials (circle best) | 1 | 2 | 3 | 30 seconds<br>indicates increased fall risk in community dwelling older adults |
| Single leg eyes closed<br>Score is the BEST of 3 trials (circle best) | 1 | 2 | 3 | >5 sec<br>indicates increased fall risk in senior athletes |
| Single leg on foam eyes open<br>Score is the BEST of 3 trials (circle best) | 1 | 2 | 3 | >15 sec<br>indicates increased fall risk in senior athletes |
| Usual Gait Speed<br>(meters/second) | 10 meters | sec | m/s | 1.2-1.46 m/s |
| Fast Gait Speed<br>(meters/second) | 10 meters | sec | m/s | >2 m/s |

Contact Becca Jordre, Becca.Jordre@usd.edu prior to conducting SAFE screening for detailed norms and instructions.

## SENIOR GAMES ATHLETES EXCEED ALL NORMS

**Cardiovascular exercise**

~5.5 hours/week.

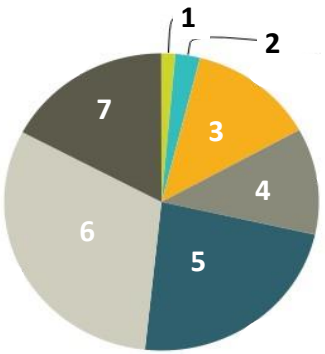
**Strength training**

~1 hour/week.

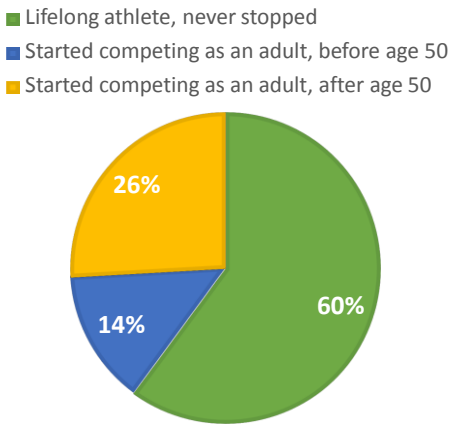
**RESULTS FROM 2,340 SENIOR ATHLETES**

UNIVERSITY OF SOUTH DAKOTA SCHOOL OF HEALTH SCIENCES
Jordre

## Senior Athletes:
## Days per Week of Purposeful Exercise[2]

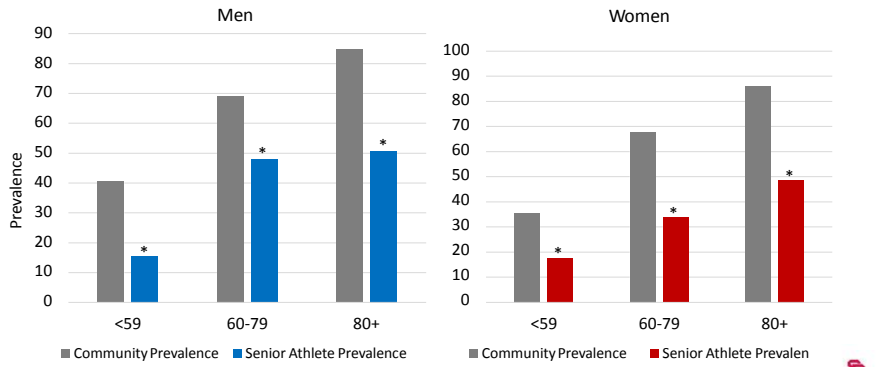



## SENIOR ATHLETE SPORT HISTORY



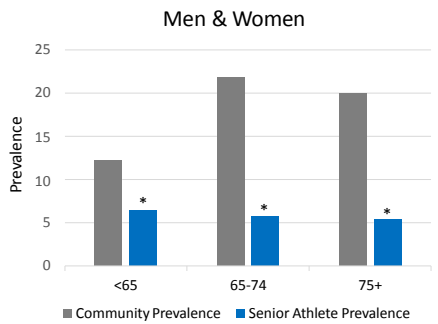

**MANY HAVE ALWAYS IDENTIFIED AS ATHLETES**

## Cardiovascular Disease Prevalence is Significantly Lower in Senior Games Athletes than Community-Dwelling Seniors[3]




*Comparisons made with binomial approximation to the normal. * Indicates significance at <.0001*

## Prevalence of Type II Diabetes Mellitus is Significantly Lower in Senior Athletes[3]




*Comparisons made with binomial approximation to the normal. * Indicates significance at <.0001*

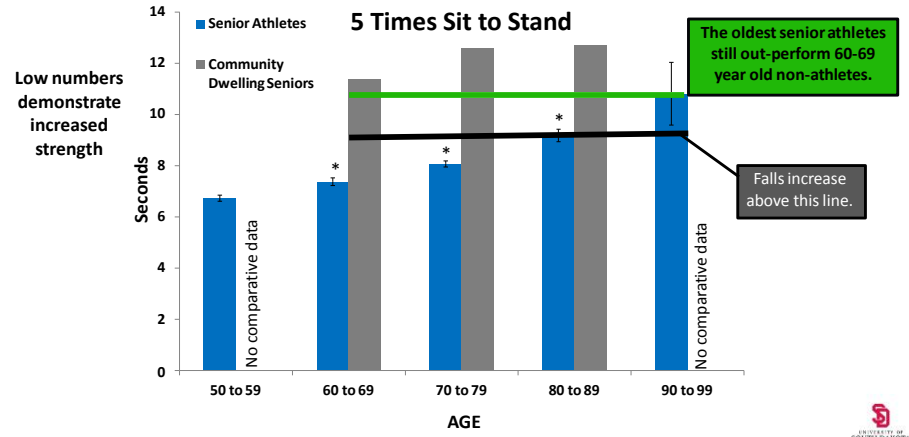
- The prevalence of diabetes in Senior Athletes stays near 5% regardless of age group.
- Athletes that compete in cardiovascular sports such as running are 74.4% less likely to have diabetes than athletes in sports with less cardiovascular challenge such as bowling.

## Five Times Sit to Stand Test

- Predicts disability[4] and falls.[5]
- A valid measure of lower extremity strength.[6]
- A strong screening tool to predict mobility decline 2 years in advance.[7]

- Standard chair height
- Arms crossed to avoid use
- Sit to stand 5 times
- Timed from "go" to final seated position after 5th stand.

## Senior Athletes Demonstrate Significantly Superior Strength [8,9]




** Indicates significance at <.0001*

## Grip Strength

Hand grip strength is predictive of mortality,[10,11] functional limitations and disability[12] 20-25 years in advance. This appears to be a stronger predictor in men.[10]

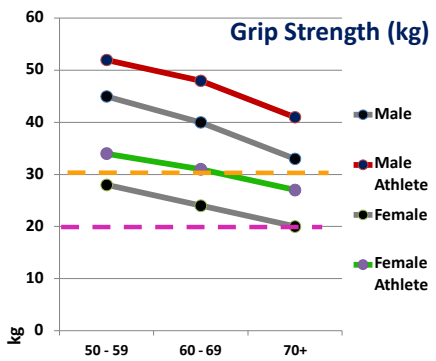
Associated with upper and lower limb strength.[13]

Supported as a screen to predict mobility disability in older adults.[14]

Older-adults with lower grip strength appear to have a lower heath-related quality of life.[15]

- Hydraulic hand dynamometer
- Average of 3 trials
- Stronger hand used for analysis
- Measured in kg

## Senior Athletes Demonstrate Significantly Superior Grip Strength[16]




Threshold for sarcopenia[17]
Men (<30 kg)
Women (<20 kg)

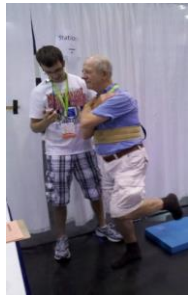
** All differences between senior athletes and non-athletes were significant with p<.0001. Cohen's d effect sizes ranged from .71-1.22.*

# Balance Testing in Senior Athletes

Eyes Open

Eyes Open On Foam

Eyes Closed



- ✓ Best of 3 trials
- ✓ Time stopped at 30 seconds
- ✓ Preferred leg

## Single Leg Stance Eyes Open

- A predictor of falls in community dwellers if below 30 seconds.[18]
- Senior athletes average 24 seconds.
- Senior athlete scores were not predictive of falls.[9]
- Senior athletes need a more difficult test.

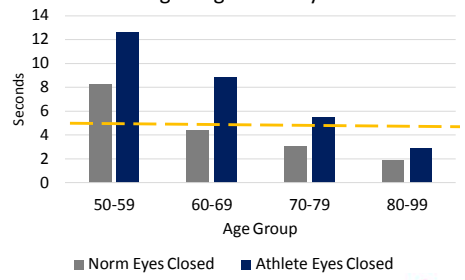
## Single Leg Stance Eyes Closed

- Senior athletes exceed all norms.[19]
- A better predictor of falls in senior athletes.
- Cut score for falls is 5.51 seconds.[9]

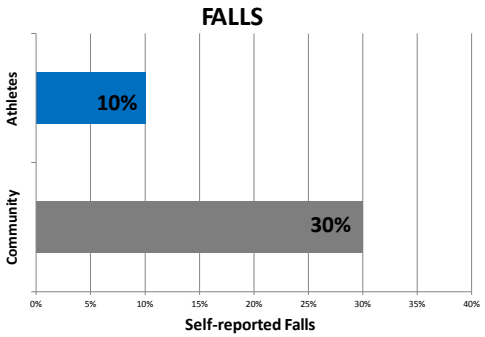
## Single Leg Stance on Foam

- No norms available
- A predictor of falls in senior athletes.[9]
- Cut Score for falls 14.27 seconds.[9]
- A combination of eyes closed and stance on foam was the best predictor of falls.[9]

Single Leg Stance Eyes Closed




## Senior Athletes Demonstrate Superior Balance and Fewer Falls[9]



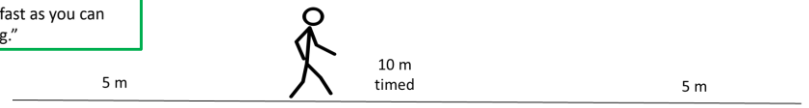

**Gait speed** is a physical performance measure useful in identifying fall risk, functional impairments, physical fitness and quality of life in older adults. It's utility is so great that it has been coined a **"vital sign"** for clinical purposes.[20]

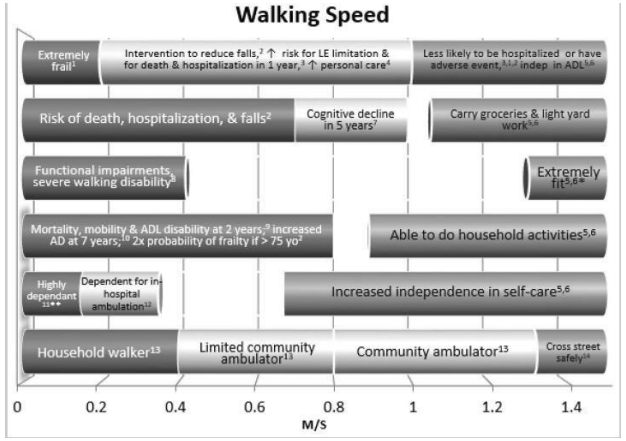

Gait speed was measured on a 10 meter walkway with an additional 5 meter acceleration and deceleration zone.

Usual: "Walk your normal pace, as if walking to the mailbox."

Fast : "Walk as fast as you can without running."

- A decline of .03 m/s per year in gait speed is considered rapid and increases mortality risk in older adults by 90%.[21]
- A usual gait speed of <1 meter/sec indicates a high risk of adverse health outcomes.[22]
- **Gait speed of ≥1.32 m/s allows an older adult to safely cross an intersection.[23]**
- Contributing variables: postural control, strength, aerobic capacity, proprioception, vision.[23]
- Fast gait speed in a valid predictor of disability in aging adults.[24]

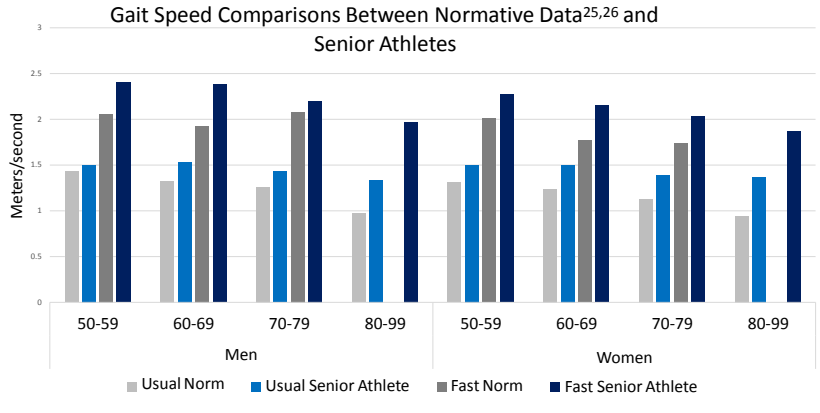





Depiction of Walking Speeds and the Associated Outcomes.[23]

Middleton A, Fritz SL, Lusardi M. Walking speed: the functional vital sign. J Aging Phys Act. 2015 Apr;23(2):314-22.

## Senior Athletes demonstrate significantly faster gait speeds



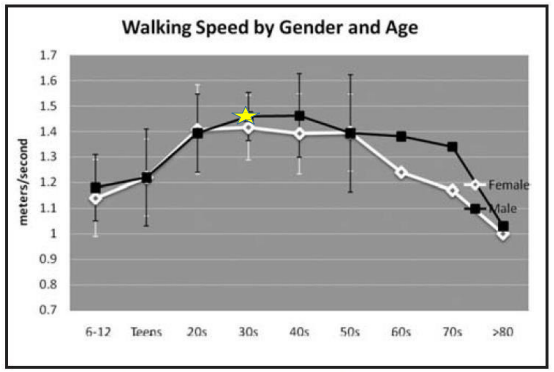




**Figure 2. Self selected walking speed categorized by gender and age (6-12 and teens,[47] 20s-50s,[42] & 60s-80s[48]).[20]**

Fritz S, Lusardi M. White paper: "walking speed: the sixth vital sign". J Geriatr Phys Ther. 2009;32(2):46-9. Erratum in: J Geriatr Phys Ther. 2009;32(3):110.

**Senior athletes walk, on average, near the speed of adults in their 30's. 1.43 m/s**☆

| Senior Athlete Usual Gait Speed | | Senior Athlete Fast Gait Speed | |
|---|---|---|---|
| N | Mean (meters/sec) | N | Mean (meters/sec) |
| 1612 | 1.43 (SD 0.22) | 1365 | 2.18 (SD 0.44) |

In the general population gait speed below **1.0 meters/second** suggests the possibility of underlying pathology and the need for further evaluation.[22]

In Senior Athletes the threshold for concern of underlying disease is **1.36 m/s usual gait speed**.[27]

Gait speeds are lower in senior athletes with ≥2 health conditions.[27]

Cardiovascular disease and diabetes mellitus seem to have the greatest impact on gait speed in Senior Athletes.[27]

## The Influence of Sport Intensity on Gait Speed[28]

| | Usual Gait Speed Mean (meters/second) | Fast Gait Speed Mean (meters/second) | *p* |
|---|---|---|---|
| Active Sport Athletes | 1.44 | 2.21 | <.0001 |
| Less Active Sport Athletes | 1.35 | 1.90 | <.0001 |

**Active Sports:** Archery, Badminton, Basketball, Cycling, Field Events, Pickleball, Race walking, Racquetball, Roadrace (5K, 10K), Softball, Swimming, Table Tennis, Tennis, Track, Triathlon, Volleyball

**Less Active Sports:** Bowling, Golf (with cart), Horseshoes, Shuffleboard

Both groups demonstrate better than average gait speed. Thus, any activity is better than being sedentary but more intense activity may be even better.

| | Usual Gait Speed m/s |
|---|---|
| Archery | 1.59* |
| Race walking | 1.55 |
| Triathlon | 1.51 |
| Cycling | 1.49 |
| Roadrace | 1.48 |
| Volleyball | 1.47 |
| Track | 1.45 |
| Tennis | 1.43 |
| Softball | 1.42 |
| Basketball | 1.41 |
| Table Tennis | 1.41 |
| Pickleball | 1.4 |
| Racquetball | 1.39 |
| Badminton | 1.39 |
| Golf (with cart) | 1.38 |
| Field Events | 1.37 |
| Swimming | 1.37 |
| Bowling | 1.36 |
| Horseshoes | 1.31 |
| Shuffleboard | 1.28 |

## Mean Gait Speed by Sport Type[28]

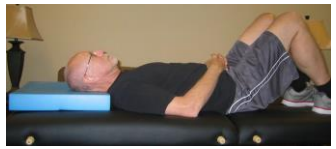
*Both usual and fast gait speeds showed a significant difference by sport type (p<.0001). Sports with an * are those with means significantly different on post hoc testing.*

| | |
|---|---|
| Senior athlete gait speed | • High usual gait speed<br>• High fast gait speeds. |
| Sports with particularly fast walkers: | • Archery (usual)<br>• Race Walking (fast) |
| Sport with slower walkers: | • Horseshoes & Shuffleboard<br>• Still exceed comm. norms |
| Significant Influences | • Specificity of training/sport<br>• Exercise volume |

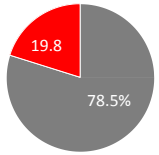
| | Fast Gait Speed m/s |
|---|---|
| Race walking | 2.73* |
| Archery | 2.52 |
| Track | 2.41 |
| Triathlon | 2.31 |
| Roadrace | 2.24 |
| Racquetball | 2.21 |
| Volleyball | 2.2 |
| Cycling | 2.18 |
| Field Events | 2.17 |
| Softball | 2.16 |
| Pickleball | 2.16 |
| Basketball | 2.13 |
| Swimming | 2.1 |
| Tennis | 2.09 |
| Badminton | 2.09 |
| Golf (with cart) | 2.05 |
| Table Tennis | 2.02 |
| Bowling | 1.86 |
| Shuffleboard | 1.83* |
| Horseshoes | 1.76* |

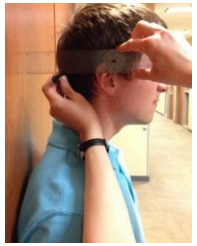
## Foam Pillow Test (FPT) for Forward Head Posture

- For senior athletes unable to lie flat for testing. A foam pillow was utilized, as needed, and documented.
- Utilized to screen for forward head posture and hyperkyphosis.
- The majority of athletes demonstrated the ability to lie flat on a firm surface in neutral.
- With a hyperkyphotic spine the neck must extend to meet the table.



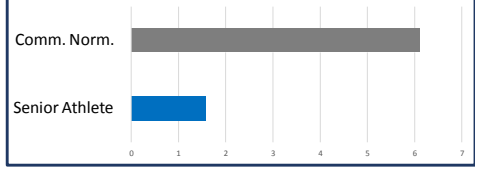
Athlete Results of Foam Pillow Test (FPT)[29]



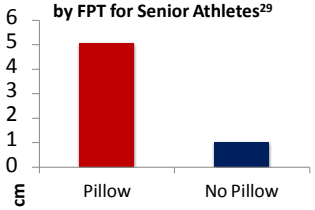



**Wall to Occiput Distance**
Athlete stands with heels touching the wall, upright with chin level. Score is 0 if occiput touches the wall. Positive results measured in cm.

**Mean Wall to Occiput (cm) Between Senior Athletes and Community-Dwelling Norms[30]**




**Mean Wall to Occiput (cm) by FPT for Senior Athletes[29]**

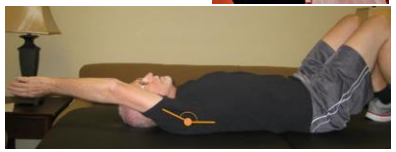



A Wall to Occiput distance of more than **0 cm** suggests the need for further examination for **osteoporosis** or potential **compression fracture**.[31,32]

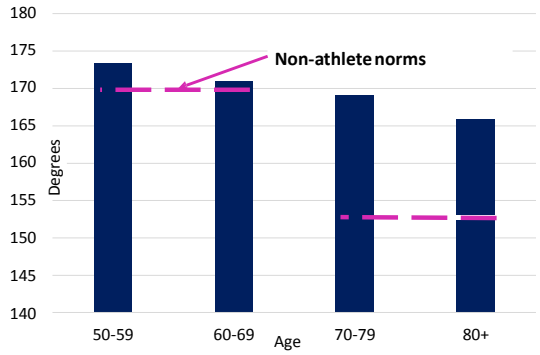
Senior Athletes enjoy a more upright posture.

Shoulder Flexion Critical for:

- Overhead reaching
- Grooming
- Spiking a volleyball
- Blocking a hit/shot
- Shooting a basketball
- Swimming

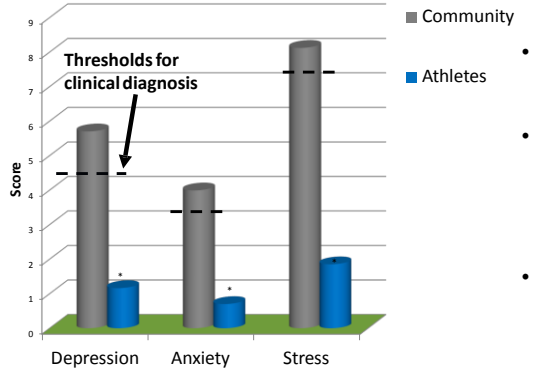


Senior Athlete Shoulder Flexion[29]




**Flexibility does decline with each decade but stays significantly above that of the average older adult (p<.0001).[33]**

## Psychological Health: Senior Athletes Demonstrate Lower Levels of Depression, Anxiety and Stress[2]




** Indicates significance at <.0001*

- Results of the Depression Anxiety and Stress Scale (DASS-21)
- Athletes demonstrate significantly lower levels of depression, anxiety and stress than non-clinical normative data.
- Results in senior athletes did not vary based on reported exercise volume, socioeconomic variables or co-morbidities.

Senior Athletes engage in purposeful exercise at rates much higher than their peers.

As a group they enjoy superior:

- CARDIOVASCULAR HEALTH
- STRENGTH
- BALANCE & FEWER FALLS
- MOBILITY
- POSTURE
- FLEXIBILITY
- MENTAL HEALTH

Decline still occurs with age, but appears to start from a higher set point which allows many athletes to stay above the threshold of disability and disease as they age.

National Senior Games Association

UNIVERSITY OF SOUTH DAKOTA SCHOOL OF HEALTH SCIENCES

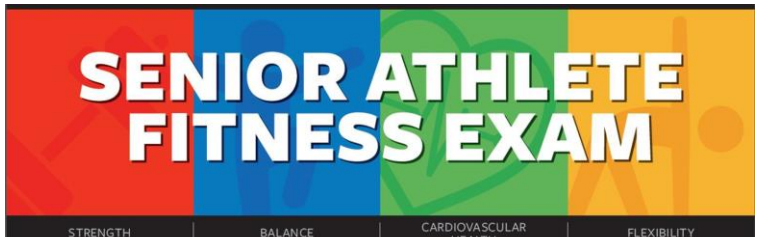
| **Senior Athlete Fitness Exam (SAFE)**<br>***A tool for the fitness screening of high-functioning senior athletes*** | | Goal |
|---|---|---|
| CARDIOVASCULAR | | |
| Blood Pressure | mmHg | <120/<80 mm Hg |
| Oxygen Saturation | % | ≥95 |
| Heart Rate | beats/min | 60-100 bpm |
| Waist Circumference (inches) | | ♀ ≤ 35”<br>♂ ≤ 40” |
| Waist to Hip Ratio | | ♀ ≤ .8<br>♂ ≤ .9 |

**Note- consider medication effects on BP and HR!**
**Consider when you complete the exam and if they have exercised before and recovered yet.**

| STRENGTH (circle dominant hand) | | |
|---|---|---|
| Grip Strength Kg-Right | kg | See chart for age and gender norms – score dominant |
| Grip Strength Kg-Left | kg | |
| Chair Stand | sec | <9 seconds |

| FLEXIBILITY | | | |
|---|---|---|---|
| Shoulder (degrees) | R | L | 168-180 degrees |
| Ankle (degrees) | R | L | 10-20 degrees<br><5 indicates fall risk |
| Hip (degrees) | R | L | 0 degrees |
| Posture<br>(needs pillow to achieve neutral supine) | Circle yes if pillow is needed. YES NO | | "NO" |

| BALANCE<br>All trials measured in seconds up to 30 seconds. | | | | |
|---|---|---|---|---|
| Single leg eyes open<br>Score is the BEST of 3 trials (circle best) | 1 | 2 | 3 | 30 seconds<br>indicates increased fall risk in community dwelling older adults |
| Single leg eyes closed<br>Score is the BEST of 3 trials (circle best) | 1 | 2 | 3 | >5 sec<br>indicates increased fall risk in senior athletes |
| Single leg on foam eyes open<br>Score is the BEST of 3 trials (circle best) | 1 | 2 | 3 | >15 sec<br>indicates increased fall risk in senior athletes |
| Usual Gait Speed<br>(meters/second) | 10 meters | sec | m/s | 1.2-1.46 m/s |
| Fast Gait Speed<br>(meters/second) | 10 meters | sec | m/s | >2 m/s |




Contact Becca Jordre, Becca.Jordre@usd.edu prior to conducting SAFE screening for detailed norms and instructions.

Becca D Jordre PT, DPT, GCS, CEEAA, Cert MDT
Associate Professor
The University of South Dakota Department of Physical Therapy 605.658.6370
Becca.Jordre@usd.edu

UNIVERSITY OF SOUTH DAKOTA
SCHOOL OF HEALTH SCIENCES

National Senior Games Association

1. Centers for Disease Control and Prevention. One in five adults meets physical activity guidelines. https://www.cdc.gov/media/releases/2013/p0502-physical-activity.html Accessed May 23, 2018.
2. Bardhoshi G, Jordre B, Schweinle W, Wollersheim Shervey S. Understanding Exercise Practices and Depression, Anxiety and Stress In Senior Games Athletes. Topics in Geriatr Rehabil.2016; 32(1): 63-71.
3. Brisk B, Jordre B, Schweinle W. Cardiovascular Disease, Diabetes and Anthropometric Measures in Competitive Senior Athletes. ExPAAC, Indianapolis, IN; Poster Presentation. July 2016.
4. Guralnik JM , Ferrucci L , Simonsick EM , Salive ME , Wallace RB . Lowerextremity function in persons over the age of 70 year LS as a predictor of subsequent disability . *N Engl J Med* . 1995 ; 332 : 556-561.
5. Buatois S , Miljkovic D , Manckoundia P , et al. Five times sit to stand test is a predictor of recurrent falls in healthy community-living subjects aged 65 and older. *J Am Geriatr Soc* 2008 ; 56 : 1575-1577.
6. Bohannon RW. Alternatives for measuring knee extension strength of the elderly at home. *Clin Rehabil*. 1998;12:434-440.
7. Wang CY, Yeh CJ, Hu MH. Mobility-related performance tests to predict mobility disability at 2-year follow-up in community-dwelling older adults. Arch Gerontol Geriatr. 2011 Jan-Feb;52(1):1-4.
8. Jordre B, Schweinle W, Beacom K, Graphenteen V, Ladwig A. The Five Times Sit to Stand Test in Senior Athletes. *J Geriatr Phys Ther*. 2013;36(1):47-50.
9. Jordre B, Schweinle W, Oetjen S, Dybsetter N, Braun M. Fall History and Associated Physical Performance Measures in Competitive Senior Athletes. Topics in Geriatr Rehabil.2016; 32(1): 1-16.
10. Gale CR, Martyn CN, Cooper C, Sayer AA. Grip strength, body composition, and mortality. Int J Epidemiol. 2007 Feb;36(1):228-35.
11. Sasaki H, Kasagi F, Yamada M, Fujita S. Grip strength predicts cause-specific mortality in middle-aged and elderly persons. Am J Med. 2007 Apr;120(4):337-42.
12. Rantanen T, Guralnik JM, Foley D, Masaki K, Leveille S, Curb JD, White L. Midlife hand grip strength as a predictor of old age disability. JAMA. 1999 Feb 10;281(6):558-60.
13. Bohannon RW. Are hand-grip and knee extension strength reflective of a common construct? Percept Mot Skills. 2012 Apr;114(2):514-8.
14. Sallinen J, Stenholm S, Rantanen T, Heliövaara M, Sainio P, Koskinen S. Hand-grip strength cut points to screen older persons at risk for mobility limitation. J Am Geriatr Soc. 2010 Sep;58(9):1721-6.
15. Sayer AA, Syddall HE, Martin HJ, Dennison EM, Roberts HC, Cooper C. Is grip strength associated with health-related quality of life? Findings from the Hertfordshire Cohort Study. Age Ageing. 2006 Jul;35(4):409-15.
16. Jordre B, Schweinle W, Aiken T, Berentschot B, LeMaster N. Grip Strength in Senior Athletes. APTA CSM Conference; Indianapolis, IN; Poster Presentation February 2015.
17. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, et al. European Working Group on Sarcopenia in Older People. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. Age Ageing. 2010 Jul;39(4):412-23.
18. Hurvitz EA, Richardson JK, Werner RA, Ruhl AM, Dixon MR. Unipedal stancetesting as an indicator of fall risk among older outpatients. Arch Phys MedRehabil. 2000 May;81(5):587-91.
19. Springer BA, Marin R, Cyhan T, Roberts H, Gill NW. Normative values for the unipedal stance test with eyes open and closed. J Geriatr Phys Ther. 2007;30(1):8-15.
20. Fritz S, Lusardi M. White paper: "walking speed: the sixth vital sign". J Geriatr Phys Ther. 2009;32(2):46-9. Erratum in: J Geriatr Phys Ther. 2009;32(3):110.
21. White DK, Neogi T, Nevitt MC, Peloquin CE et al. Trajectories of gait speed predict mortality in well-functioning older adults:the Health, Aging and Body Composition study. J Gerontol A Biol Sci Med Sci. 2013 Apr;68(4):456-64.
22. Cesari M, Kritchevsky SB, Penninx BW, et al. Prognostic value of usual gait speed in well-functioning older people--results from the Health, Aging and Body Composition Study. J Am Geriatr Soc. 2005 Oct;53(10):1675-80.
23. Middleton A, Fritz SL, Lusardi M. Walking speed: the functional vital sign. J Aging Phys Act. 2015 Apr;23(2):314-22.
24. Artaud F, Singh-Manoux A, Dugravot A, Tzourio C, Elbaz A. Decline in Fast Gait Speed as a Predictor of Disability in Older Adults. J Am Geriatr Soc. 2015 Jun;63(6):1129-36.
25. Bohannon RW, Williams Andrews A. Normal walking speed: a descriptive meta-analysis. Physiotherapy. 2011 Sep;97(3):182-9.
26. Bohannon RW. Comfortable and maximum walking speed of adults aged 20-79 years:reference values and determinants. Age Ageing. 1997 Jan;26(1):15-9.
27. Jordre B, Schweinle W, Bosma M, O'Neil K, Vance C. Gait Speed and Chronic Disease in Senior Athletes. APTA CSM Conference; Anaheim, CA; Platform Presentation. February 2016.
28. Jordre B, Schweinle W, Barber L, Divine E, Kling K. The influence of Exercise Training on Gait Speed in Senior Athletes. ExPAAC; Indianapolis, IN; Poster Presentation. July 2016
29. Jordre B, Schweinle W, Kopriva I, Carlson J, McMahon M. Forward Head Posture and Shoulder Flexibility in Senior Athletes. APTA CSM Conference; Indianapolis, IN; Poster Presentation February 2015.
30. DeBari M, Chiarlone M, Matteuzzi D et al. Thoracic kyphosis and ventilator dysfunction in unselected older persons: an epidemiological study in Dicomano, Italy. J Am Geriatr Soc. 2004; 52(6): 909-915.
31. Siminoski K, Lee K, Warshawski R. Accuracy of physical examination for detection of thoracic vertebral fractures. J Bone Miner Res. 2003;18(suppl 2):F284-S82.
32. Green AD, Colón-Emeric CS, Bastian L, Drake MT, Lyles KW. Does this woman have osteoporosis? JAMA. 2004 Dec 15;292(23):2890-900.
33. Jordre B, Schweinle W, Brown J, Lovro C, Wickett B. Flexibility of the Aging Athlete. APTA CSM Conference; San Antonio, TX; Poster Presentation. February 2017.
34. Jordre B, Schweinle W, Johnson M, OKief A, Pohlman I. Physical Performance Measures in Competitive Senior Archers. IAGG World Congress of Gerontology and Geriatrics; San Francisco, CA; Poster Presentation. July 2017.
35. McFarland K, Norman S, Paul J, Jordre B, Schweinle W. Physical Performance Measures in Senior Athlete Swimmers. SHS Research Conference; Vermillion, SD; Platform Presentation. April 2018.
36. Loudenslager M, Nour K, Bolstad T, Jordre B, Schweinle W. Physical Performance Measures that Predict Success in Competitive S enior Swimmers. SHS Research Conference; Vermillion, SD; Platform Presentation. April 2018.
37. Pelletier, L. G., Rocchi, M. A., Vallerand, R. J., Deci, E. L., & Ryan, R. M. Validation of the revised sport motivation scale (SMS-II). Psychology of Sport and Exercise. 2013; 14(3), 329-341.
38. Mammenga J, Jordre B, Schweinle W. Sport Motivation in National Senior Games Athletes. [Honors Thesis]. Vermillion, SD: The University of South Dakota: 2018.